Table of Contents for Eastman Chemical Resins, Inc. SIP Package
RACT 2 Case-by-Case Evaluation
Installation Permit No. 0058-I026

Pennsylvania Department of Environmental Protection
Bureau of Air Quality

RACT SIP COMPLETENESS CHECKLIST

TO BE FILLED IN BY REGIONAL STAFF AND SUBMITTED TO CENTRAL OFFICE

Facility Name: _Eastman Chemical Resins, Inc.___________

RACT Plan Approval/Permit Number: _Installation Permit No. 0058-I026 ____

Plan Approval/Permit Issuance Date: _April 21, 2020 ___________________

TECHNICAL MATERIALS

Included	Not Included	Not Applicable	
☒	☐	☐	**Identification of all regulated (NOx and VOC) pollutants affected by the RACT plan (Review memo and RACT Permit)**
☒	☐	☐	**Quantification of the changes in plan allowable emissions from the affected sources as a result of RACT implementation. (Review Memo)**
☒	☐	☐	**Rationale as to why applicable CTG or ACT regulation is not RACT for the facility. (Review Memo)**
☐	☐	☒	**Demonstration that the NAAQS, PSD increment, reasonable further progress demonstration, and visibility, as applicable, are protected if the plan is approved and implemented. (Review Memo)**
☐	☐	☒	**In the event of actual emission increase as a result of RACT SIP revision: Modeling information to support the proposed revision, including input data, output data, model used, ambient monitoring data used, meteorological data used, justification for use of offsite data (where used), modes of models used, assumptions, and other information relevant to the determination of adequacy of the modeling analysis. (Review Memo)**
☐	☐	☒	**Include evidence, where necessary that emission limitations are based on continuous emission reduction technology. (Review Memo)**
☒	☐	☐	**State in RACT PA/OP that expiration date shown in PA or OP is for state purposes. Either use the statement below or redact the expiration date on the permit.** **(Sample: The expiration date shown in this permit is for state purposes. For federal enforcement purposes the conditions of this operating permit which pertain to the implementation of RACT regulations shall remain in effect as part of the State Implementation Plan (SIP) until replaced pursuant to 40 CFR 51 and approved by the U.S. Environmental Protection Agency (EPA). The operating permit shall become enforceable by the U.S. EPA upon its approval of the above as a revision to the SIP.) (RACT Permit)**
☐	☐	☒	**Include evidence that the State has the necessary legal authority under State law to adopt and implement the RACT plan. (Reference of PA's Air Pollution Control Act (January 8, 1960, P.L. 2119, as amended and 25 PA Code Chapter 127 (NSR), and 25 PA Code Chapter 129 §§129.91 – 95 in RACT PA/OP). (Review memo or more likely operating permit)**

(Back)

☒	☐	☐	**State that independent technical and economic justification for RACT determination by the Department was performed. As long as you reviewed the companies proposal you may agree with it but that must be stated. (Review memo)**
☐	☐	☒	**Confidential Business Information excluded, highlighted or marked. Please also redact all checks from the application. (Review Memo, RACT Permit, RACT Plan by the company)**
☒	☐	☐	**Adequate compliance demonstration, monitoring, recordkeeping, work practice standards, and reporting requirements. (Review memo and RACT Permit)**

ADMINISTRATIVE DOCUMENTS

Attached	Not Attached	Not Applicable	
☒	☐	☐	**Signed copy of final RACT Plan Approval/Operating Permit.**
☒	☐	☐	**Redacted copy of the RACT Plan Approval/Operating Permit. Reviewer should be able to read the redacted text. (We can do electronically if the PA/OP is uploaded in AIMS or available in pdf format). Make sure that the expiration date of the operating permit is redacted. SIPs do not expire.**
☒	☐	☐	**Signed Technical Support Document or Review Memorandum. The review memo should contain a discussion about previous case by case RACT determinations so that requirements can be compared**
☒	☐	☐	**Public Notice evidence: Include a copy of the actual published notice of the public hearing as it appeared in the local newspaper(s). The newspaper page must be included to show the date of publication. The notice must specifically identify by title and number each RACT regulation adopted or amended. A signed affidavit showing the dates of publication and the newspaper clipping is best. Next best is a copy of the newspaper clippings from all days the article was published. An email showing that the newspaper article was purchased is acceptable unless the EPA receives comments during their comment period stating that there is no proof of publication. The newspaper notice must say that the case by case requirements will be submitted to the EPA as an amendment to the SIP**
☒	☐	☐	**A separate formal certification duly signed indicating that public hearings were held. If no public hearings were held the review memo should state that.**
☒	☐	☐	**Public hearing minutes: This document must include certification that the hearing was held in accordance with the information in the public notice. It must also list the RACT regulations that were adopted, the date and place of the public hearing, and name and affiliation of each commenter. If there were no comments made during the notice period or at the hearing, please indicate that in the review memo.**
☒	☐	☐	**Comment and Response Document: A compilation of EPA, company, and public comments and Department's responses to these comments.**
☒	☐	☐	**Copy of RACT proposal, amendments, and other written correspondence between the Department and the facility.**

ALLEGHENY COUNTY HEALTH DEPARTMENT

AIR QUALITY PROGRAM
301 39th Street, Bldg. #7
Pittsburgh, PA 15201-1811

Major Source
INSTALLATION PERMIT

Issued To:	**Eastman Chemical Resins, Inc.** **Jefferson Site** 2200 State Highway 837 West Elizabeth, PA 15088-0545	**ACHD Permit#:**	**0058-I026**
		Date of Issuance:	April 21, 2020
		~~Expiration Date:~~	~~(See Section III.12)~~

Issued By: Digitally signed by JoAnn Truchan, PE Date: 2020.04.22 09:09:00 -04'00'
JoAnn Truchan, P.E.
Section Chief, Engineering

Prepared By: Digitally signed by Helen Gurvich Date: 2020.04.22 08:54:50 -04'00'
Helen O. Gurvich
Air Quality Engineer

IV. SITE LEVEL TERMS AND CONDITIONS

Pages 2 through10 have been redacted.

1. Reporting of Upset Conditions (§2103.12.k.2)

The permittee shall promptly report all deviations from permit requirements, including those attributable to upset conditions as defined in Article XXI §2108.01.c, the probable cause of such deviations, and any corrective actions or preventive measures taken.

2. Visible Emissions (§2104.01.a)

Except as provided for by Article XXI §2108.01.d pertaining to a cold start, no person shall operate, or allow to be operated, any source in such manner that the opacity of visible emissions from a flue or process fugitive emissions from such source, excluding uncombined water:

a. Equal or exceed an opacity of 20% for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or,
b. Equal or exceed an opacity of 60% at any time.

3. Odor Emissions (§2104.04) (County-only enforceable)

No person shall operate, or allow to be operated, any source in such manner that emissions of malodorous matter from such source are perceptible beyond the property line.

4. Materials Handling (§2104.05)

The permittee shall not conduct, or allow to be conducted, any materials handling operation in such manner that emissions from such operation are visible at or beyond the property line.

5. Operation and Maintenance (§2105.03)

All air pollution control equipment required by this permit or any order under Article XXI, and all equivalent compliance techniques approved by the Department, shall be properly installed, maintained, and operated consistently with good air pollution control practice.

6. Open Burning (§2105.50)

No person shall conduct, or allow to be conducted, the open burning of any material, except where the Department has issued an Open Burning Permit to such person in accordance with Article XXI §2105.50 or where the open burning is conducted solely for the purpose of non-commercial preparation of food for human consumption, recreation, light, ornament, or provision of warmth for outside workers, and in a manner which contributes a negligible amount of air contaminants.

7. Shutdown of Control Equipment (§2108.01.b)

a. In the event any air pollution control equipment is shut down for reasons other than a breakdown, the person responsible for such equipment shall report, in writing, to the Department the intent to shut down such equipment at least 24 hours prior to the planned shutdown. Notwithstanding the submission of such report, the equipment shall not be shut down until the approval of the Department is obtained; provided, however, that no such report shall be required if the source(s)

Pages 12 through 17 have been redacted.

erosion or other means;

d. The adoption of work or other practices to minimize emissions;

e. Enclosure of the source; and

f. The proper hooding, venting, and collection of fugitive emissions.

25. Episode Plans (§2106.02)

The permittee shall upon written request of the Department, submit a source curtailment plan, consistent with good industrial practice and safe operating procedures, designed to reduce emissions of air contaminants during air pollution episodes. Such plans shall meet the requirements of Article XXI §2106.02.

26. New Source Performance Standards (§2105.05)

a. It shall be a violation of this permit giving rise to the remedies provided by §2109.02 of Article XXI for any person to operate, or allow to be operated, any source in a manner that does not comply with all requirements of any applicable NSPS now or hereafter established by the EPA, except if such person has obtained from EPA a waiver pursuant to Section 111 or Section 129 of the Clean Air Act or is otherwise lawfully temporarily relieved of the duty to comply with such requirements.

b. Any person who operates, or allows to be operated, any source subject to any NSPS shall conduct, or cause to be conducted, such tests, measurements, monitoring and the like as is required by such standard. All notices, reports, test results and the like as are required by such standard shall be submitted to the Department in the manner and time specified by such standard. All information, data and the like which is required to be maintained by such standard shall be made available to the Department upon request for inspection and copying.

27. Miscellaneous Organic Chemical Manufacturing NESHAP (40 CFR Part 63, Subpart FFFF)

The permittee shall comply with all applicable requirements of the National Emission Standards for Hazardous Air Pollutants, 40 CFR Part 63, Subpart FFFF – the "Miscellaneous Organic Chemical Manufacturing NESHAP" or "MON". [25 PA Code §129.99; 25 PA Code §129.100]

V. EMISSION UNIT LEVEL TERMS AND CONDITIONS

A. C-5 – Storage Tanks

~~1. **Restrictions:**~~

~~The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit(s) associated with the C5 VOC storage tanks. [§2102.04.b.5]~~

2. **Work Practice Standard:**

a. The permittee shall do the following for all VOC storage tanks and associated equipment: [§2105.03, 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in according with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The VOC storage tanks shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

B. C-5 Operations – Pastillating Belts #1 and #2 (S055)

~~1. Restrictions:~~

~~The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit(s) associated with Pastillating Belts #1 and #2. [2102.04.b.5]~~

2. Work Practice Standard:

a. The permittee shall do the following for Pastillating Belts #1 and #2 and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The Pastillating Belts #1 and #2 shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

C. MP Poly Unit (S034)

1. Restrictions:

a. ~~The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit(s) associated with the MP Poly Unit. [2102.04.b.5]~~

b. The permittee shall properly maintain and operate the condensers E-500-5, E-701-5, and E-701-4 at all times when emissions are routed to them. [§2105.03; RACT Order #257, condition 1.7; 25 PA Code §129.99]

c. The inlet coolant temperature to the condenser E-701-4 (S034) shall not exceed 10°C (50°F) over any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions. [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.2.A; 25 PA Code §129.99]

d. If measured one-hour block average exit vapor temperatures for the condenser E-701-4 (S034) exceed 35°C from the condenser, the permittee shall take the following actions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.1.C ;25 PA Code §129.99]

   a) Confirm that the glycol cooler is operating properly by reviewing current operating conditions (e.g. that the chiller system is operating and circulating coolant, and that glycol coolant is being supplied at less than 10°C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°C. Exit vapor temperature exceeding 35°C due to solely to high ambient temperatures shall be documented per paragraph b.
   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 35°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 50°F (10°C), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.
   c) Periods of exit vapor temperatures in excess of 35°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

2. Monitoring Requirements:

a. The permittee shall install, operate, and maintain an inlet coolant temperature instrument on E-701-4 condenser that continuously monitors the coolant inlet temperature at all times when emissions are routed to it. The temperature probes used shall be certified by the manufacturer to be accurate to within 2% of the temperature measured in Celsius or to within 2.5°C, whichever is greater. The permittee shall record the coolant inlet temperature at least once every 15 minutes while the equipment associated with the temperature probe and transmitter is in operation. [§2102.04.b.6; §2103.12.i; RACT Order #257, condition 1.1 and 1.2; 25 PA Code §129.99]

3. Record Keeping Requirements:

a. The permittee shall keep and maintain records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

4. Work Practice Standard:

a. The permittee shall do the following for MP Poly Unit (filtrate system: filtrate receiver, neutralizer, solvent wash tank, heel tank, Funda filter) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The MP Poly Unit (filtrate system: filtrate receiver, neutralizer, solvent wash tank, heel tank, Funda filter) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

D. WW Poly Unit (S013, S020, S023, S027)

1. Restrictions:

a. ~~The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit(s) associated with the WW Poly Unit. [2102.04.b.5]~~

b. Refrigerated vent condensers [E-200-7 (S013), E-900-7 (S020), E-903-3 (S023), and E-901-7 (S027)]: The condensers shall be properly maintained and operated according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, conditions 1.3 and 1.4; 25 PA Code §129.99]

1) The inlet coolant temperature to each condenser shall not exceed 10°C in any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions;
2) The exit vapor temperature of each condenser shall not exceed 35°C over any one-hour block average when emissions are being routed through them, except as specified in condition V.A.1.e.3) below;
3) If measured one-hour block average exit vapor temperatures exceed 35°C from a condenser, the permittee shall take the following actions:
   a) Confirm that the glycol cooler is operating properly by reviewing current operating conditions (e.g. that the chiller system is operating and circulating coolant, and that glycol coolant is being supplied at less than 10°C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°C. Exit vapor temperature exceeding 35°C due to solely to high ambient temperatures shall be documented per paragraph b.
   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 35°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 50°F (10°C), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.

   c) Periods of exit vapor temperatures in excess of 35°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

2. Monitoring Requirements:

a. The permittee shall install, operate, and maintain an inlet coolant temperature instrument on E-200-7, E-900-7, E-901-7, and E-903-3 condensers that continuously monitor the coolant inlet temperature. The temperature probes used shall be certified by the manufacturer to be accurate to within 2% of the temperature measured in Celsius or to within 2.5°C, whichever is greater. The permittee shall record the coolant inlet temperature at least once every 15 minutes while the equipment associated with the temperature probe and transmitter is in operation. [§2102.04.b.6; §2103.12.i; RACT Order #257, conditions 1.1 -1.3; 25 PA Code §129.99]

3. Record Keeping Requirements:

a. The permittee shall keep and maintain records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

b. The permittee shall keep records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment. [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]

4. Work Practice Standard:

a. The permittee shall do the following for WW Poly Unit (feed dryers and regeneration, west filtrate receiver, solvent wash receiver, and east filtrate receiver) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The WW Poly Unit (feed dryers and regeneration, west filtrate receiver, solvent wash receiver, and east filtrate receiver) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

E. WW Poly Storage Tanks (S025)

1. Restrictions:

~~a. The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with the WW Poly Storage Tanks. [2102.04.b.5]~~

b. The inlet coolant temperature to the condenser E-202-1 shall not exceed 10°C (50°F) over any one-hour block average when emissions are routed through the condensers with the exception of activities to mitigate emergency conditions. [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.4; 25 PA Code §129.99]

2. Record Keeping Requirements:

a. The permittee shall keep and maintain records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

b. The permittee shall keep records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment. [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]

3. Work Practice Standard:

a. The permittee shall do the following for WW Poly storage tanks (73, 75, 76, 77) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The WW Poly storage tanks (73, 75, 76, 77) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

F. LTC Process Operations (S108, S109, S110, S111, S112, S113, S114)

1. Restrictions:

~~a. The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with the LTC Process Operations. [2102.04.b.5]~~

b. Cooling tower water chilled vent condensers [E-301B-E3 (S109); E-301-4 (S108); E-607-2 (S110); E-RK5-4 (S111); E-RK6-3 (S112); E-RK7-4 (S113)]: The condensers shall be properly operated and maintained according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.1.H; 25 PA Code §129.99]

1) The inlet coolant temperature to each condenser shall not exceed 10°F (5.6°C) above ambient air temperature over any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions and except that at no time will coolant temperature be required to be less than 50°F (10°C).
2) The exit vapor temperature of each condenser shall not exceed 40°C over any one-hour block average when emissions are being routed through them, except as specified in paragraph 3).
3) If measured one-hour block average exit vapor temperatures exceed 40°C from a condenser, the permittee shall take the following actions:
   a) Confirm that the cooling tower is operating properly by reviewing current operating conditions (e.g. that the cooling system is operating and circulating cooling water, and that cooling water is being supplied at less than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to less than 50°F (10 °C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to less than 50°F (10 °C)). Exit vapor temperature exceeding 40°C due to solely to high ambient temperatures shall be documented per paragraph b.

   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 40°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to be less than 50°F (10°C)), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.

   c) Periods of exit vapor temperatures in excess of 40°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

c. The vacuum leak rate from the #1 shall not exceed 10 lb/hr. The vacuum leak rate from #2 LTC Vacuum System shall not exceed 15 lb/hr. Compliance with this condition shall be demonstrated during regular compliance testing performed at least once every five years after the most recent stack test. [§2102.04.b.6; §2102.04.e; 25 PA Code §129.99 & §129.100]

2. **Record Keeping Requirements:**

a. The permittee shall keep and maintain the following data on-site for these operations [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]:

1) All records of monitoring required by V.A.3 above.
2) Records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment.
3) Maximum resin (lb/min) and polymerizate (gal/min) feed rates (daily).
4) Amount (lbs.) and type of resin and polymerizate (monthly, 12-month rolling total)
5) Changes in #4 LTC Vacuum System vacuum pump status (upon occurrence).

3. **Work Practice Standard:**

a. The permittee shall do the following for LTC Process (#1 and #2 Vacuum systems and #1/#2 Pastillator Belt) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
2) Keep records of any maintenance; and
3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The LTC Process (#1 and #2 Vacuum systems and #1/#2 Pastillator Belt) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

G. Dresinate Production Line (S085)

~~1. Restrictions:~~

~~The permittee shall continue to comply with all regulatory and Permit requirements. [2102.04.b.5]~~

2. Work Practice Standard:

a. The permittee shall do the following for Dresinate Production Line (Double Drum Dryer) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The Dresinate Production Line (Double Drum Dryer) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

H. Hydrogenation Unit (S004, S007, S012)

1. Restrictions:

a. The maximum production rate for Hydrogenation Unit process shall not exceed 22 million pounds per 12-month rolling period. [§2102.04.e; 25 PA Code §129.99]

b. Refrigerated vent condensers E-104-2 (S012), E-201-2 (S004), E-403-2 (S007): The condensers shall be properly maintained and operated according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, conditions 1.3 and 1.4; 25 PA Code §129.99]
1) The outlet coolant temperature shall not exceed at any time 40°F.
2) Instrumentation shall be provided to continuously monitor the coolant outlet temperature of each condenser to within one (1) degree Fahrenheit at all times.

2. Record Keeping Requirements:

a. The permittee shall keep and maintain production records and records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

b. The permittee shall keep records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment. [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]

~~**3. Monitoring Requirements:**~~

~~a. The permittee shall monitor and record the exit vapor temperature of each refrigerated vent condensers at least once every 15 minutes when the process is in operation. [§2102.04.b.6, §2102.04.e., §2103.12.i]~~

4. Work Practice Standard:

a. The permittee shall do the following for Hydrogenation Unit (tanks 103 and 104, catalyst catch tank, Mott filter, Heel tank, Vent tanks, Autoclaves #1 and #2, Storage tanks 102, 105, 106) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
2) Keep records of any maintenance; and
3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The Hydrogenation Unit (tanks 103 and 104, catalyst catch tank, Mott filter, Heel tank, Vent tanks, Autoclaves #1 and #2, Storage tanks 102, 105, 106) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

I. Wastewater Treatment Plant (F027, F033, F034, F035)

1. Work Practice Standard:

a. The permittee shall do the following for Wastewater Treatment Plant (Bioaeration tank, tanks 702A, 702B, and 702C) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]

1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
2) Keep records of any maintenance; and
3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The Wastewater Treatment Plant (Bioaeration tank, tanks 702A, 702B, and 702C) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

Pages 31 through 32 have been redacted.

ALLEGHENY COUNTY HEALTH DEPARTMENT
AIR QUALITY PROGRAM

April 21, 2020

SUBJECT: **Reasonably Available Control Technology (RACT II) Determination**
Eastman Chemical Resins, Inc.
Jefferson Site
2200 State Highway 837,
West Elizabeth, PA 15088-7311
Allegheny County

Installation Permit No. 0058-I026

TO: JoAnn Truchan, P.E.
Section Chief, Engineering

FROM: Helen O. Gurvich
Air Quality Engineer

I. Executive Summary

Eastman Chemical Resins, Inc., Jefferson Site facility (Eastman) is defined as a major source of VOC emissions and was subjected to a Reasonable Achievable Control Technology (RACT II) review by the Allegheny County Health Department (ACHD) required for the 1997 and 2008 Ozone National Ambient Air Quality Standard (NAAQS). The findings of the review established that the facility has few technically feasible controls options for controlling VOC emissions from the processes, but they are deemed financially infeasible due to their high cost per ton removed.

These findings are based on the following documents:

- RACT analysis performed by ERG (Eastman Chemical RACT Evaluations_9-23-15.docs)
- RACT analysis performed by Eastman Chemical Resins, Inc. (Eastman_RACT2_Report_20200115.pdf)
- Installation Permit No. 0058-I011d dated 5/15/2019
- Installation Permit No. 0058-I018a dated 3/07/2019
- Installation Permit No. 0058-I022a dated 9/20/2019
- Installation Permit No. 0058-I023a dated 12/23/2019
- Installation Permit No. 0058-I016a dated 04/14/2020
- Installation Permit No. 0058-I012a dated 10/30/2008
- Installation Permit No. 0058-I017 dated 7/22/2010
- New Installation Permit Application submitted at December 13, 2019
- New Installation Permit Application submitted at January 24, 2020

II. Regulatory Basis

ACHD requested all major sources of NO_X (potential emissions of 100 tons per year or greater) and all major sources of VOC (potential emissions of 50 tons per year or greater) to reevaluate NO_X and/or VOC RACT for incorporation into Allegheny County's portion of the PA SIP. This document is the result of ACHD's determination of RACT for Eastman based on the materials submitted by the subject source and other relevant information.

III. Facility Description

The Eastman Chemical Resins, Inc., Jefferson Site facility (Eastman) produces synthetic hydrocarbon resins from C_5 feedstock, monomers, solvents and catalysts by way of cationic polymerization. Resins produced include aliphatic, aliphatic/aromatic, aromatic and liquid resins for use in adhesives, plastics, rubber, graphic arts and numerous other products.

The plant is comprised of three polymerization processes (C5, MP-Poly, and WW-Poly), a resin hydrogenation process, four finishing processes (LTC1, LTC2, and C-5), and an emulsion process, five boilers ranging from 18.6 MM Btu/hr to 38.2 MM Btu/hr, a wastewater treatment plant, a pilot plant for testing formulations and processes and approximately 200 storage tanks of various sizes.

The facility is a major source of Volatile Organic Compounds (VOC) and Hazardous Air Pollutants (HAPs) as defined in Article XXI, 2101.20. Detailed descriptions of the relevant emissions units are provided in the following tables.

The installation permit numbers listed are just for reference and are not incorporated into the SIP.

Table 1 Facility Sources Subject to Case-by-Case RACT II and Their Existing RACT I Limits

Source ID	Description	Rating	VOC PTE (TPY)	VOC Presumptive Limit (RACT II)	VOC Limit (RACT I) – Consent Order No. 257
S055	Pastillating Belts, UHF Filter – C-5 operations (IP #0058-I018a)	22,000 lbs/hr	6.21	25 Pa Code 129.99	Good operating practices
S034	Filtrate system (filtrate receiver, neutralizer, solvent wash tank, heel tank, Funda filter) – MP Poly Unit (IP #0058-I022a)	103,000,000 lbs/yr	10.33	25 Pa Code 129.99	Condensers, good operating practices
S013	Feed dryers and regeneration – WW Poly Unit (IP #0058-I023a)	80,000,000 lbs/yr	4.86	25 Pa Code 129.99	Condensers, good operating practices
S020	West Filtrate Receiver - WW Poly Unit (IP #0058-I023a)	80,000,000 lbs/yr	5.11	25 Pa Code 129.99	Condensers, good operating practices
S023	Solvent Wash Receiver - WW Poly Unit (IP #0058-I023a)	80,000,000 lbs/yr	7.52	25 Pa Code 129.99	Good operating practices
S027	East Filtrate Receiver - WW Poly Unit (IP #0058-I023a)	80,000,000 lbs/yr	5.11	25 Pa Code 129.99	Good operating practices
S025	Storage Tanks 73/75/76/77- WW Poly Unit (IP #0058-I023a)	75,200 gal each	5.4	25 Pa Code 129.99	Good operating practices
S109	#1 Vacuum System – LTC Process (IP #0058-I016a)	67,240,000 lbs/yr	3.80	25 Pa Code 129.99	Good operating practices
S110	#2 Vacuum System – LTC Process (IP #0058-I016a)	67,240,000 lbs/yr	8.09	25 Pa Code 129.99	Good operating practices
S114	#1/#2 Pastillator Belt – LTC Process (IP #0058-I016a)	67,240,000 lbs/yr	2.80	25 Pa Code 129.99	Good operating practices
S004	Metering Tanks (tanks 103 and 104, catalyst catch tank, Mott filter, Heel tank) – Hydrogenation Unit (based on December 2019 testing by Eastman)	22,500,000 lbs/yr	13	Throughput restriction of 22.5 MM lbs/yr, 25 Pa Code 129.99	Condensers, good operating practices
S012	Storage tanks 102, 105, 106 - Hydrogenation Unit (based on December 2019 testing by Eastman)	2 - 6,000 gal each; 1 – 10,000 gal	6.3	Throughput restriction of 22.5 MM lbs/yr, 25 Pa Code 129.99	Condensers, good operating practices
S007	Vent tanks, Autoclaves #1 and #2 - Hydrogenation Unit (based on December 2019 testing by Eastman)	Autoclaves - 1,000 gal each	15	Throughput restriction of 22.5	Condensers, good operating practices

Source ID	Description	Rating	VOC PTE (TPY)	VOC Presumptive Limit (RACT II)	VOC Limit (RACT I) – Consent Order No. 257
				MM lbs/yr, 25 Pa Code 129.99	
F033, F034, F035	Tanks 702A, 702B, 702C – Wastewater Treatment Plant (new IP application)	50,000 gal each	8.84	25 Pa Code 129.99	Good operating practices
F027	Bio Aeration Tank - Wastewater Treatment Plant (new IP application)	157,000 gal	15.25	25 Pa Code 129.99	Good operating practices
S085	Double Drum Dryer – Dresinate Production Line (IP #0058-I012a)	500 lbs/hr	5.48	25 Pa Code 129.99	Good operating practices
	Fugitive Emissions from Equipment Leaks (valves, pumps, pipe connectors, etc.)	NA	64.10	25 Pa Code 129.99	LDAR program

Table 2 Facility Sources Subject to Presumptive RACT II per PA Code 129.97

Description	Rating	Stack ID	VOC PTE (TPY)	Basis for Presumptive	Presumptive RACT Requirement
C-5 Operations (Installation Permit #0058-I011d)					
Resin Kettles #9 and #10	140 MM lbs/yr	S053, S054	1.81	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Resin Storage Tanks (121, 123, 124, 366, 367, 601 & 602)	19,432 – 108,291 gal	S064, S066, S097, S267 – S270	1.774	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Resin Storage Tank 504 and 161	60,914 & 158,630 gal	S059, S238	2.00	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Raw material tank T-50	528,765 gal	S216	2.8	25 PA Code 129.96(b)	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Raw material tank T-54	1,469,451 gal	S060	1.66	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Raw material tank T-55	579,586 gal	S061	1.16	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
C-5 Operations (Installation Permit #0058-I018a)					
Pastillating Belts (Fugitive)	22,000 lbs/hr	S055	1.09	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices

Description	Rating	Stack ID	VOC PTE (TPY)	Basis for Presumptive	Presumptive RACT Requirement
C-5 Operations (Installation Permit #0058-I017)					
Storage tank 52	525,000 gal	S218	2.37	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
MP Polymerization Unit (Installation Permit #0058-I022a)					
Reactor	103 MM lbs/yr	S029	1.65	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
WW Polymerization Unit (Installation Permit #0058-I023a)					
North and South Reactors	80 MM lbs/yr	S017	1.78	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Storage tanks 68/69/74	75,200 gal each	S024	1.4	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
WW Polymerization Unit (new IP application)					
Storage Tank 35	169,000 gal	S075	1.0	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
LTC Process Operations (Installation Permit #0058-I016a)					
#4 Vacuum System	67.24 MM lb/yr	S124	1.46	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Hydrogenation Unit (based on December 2019 testing)					
Storage tanks 100 and 101	6,000 gal each	S001	1.2	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Pilot Plant (new IP application)					
Neutralizer and reactor	21 acfm	S155	2.2	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Emulsion Process (based on stack testing in 2007)					
Tank RK2	1,000 gal	NA	1.21	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Other Storage Tank (new IP application)					

Description	Rating	Stack ID	VOC PTE (TPY)	Basis for Presumptive	Presumptive RACT Requirement
Storage Tank 78	169,000 gal	S232	1.0	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices

Table 3 Facility Sources Exempt from RACT II per PA Code 129.96(c) {< 1 TPY NO_X; < 1 TPY VOC}

Description	Rating	Stack ID	VOC PTE (TPY)
C-5 Operations (Installation Permit #0058-I011d)			
Thermal Oxidizer or Carbon Beds for 500 battery tanks, if TO downtime	140 MM lbs/yr	S044 S044A	0.26
Hot Oil Furnace	10.33 MMBtu/hr	S056	0.29
Resin Kettle #8	140 MM lbs/yr	S052	0.38
Sparkler Filter with condenser	140 MM lbs/yr	S312	0.05
Sparkler Precoat	140 MM lbs/yr	NA	0.01
Resin Product Loading	140 MM lbs/yr	NA	0.94
Raw material tank T-500	112,251 gal	S058	0.19
Raw material tank T-511	15,228 gal	S274	0.1
MP Polymerization Unit (Installation Permit #0058-I022a)			
Storage tank T-301	75,202 gal	NA	0.46
Storage tank T-302	75,202 gal	NA	0.46
Storage tank T-303	75,202 gal	NA	0.46
Preblend Tank	103 MM lbs/yr	S035	0.99
Dryers regeneration, Precoat tank, Mole sieve drain tank	103 MM lbs/yr	S033	0.51
WW Polymerization Unit (Installation Permit #0058-I023a)			
Feed Dryer regeneration	404 reg/yr	S013a	0.01
East Preblend tank	80 MM lbs/yr	S014	0.57
North Preblend tank	80 MM lbs/yr	S015	0.57
Slurry tank	80 MM lbs/yr	S016	0.02
North Neutralizer	80 MM lbs/yr	S018	0.31
Funda Filter Steam Out/Flushing	80 MM lbs/yr	S019	0.01
Funda Filter Condensate Tank	80 MM lbs/yr	S019a	0.00
South Neutralizer	80 MM lbs/yr	S021	0.31
Reclaim Pot	80 MM lbs/yr	S022	0.13
Storage Tank 10	110,159 gal	S195	0.29
Storage Tank 22	15,863 gal	S206	0.03
Storage Tank 24	15,863 gal	S208	
Storage Tank 23	15,863 gal	S207	0.03
Storage Tank 25	15,863 gal	S209	
Storage Tank 27	16,257 gal	S211	0.04
Storage Tank 26	16,257 gal	S210	0.42
Storage Tank 28	16,257 gal	S212	
Storage Tank 29	16,257 gal	S213	
Storage Tank 34	169,000 gal	S074	0.27
Storage Tank 71	75,200 gal	S230	0.29
Storage Tank 72	75,200 gal	S231	0.42
Storage Tank 200	25,381 gal	S239	0.18
Storage Tank 201	25,381 gal	S240	
Storage Tank 202	25,381 gal	S241	
Storage Tank 204	41,878 gal	S300	0.04
Storage Tank 205	25,381 gal		
Storage Tank 206	25,381 gal		
Storage Tank 207	25,381 gal		
Storage Tank 66	75,200 gal	S228	0.3

Description	Rating	Stack ID	VOC PTE (TPY)
Storage Tank 67	75,200 gal	S026	0.9
LTC Process Operations (Installation Permit #0058-I016a)			
Reclaim Solution Tank	67.24 MM lbs/yr	S108	0.58
Resin Kettle #5	67.24 MM lbs/yr	S111	0.32
Resin Kettle #6	67.24 MM lbs/yr	S112	0.24
Resin Kettle #7	67.24 MM lbs/yr	S113	0.68
Berndorf Belt	67.24 MM lbs/yr	S165	0.53
#1/#2 oil/water separator	67.24 MM lbs/yr	S110A	0.01
#4 oil/water separator	67.24 MM lbs/yr	S125	0.01
Drumming operation	67.24 MM lbs/yr	NA	0.18
Truck loading	67.24 MM lbs/yr	NA	0.37
LTC #2 Heater	8.8 MM Btu/hr	S107	0.25
LTC #4 Heater	10 MM Btu/hr	S119	0.28
Wastewater Treatment Plant (new IP application)			
Tanks 701A and 701B, Back Porch Sumps	Tanks – 50,000 gal each; sumps – 17,500 gal total	S147	0.48
Bio Clarifier	55,000 gal	F028	0.11
Sludge Batch Tank	5,200 gal	F036	0.00
Sludge Solids Handling	6,000 gal	F037	0.00
Dresinate Production Line (Installation Permit #0058-I012a)			
Tank R-1-A	67,631 gal	S187	0.01
Tank 782	10,000 gal	S290	0.01
Emulsion Process (based on stack testing in 2007)			
Tank RK1	1,000 gal	-	0.67
Blend tanks 1, 2, 3, and 4	1,2 – 6,000 gal each; 3,4 – 5,000 gal each	S162	0.28
Other Storage Tanks (Eastman judgement, based on material stored)			
Tank 4	88,122 gal	NA	<1
Tank 80	11,982 gal	NA	<1
Tank 151	1,503,943 gal	NA	<1
Tank 208	25,379 gal	NA	<1
Tank 252	30,455 gal	NA	<1
Tank 261	20,000 gal	NA	<1
Tank 262	20,079 gal	NA	<1
Tank 263	20,726 gal	NA	<1
Tank 264	20,000 gal	NA	<1
Tank 265	21,134 gal	NA	<1
Tank 365	20,000 gal	NA	<1
Tank 511	16,356 gal	NA	<1
Tank 761	10,000 gal	NA	<1
Tank 764	17,500 gal	NA	<1
Tank 766	3,800 gal	NA	<1
Tank 775	8,768 gal	NA	<1
Tank 783	11,400 gal	NA	<1
Combustion Sources			
Unilux Boiler 1 (IP #0058-I020)	18.6 MM Btu/hr	S141	0.44
Unilux Boiler 2 (IP #0058-I020)	18.6 MM Btu/hr	S141	0.44
Unilux Boiler 3 (IP #0058-I020)	18.6 MM Btu/hr	S143	0.44
Unilux Boiler 4 (IP #0058-I020)	18.6 MM Btu/hr	S142	0.44
Boiler house emergency generator (IP #0058-I020)	250 kW	F100	0.01
Trane Boiler	38 MM Btu/hr	S144	0.92

IV. RACT Determination

Two detailed RACT Reviews were performed to evaluate the Eastman facility; one was performed by Eastman, and one by Allegheny County Health Department (ACHD). Both submissions were considered in the final RACT disposition for the Facility and findings from each were incorporated into the ACHD RACT II Determination.

It has been determined that, based on the configuration and operation of these tanks, it is not technically feasible to enclose or capture and control the following sources that are subject to case-by-case analysis:

- Raw material tank T-50 (C-5 operations): this tank is internal floating roof tank. There is no reasonable method to capture emissions from floating roof tank.
- Tanks 702A, 702B, 702C (Wastewater Treatment Plant): all of these tanks are open-top tanks used for pre-treatment prior to the biological treatment operations. There is no reasonable method to capture emissions from these open-top tanks. Enclosure or a floating roof is not technically feasible due to the tank configuration and operation.
- Bio Aeration Tank (Wastewater Treatment Plant): this biological treatment tank is open to the atmosphere. There is no reasonable method to capture the emissions from this operation. Enclosure or a floating roof is not technically feasible due to the tank configuration and operation.

The Technically Feasible Control Options for sources where is it was determined that an economic analysis is required for Eastman are detailed in Table 4. All control cost analyses were conducted pursuant to procedures provided in US EPA's Office of Air Quality Planning and Standards (OAQPS) Control Cost Manual, 7th Edition.

Table 4 – Technically Feasible VOC Control Cost Comparisons

Control Option		S109 LTC	S110 LTC	S114 LTC	S013 & S013a WW Poly	S020 WW Poly	S023 WW Poly	S027 WW Poly
Thermal Oxidation (98%)	tpy VOC Removed	3.6	7.6	2.6	4.6	4.8	7.1	4.8
	Cost	$143,908	$148,047	$311,632	$156,264	$183,607	$175,518	$175,934
	$/ton	40,137	19,443	118,251	34,162	38,176	24,798	36,653
Catalytic Oxidation (98%)	tpy VOC Removed	3.6	7.6	2.6	4.6	4.8	7.1	4.8
	Cost	$134,852	$135,637	$254,524	$138,270	$154,741	$148,790	$149,202
	$/ton	37,705	17,814	96,581	30,228	32,174	21,022	31,084
Carbon Adsorption (fixed bed) (90-95%)	tpy VOC Removed	3.5	7.4	2.4	4.4	4.7	6.9	4.7
	Cost	$181,762	$179,679	$180,804	$154,297	$156,903	$156,790	$155,442
	$/ton	52,426	24,343	74,706	34,797	33,654	22,852	33,073
Rotary Concentrator/ Oxidation (98%)	tpy VOC Removed	3.6	7.6	2.6	4.6	4.8	7.1	4.8
	Cost	$184,606	$184,634	$219,307	$184,832	$187,503	$186,464	$186,464
	$/ton	51,616	24,249	83,218	40,408	38,986	26,345	38,847
Refrigerated Condenser (95%)	tpy VOC Removed	3.5	7.4	2.6	4.4	4.7	6.9	4.7
	Cost	$136,399	$138,457	$1,296,659	$149,704	$219,179	$189,142	$192,802
	$/ton	39,342	18,758	507,565	33,761	47,011	27,567	41,022

Table 4 – Technically Feasible VOC Control Cost Comparisons (continue)

Control Option		S025 WW Poly	S055 C-5	S034 MP Poly	S004 Hydro	S007 Hydro	S012 Hydro	S085 Dresinate
Thermal Oxidation (98%)	tpy VOC Removed	5.1	5.8	9.7	12.2	14.1	5.9	5.2
	Cost	$154,798	$526,415	$177,803	$165,140	$174,148	$146,413	$345,875
	$/ton	30,178	90,761	18,288	13,536	12,335	24,692	66,816
Catalytic Oxidation (98%)	tpy VOC Removed	5.1	5.8	9.7	12.2	14.1	5.9	5.2
	Cost	$137,691	$412,727	$150,236	$142,844	$147,584	$135,286	$280,531
	$/ton	26,843	71,160	15,452	11,708	10,454	22,816	54,193
Carbon Adsorption (fixed bed) (90-95%)	tpy VOC Removed	5.0	5.4	8.9	10.3	13.0	5.4	4.8
	Cost	$156,423	$207,403	$158,992	$161,638	$161,521	$180,771	$186,358
	$/ton	31,458	38,408	17,807	15,693	12,458	33,197	39,200
Rotary Concentrator/ Oxidation (98%)	tpy VOC Removed	5.1	5.8	9.7	12.2	14.1	5.9	5.2
	Cost	$184,776	$285,728	$186,833	$185,480	$186,486	$184,620	$229,409
	$/ton	36,022	49,263	19,216	15,203	13,209	31,136	44,317
Refrigerated Condenser (95%)	tpy VOC Removed	5.0	5.7	9.4	11.5	13.7	5.7	5.0
	Cost	$146,875	$2,920,397	$193,751	$160,986	$182,016	$137,554	$1,504,896
	$/ton	29,538	512,350	20,557	13,999	13,300	23,931	299,894

ACHD has determined that thermal oxidation, catalytic oxidation, carbon adsorption (fixed bed), rotary concentrator/oxidation, and refrigerated condenser are technically feasible control options for controlling VOC emissions from the processes of the Eastman facility, but they are deemed financially infeasible due to their high cost per ton removed.

ACHD has determined that that it was unnecessary to conduct RACT evaluations on the equipment leak emissions for processes WW Poly, MP Poly, or the LTC process lines. The source is subject to the MON. Under the MON, the source is required to have a Leak Detection and Repair (LDAR) program. These requirements are relatively stringent, and ACHD does not believe more stringent requirements would be considered cost-effective. The LDAR requirements of the MON are considered RACT for the emissions from equipment leaks.

V. RACT Summary

Based on the findings in this RACT analysis, the Eastman facility has few technically feasible controls options for controlling VOC emissions from the processes, but they are deemed financially infeasible due to their high cost per ton removed.

The potential VOC emissions from the Hydro operations are based on the results of the stack test conducted in December 2019 and a throughput restriction of 22,500,000 lbs/year. Eastman proposes that RACT II for Hydro is a throughput limit of 22,500,000 lbs/year. The upcoming Installation Permit application for this process will be based on that limit.

The new RACT II conditions will not result in any additional reductions in VOC from the Eastman. The conditions of Plan Approval Order and Agreement #257 (RACT I), issued January 14, 1997, have been superseded by the case-by-case and presumptive RACT II conditions in this proposed permit. The RACT II conditions are at least as stringent as those from RACT I.

VI. RACT II Permit Conditions

Source ID	Description	Permit Condition 0058-I026	RACT II Regulations
NA	Site Level Terms and Conditions	Condition IV.27	25 PA Code §129.99 25 PA Code §129.100
Storage Tanks	C-5 Operations (Installation Permit #0058-I011d)	Condition V.A.2.a Condition V.A.2.b	25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S055	C-5 Operations (Installation Permit #0058-I018a)	Condition V.B.2.a Condition V.B.2.b	25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S034	MP Poly Unit (Installation Permit #0058-I022a)	Condition V.C.1.b Condition V.C.1.c Condition V.C.1.d Condition V.C.2.a Condition V.C.3.a Condition V.C.4.a Condition V.C.4.b	25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S013, S020, S023, S027	WW Poly Unit (Installation Permit #0058-I023a)	Condition V.D.1.b Condition V.D.2.a Condition V.D.3.a Condition V.D.3.b Condition V.D.4.a Condition V.D.4.b	25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.100 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S025	WW Poly Storage Tanks (Installation Permit #0058-I023a)	Condition V.E.1.b Condition V.E.2.a Condition V.E.2.b Condition V.E.3.a Condition V.E.3.b	25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.100 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S109, S110, S114	LTC Process Operations (Installation Permit #0058-I016a)	Condition V.F.1.b Condition V.F.1.c Condition V.F.2.a Condition V.F.3.a Condition V.F.3.b	25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.100 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S085	Dresinate Production Line (Installation Permit #0058-I012a)	Condition V.G.2.a Condition V.G.2.b	25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S004, S007, S012	Hydrogenation Unit	Condition V.H.1.a Condition V.H.1.b Condition V.H.2.a Condition V.H.2.b	25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.100

Source ID	Description	Permit Condition 0058-I026	RACT II Regulations
		Condition V.H.3.a Condition V.H.4.a Condition V.H.4.b	25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
F027, F033, F034, F035	Wastewater Treatment Plant	Condition V.I.1.a Condition V.I.1.b	25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99

ALLEGHENY COUNTY HEALTH DEPARTMENT
Air Quality Program

SUMMARY OF PUBLIC COMMENTS AND DEPARTMENT RESPONSES ON THE PROPOSED ISSUANCE OF EASTMAN CHEMICAL RESINS, INC., JEFFERSON SITE, INSTALLATION PERMIT NO. 0058-I026

[Notice of the opportunity for public comment appeared in the legal section of the Pittsburgh Post-Gazette on February 6, 2020. The public comment period ended on March 17, 2020.]

1. **COMMENT:** ACHD has indicated that the RACT II determinations for certain sources are based in part on information in a Draft Installation Permit (IP No. 0058-I016a) that hasn't been issued yet, and two Installation Permit applications that have been submitted by Eastman. All Installation Permits that are being relied on to inform the RACT II Determinations for the facility should be issued prior to issuing the final Installation Permit for RACT II.

   RESPONSE: Installation Permit No, 0058-I016a was issued at April 14, 2020. The RACT II evaluation was not based on any other unissued permits.

2. **COMMENT:** In the permit review memo, ACHD indicated that Raw Material Tank T50 (C-5 Operations) is a raw material tank subject to case-by-case RACT. Please explain if the tank is subject to Source Standards for tanks found at 25 PA Code 129.56. Tanks that meet the criteria for sources subject to this regulation are not subject to RACT per the applicability criteria at 25 PA Code 129.96.(b).

   RESPONSE: This tank is subject to Source Standards for tanks found at 25 PA Code 129.56, so this tank T50 will be removed from the Table 1 "Facility Sources Subject to Case-by-Case RACT II and Their Existing RACT I Limits" and put to the Table 2 "Facility Sources Subject to Presumptive RACT II per PA Code 129.97".

3. **COMMENT:** In the permit review memo, ACHD indicated that Tanks 702A, 702B, 702C, and the Bioaeration Tank associated with the Wastewater Treatment Plant are open-top tanks and that there are no reasonable methods for capturing emissions from these types of tanks. ACHD should indicate each control method evaluated for the tanks and justify whether they were technically infeasible or economically infeasible.

   RESPONSE: The only viable method of control for these tanks would be to enclose the tanks or install a floating roof. Because of the configuration and operation of these tanks, neither enclosing them nor installing a floating roof is technically feasible.

4. **COMMENT:** In ACHD's review memo, ACHD has indicated that it did not perform a RACT evaluation for equipment leak emissions from Sources WW Poly, MP Poly, or the LTC process lines because these sources are subject to MON. While MON may be the most technically/cost feasible control option for these sources, ACHD still needs to perform a technical feasibility and cost evaluation for other possible control options as part of the RACT case by case analysis for these sources to demonstrate that there aren't other control options that are more cost effective and result in greater control of VOC emissions.

   RESPONSE: A RACT evaluation was performed on the individual equipment and processes within each of these process lines. Beyond an LDAR program, there is no technically feasible means of controlling emissions from equipment leaks not otherwise accounted for in the RACT evaluations of the individual processes. A RACT citation was added to Condition IV.27 to incorporate the conditions of the MON.

5. **COMMENT**: Condition V.A. for C-5 Storage Tanks – Commenter notes that Work Practice Standard 2.a.1 states that Eastman should perform regular maintenance "considering the manufacturer's or the operator's

maintenance procedures". Commenter asked to explain and justify how this condition is enforceable as a practical matter. For instance, the condition could be revised to "Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures."

RESPONSE: The revision has been made to the final permit.

6. **COMMENT:** The permit conditions for the following sources should further define how the sources should be properly maintained and operated and include associated monitoring and recordkeeping requirements to ensure compliance with the work practices:
   a. source V.B C-5 Operations – Pastillating Belts #1 and #2 (S055)
   b. V.C MP Poly Unit (S034)
   c. V.D. WW Poly Unit (S013, S013a, S020, S023, and S027)
   d. V.E. WW Poly Unit Storage Tanks (S025)
   e. V.F LTC Process Operations (S109, S110, S114)
   f. V.G Dresinate Production Line (S085)
   g. V.H. Hydrogenation Unit (S004, S007, S012)
   h. V.I Wastewater Treatment Plant (F027, F033, F034, F035)

   RESPONSE: The Work Practice Standard conditions were added to all mentioned sources. The revision has been made to the final permit.

7. **COMMENT:** Permit Condition V.C MP Poly Unit (S034) - The permit should identify what corrective actions will be taken by Eastman when inlet coolant temperature requirements are not being met.

   RESPONSE: The corrective actions for S034 was added and the revision has been made to the final permit.

8. **COMMENT:** The following sources use condensers as a VOC emissions control device: V.D. WW Poly Unit (S013, S013a, S020, S023, and S027), V.E. WW Poly Unit Storage Tanks (S025), and V.H. Hydrogenation Unit (S004, S007, S012). For these sources, please explain and justify the recordkeeping requirements. For instance, a recordkeeping condition similar to Condition No. V.F.3.a.2. for LTC Process Operations (S109, S110, S114) could be included for the above mentioned units. The condition requires Eastman to keep "records of operation, inspection, calibration, maintenance, and/or replacement of process or control equipment"

   RESPONSE: The recordkeeping requirements were added, and the revision has been made to the final permit, with the exception of the Hydrogenation Unit (see comment #37 below).

9. **COMMENT:** Permit Condition V.E. WW Poly Unit Storage Tanks (S025) - ACHD should indicate the frequency at which Eastman should monitor and record condenser coolant temperatures in Condition V.E.2.

   RESPONSE: Conditions for monitoring and recordkeeping for S025 are included in the Installation Permit No.0058-I023a and therefore do not need to be included in RACT Permit. No revisions were made.

10. **COMMENT:** Permit Condition V.F LTC Process Operations (S109, S110, S114) - ACHD should incorporate the short-term emission rate of VOC vacuum leak rate for the #4 LTC Vacuum system (10 lb/hr as proposed in Draft Installation Permit IP No. 0058-I016a) as part of the RACT II determination for this source. ACHD should also include the appropriate monitoring and recordkeeping in the permit as part of the RACT determination to ensure compliance with the VOC emission limit for the #4 LTC Vacuum.

    RESPONSE: The #4 LTC Vacuum System is not subject to case-by-case RACT. As there is no feasible way to monitor the continuous vacuum leak rate, the case-by-case RACT determination for the #1 and #2 Vacuum System is proper operation and maintenance (condition V.F.3.a) and the LDAR requirements of the MON (condition IV.27). See response to comment 4 above. In addition, Condition V.F.1.c was added to the permit for short-term emissions and testing requirements for #1 and #2 Vacuum System.

11. **COMMENT:** Permit Condition V.H. Hydrogenation Unit (S004, S007, S012) - ACHD should indicate the frequency at which Eastman should monitor and record condenser coolant temperatures in Condition V.H.2.

    RESPONSE: Monitoring condition was added to the final permit. See also comment #37 below.

12. **COMMENT:** Section II: Facility Description. It should be noted in the facility description that this RACT II obligation will replace the 1997 RACT Order No. 257 (RACT I) and the requirement to determine RACT as set forth in paragraph 78 of the December 8, 2011 consent decree between Eastman Chemical and the US EPA (United States of America and Allegheny County Health Department vs. Eastman Chemical Resins, Inc., Civil Action No. 11-1240). 25 PA Code §129.99(g) requires that this RACT permit supersede the 1997 RACT Order unless the 1997 RACT Order contains more stringent requirements. As noted in Section V of the permit and technical support document, the requirements in this RACT IP are not more stringent than those found in the 1997 RACT Order. Moreover, the Consent Decree requires that this RACT Order "supersede in its entirety the 1997 RACT Order". See Paragraph 78 of the Consent Decree.

    RESPONSE: The Department has the authority and statutory obligation to make a RACT determination and issue to this permit to meet the 2008 Ozone RACT (RACT II). Furthermore, there is nothing in the Consent Decree that prohibits the Department from doing so. Paragraph 78 of the Consent Decree states "Within ninety (90) Days after Eastman's receipt of the last of the Process Unit-wide Article XXI installation permits for the Facility required by this Consent Decree, Eastman shall submit to ACHD a VOC RACT Proposal for the Facility." As the conditions of the Consent Decree have not yet been fully met, the conditions of the 1997 Consent Order No. 257 (RACT I) are still in effect, except where the Department determined RACT to be the same as RACT I.

13. **COMMENT:** Section III: General Conditions and Section IV: Site Level Terms and Conditions. Eastman requests that the ACHD remove the terms and conditions found in Sections III and IV from this RACT Installation Permit. These terms and conditions are a recitation of the referenced Article XXI rules that are already part of the Pennsylvania State Implementation Plan (SIP). They should not be incorporated into the SIP as part of this case-by-case RACT SIP Amendment. Similarly, Sections I, II and VI should also not be incorporated into the SIP as they do not contain applicable requirements that must be incorporated into the SIP pursuant to 25 PA Code §129.99(h). Only the Section V Emission Unit Level Terms and Conditions need to be incorporated into the SIP pursuant to this requirement.

    The commenter has also provided changes shown in Section III and IV to illustrate how these boilerplate conditions have been modified from what appears in Article XXI. Eastman is not requesting that the tracked changes shown in Sections III and IV be made in this Installation Permit.

    RESPONSE: Prior to submission for incorporation into the SIP, the permit will be redacted such that only those conditions subject to 25 PA Code §129.99 will be included. However, as this is still an enforceable installation permit, the conditions in Sections I-IV, and VI are still included in the final issued permit.

    As the commenter notes, Sections III and IV contain boilerplate language found in all installation permits, and therefore remain unchanged.

14. **COMMENT:** Section V: Emission Unit Level Terms and Conditions. The commenter notes that this RACT II obligation will replace the 1997 RACT Order No. 257 (RACT I) and the requirement to determine RACT as set forth in paragraph 78 of the December 8, 2011 consent decree. See comment #12 above.

    RESPONSE: See response to comment #12 above.

15. **<u>COMMENT:</u>** Condition V.A.1. This condition should be clarified to read "*Continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with the C5 VOC storage tanks*".

    <u>RESPONSE:</u> The revision has been made to the final permit.

16. **<u>COMMENT:</u>** Conditions V.A.2.a and V.A.2.b. These conditions should be clarified to specify "VOC" storage tanks.

    <u>RESPONSE:</u> The revision has been made to the final permit.

17. **<u>COMMENT:</u>** Conditions V.A.2.b, V.B.2, V.C.1.b, V.C.2, V.C.3, V.D.1.b, V.D.2, V.D.3, V.D.4, V.E.1.b, V.E.2, V.E.3, V.F.1.b, V.F.3, V.F.4, V.G.2, V.H.2, V.H.3, and V.I.1. Paragraph 78 of the consent decree states "The new RACT Order … required by this Paragraph shall supersede [sic] in its entirety the 1997 RACT Order" unless the 1997 RACT Order contains more stringent requirements. That is not the case for 1997 RACT Order section 1.7, which is a general provision requiring that Eastman properly maintain and operate the equipment. Therefore, references to section 1.7 should be removed. This comment also applies other instances when conditions 1.1 through 1.7 are referenced.

    <u>RESPONSE:</u> See response to comment #12 above. In these conditions, the RACT II requirement was determined to be continuation of RACT I. The permit remains unchanged for these conditions and all subsequent conditions where section 1.7 of the 1997 RACT Order is referenced.

18. **<u>COMMENT:</u>** Condition V.B.1. This condition should be clarified to read "*Continue to comply with all applicable regulatory requirements and the VOC control requirements in the applicable Installation Permit associated with S055*".

    <u>RESPONSE:</u> The revision has been made to the final permit, with the exception of using "Pastillating Belts #1 and #2" instead of "S055".

19. **<u>COMMENT:</u>** Condition V.C.1.a. That this condition should be clarified to read "*Continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with S034*"

    <u>RESPONSE:</u> The revision has been made to the final permit, with the exception of using "MP Poly Unit" instead of "S055"

20. **<u>COMMENT:</u>** Conditions V.C.1.b, V.C.1.c, and V.C.2. Condensers E-400-6 and E-203-4 are not associated with the MP Poly Process stack S034 and should be removed from these conditions.

    <u>RESPONSE:</u> The revision has been made to the final permit.

21. **<u>COMMENT:</u>** Condition V.C.2. This comment should clarify that it only applies when emissions are being routed to the condenser

    <u>RESPONSE:</u> The Department agrees and the revision has been made to the final permit.

22. **<u>COMMENT:</u>** Condition V.C.3. The requirement to keep and maintain records of monthly and 12-month moving polymerizate production should be removed since there is no production limit subject to RACT.

    <u>RESPONSE:</u> The Department agrees, and the revision has been made to the final permit.

23. **<u>COMMENT:</u>** Section V.D. Emission point S013a should be removed as there is no such emission point in Installation Permit #0058-I023a.

<u>RESPONSE:</u> Emission point S013a included in Technical Support Document for Installation Permit #0058-I023a. VOC emissions for this point is 0.01 tpy. This emission point included in Table 3 of Section III and removed from Table 1 of this Section and from Section VI. Also this emission point removed from the permit.

24. **<u>COMMENT:</u>** Condition V.D.1.a. This condition should be clarified to read "*Continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with S013, S020, S023, and S027*".

<u>RESPONSE:</u> The revision has been made to the final permit, with the exception of using "WW Poly Unit" instead of "S013, S020, S023, and S027".

25. **<u>COMMENT:</u>** Condition V.D.1.b. The following condensers are not included in the table in Section VI of the Technical Support Document as subject to RACT II permit conditions and should be removed: E-600-9, E-601-11, E-700-6, and E-701-7.

<u>RESPONSE:</u> The revision has been made to the final permit.

26. **<u>COMMENT:</u>** Condition V.D.1.b.3.b). This condition should read "…when the coolant supply temperature is ~~more~~ <u>less</u> than 50°F (10°C)~~, or when the coolant supply is interrupted~~."

<u>RESPONSE:</u> The Department disagrees. The purpose of this condition is to document instances of temperature exceedances due to problems with the coolant. This would be if the coolant is too hot or not properly flowing. The permit remains unchanged.

27. **<u>COMMENT:</u>** Condition V.D.2. The following condensers are not associated with the listed emission points of this section and should be removed: E-300-4, E-301-4, E-600-9, E-601-11, E-700-6, E-701-7, and E-800-3.

<u>RESPONSE:</u> The revision has been made to the final permit.

28. **<u>COMMENT:</u>** Condition V.D.3. The requirement to keep and maintain records of monthly and 12-month moving polymerizate production should be removed since there is no production limit subject to RACT.

<u>RESPONSE:</u> The revision has been made to the final permit.

29. **<u>COMMENT:</u>** Condition V.E.1.a. This condition should be clarified to read "*Continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with S025*".

<u>RESPONSE:</u> The revision has been made to the final permit, with the exception of using "WW Poly Storage Tanks" instead of "S025".

30. **<u>COMMENT:</u>** Condition V.E.1.b. Condensers E-201-2 and E-67-3 are not associated with the WW Poly Storage Tanks and should be removed.

<u>RESPONSE:</u> The revision has been made to the final permit.

31. **<u>COMMENT:</u>** Section V.F. The LTC process should also include emission points S108, S111, S112, and S113. S114 should be corrected to S124.

RESPONSE: The revision has been made to the final permit.

32. **COMMENT:** Condition V.F.1.a. This condition should be clarified to read "*Continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with S108, S109, S110, S111, S112, S113, and S124*".

RESPONSE: The revision has been made to the final permit, with the exception of using "LTC Process Operations" instead of "S108, S109, S110, S111, S112, S113, and S114". Please note that the change from S114 to S124 is incorrect. S124 is the emission point for the #4 Vacuum System which is not subject to case-by-case RACT. S114 is the emission point for the LTC #1/#2 Pastillator Belts which are subject to case-by-case RACT.

33. **COMMENT:** Condition V.F.1.3.b). his condition should read "…when the coolant supply temperature is ~~more~~ less than 50°F (10°C)~~, or when the coolant supply is interrupted~~."

RESPONSE: The Department disagrees. The purpose of this condition is to document instances of temperature exceedances due to problems with the coolant. This would be if the coolant is too hot or not properly flowing. The permit remains unchanged.

34. **COMMENT:** Condition V.F.3.a.6). This condition should be removed, as Eastman is not utilizing the Air Emissions Inventory Improvement Program (EIIP) and has no plans to do so.

RESPONSE: The revision has been made to the final permit.

35. **COMMENT:** Condition V.G.1. This condition should be clarified to read "*Continue to comply with all applicable regulatory ~~and Permit~~ requirements*". There are no control requirements in the applicable permit, so the phrase "and Permit" should be removed.

RESPONSE: The Department disagrees. The purpose of this condition is to reiterate that all conditions of the applicable permit still apply, and that this permit does not remove them. The permit remains unchanged.

36. **COMMENT:** Condition V.H.1.b. The following condensers are part of the Hydrogenation Unit and should be added: E-104-2 (S012), E-201-2 (S004), E-403-2 (S007).

RESPONSE: The revision has been made to the final permit.

37. **COMMENT:** Condition V.H.1.b.1)-3). This section conflicts with Consent Order paragraph 19 and Appendix A, which require condensers to comply with ACHD Permit # 0058-I001. ACHD Permit # 0058-I001 includes compliance temperatures for condenser water outlets, not inlets. Requiring the inlet coolant to be a higher temperature (50°F, as per this section) than the outlet temperature (40°F, as per IP #0058-I001, condition 3.b) is not logical and does not indicate compliance. Also, monitoring both inlet and outlet coolant temperatures is excessive and redundant and does not improve compliance. There currently is no instrumentation in place to monitor and comply with the proposed refrigerated inlet coolant temperature limits of this section. Section V.H.1.b.1) through 3) should be deleted; and Eastman will continue to comply with Consent Order paragraph 19 and Appendix A and ACHD Permit # 0058-I001.

RESPONSE: The Department partially agrees and partially disagrees. The purpose of this condition was to provide for a means of demonstrating if an exceedance of outlet vapor temperature is due solely to ambient conditions and to be consistent with other condensers and the language agreed upon between Eastman, ACHD, and the EPA. However, the Department does agree that the in the case of the Hydrogenation Unit, this language does not apply. The Department also agrees that the language in Installation Permit #0058-I001, along with the requirements from Appendix A of the consent decree constitute RACT. The permit has been amended to remove the previous conditions and replace them with that of IP #0058-I001.

LIST OF COMMENTERS

Name	**Affiliation**
Gwendolyn Supplee	**EPA, Region III** **Permit Branch, 3AD10**
Cynthia Stahl, PhD	**EPA, Region III** **Permit Branch, 3AD10**
Janice S. Kane, P.E. Environmental Coordinator	**Eastman Chemical Resins, Inc.** **Jefferson Site**

AIR QUALITY PROGRAM
301 39th Street, Bldg. #7
Pittsburgh, PA 15201-1811

Major Source
INSTALLATION PERMIT

Issued To:	**Eastman Chemical Resins, Inc.** **Jefferson Site** 2200 State Highway 837 West Elizabeth, PA 15088-0545	**ACHD Permit#:**	**0058-I026**
		Date of Issuance:	------
		Expiration Date:	(See Section III.12)

Issued By:	____________________ **JoAnn Truchan, P.E.** **Section Chief, Engineering**	**Prepared By:**	____________________ **Helen O. Gurvich** **Air Quality Engineer**

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AMENDMENTS:

DATE	***SECTION(S)***

I. CONTACT INFORMATION

Facility Location:	**Eastman Chemical Resins, Inc.** **Jefferson Site** 2200 State Highway 837 West Elizabeth, PA 15088-0545
Permittee/Owner:	**Eastman Chemical Resins, Inc.** **Jefferson Site** 2200 State Highway 837 West Elizabeth, PA 15088-0545
Responsible Official:	**Eugene M. Ingram**
Title:	Jefferson Site Manager
Company:	**Eastman Chemical Resins, Inc.** **Jefferson Site**
Address:	2200 State Highway 837 P.O. Box 545 West Elizabeth, PA 15088-0545
Telephone Number:	412-384-2520
Fax Number:	412-384-7311
Facility Contact:	**Janice Kane**
Title:	Senior Environmental Coordinator
Telephone Number:	412-384-2520, ext. 2243
Fax Number:	412-384-7311
E-mail Address:	**jsnyderkane@eastman.com**

AGENCY ADDRESSES:

ACHD Contact:	**Chief Engineer** **Allegheny County Health Department** Air Quality Program 301 39th Street, Building #7 Pittsburgh, PA 15201-1811 aqpermits@alleghenycounty.us
EPA Contact:	**Enforcement Programs Section (3AP12)** **USEPA Region III** 1650 Arch Street Philadelphia, PA 19103-2029

II. FACILITY DESCRIPTION

FACILITY DESCRIPTION

The Eastman Chemical Resins, Inc., Jefferson Site facility (Eastman) produces synthetic hydrocarbon resins from C5 feedstock, monomers, solvents and catalysts by way of cationic polymerization. Resins produced include aliphatic, aliphatic/aromatic, aromatic and liquid resins for use in adhesives, plastics, rubber, graphic arts and numerous other products. The plant is comprised of three polymerization processes (C5, MP-Poly, and WW-Poly), a resin hydrogenation process, four finishing processes (LTC1, LTC2, and C-5), and an emulsion process, five boilers ranging from 18.6 MM Btu/hr to 38.2 MM Btu/hr, a wastewater treatment plant, a pilot plant for testing formulations and processes and approximately 200 storage tanks of various sizes.

The facility is a major source of volatile organic compounds (VOCs) and Hazardous Air Pollutants (HAPs); and a minor source of particulate matter (PM), particulate matter <10 µm in diameter (PM_{10}), particulate matter <2.5 µm in diameter ($PM_{2.5}$), nitrogen oxides (NO_X), sulfur oxides (SO_X), as defined in §2102.20 of Article XXI. The facility is also a minor source of greenhouse gas emissions (CO_2e) as defined in the U.S. EPA Greenhouse Gas Tailoring Rule.

INSTALLATION DESCRIPTION

This permit is an installation addressing the requirements for case-by-case RACT for this facility.

DECLARATION OF POLICY

Pollution prevention is recognized as the preferred strategy (over pollution control) for reducing risk to air resources. Accordingly, pollution prevention measures should be integrated into air pollution control programs wherever possible, and the adoption by sources of cost-effective compliance strategies, incorporating pollution prevention, is encouraged. The Department will give expedited consideration to any permit modification request based on pollution prevention principles.

The permittee is subject to the terms and conditions set forth below. These terms and conditions constitute provisions of *Allegheny County Health Department Rules and Regulations, Article XXI Air Pollution Control*. The subject equipment has been conditionally approved for operation. The equipment shall be operated in conformity with the plans, specifications, conditions, and instructions which are part of your application, and may be periodically inspected for compliance by the Department. In the event that the terms and conditions of this permit or the applicable provisions of Article XXI conflict with the application for this permit, these terms and conditions and the applicable provisions of Article XXI shall prevail. Additionally, nothing in this permit relieves the permittee from the obligation to comply with all applicable Federal, State and Local laws and regulations.

III. GENERAL CONDITIONS

1. Prohibition of Air Pollution (§2101.11)

It shall be a violation of this permit to fail to comply with, or to cause or assist in the violation of, any requirement of this permit, or any order or permit issued pursuant to authority granted by Article XXI. The permittee shall not willfully, negligently, or through the failure to provide and operate necessary control equipment or to take necessary precautions, operate any source of air contaminants in such manner that emissions from such source:

a. Exceed the amounts permitted by this permit or by any order or permit issued pursuant to Article XXI;
b. Cause an exceedance of the ambient air quality standards established by Article XXI §2101.10; or
c. May reasonably be anticipated to endanger the public health, safety, or welfare.

2. Nuisances (§2101.13)

Any violation of any requirement of this Permit shall constitute a nuisance.

3. Definitions (§2101.20)

a. Except as specifically provided in this permit, terms used retain the meaning accorded them under the applicable provisions and requirements of Article XXI or the applicable federal or state regulation. Whenever used in this permit, or in any action taken pursuant to this permit, the words and phrases shall have the meanings stated, unless the context clearly indicates otherwise.

b. Unless specified otherwise in this permit or in the applicable regulation, the term "*year*" shall mean any twelve (12) consecutive months.

4. Certification (§2102.01)

Any report or compliance certification submitted under this permit shall contain written certification by a responsible official as to truth, accuracy, and completeness. This certification and any other certification required under this permit shall be signed by a responsible official of the source, and shall state that, based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate, and complete.

5. Operation and Maintenance (§2105.03)

All air pollution control equipment required by this permit or Article XXI, and all equivalent compliance techniques that have been approved by the Department, shall be properly installed, maintained, and operated consistent with good air pollution control practice.

6. Conditions (§2102.03.c)

It shall be a violation of this permit giving rise to the remedies provided by Article XXI §2109.02, for any person to fail to comply with any terms or conditions set forth in this permit.

7. Transfers (§2102.03.e)

This permit shall not be transferable from one person to another, except in accordance with Article XXI §2102.03.e and in cases of change-in-ownership which are documented to the satisfaction of the Department, and shall be valid only for the specific sources and equipment for which this permit was issued. The transfer of permits in the case of change-in-ownership may be made consistent with the administrative permit amendment procedure of Article XXI §2103.14.b.

8. Effect (§2102.03.g)

Issuance of this permit shall not in any manner relieve any person of the duty to fully comply with the requirements of Article XXI or any other provision of law, nor shall it in any manner preclude or affect the right of the Department to initiate any enforcement action whatsoever for violations of Article XXI or this Permit, whether occurring before or after the issuance of such permit. Further, the issuance of this permit shall not be a defense to any nuisance action, nor shall such permit be construed as a certificate of compliance with the requirements of Article XXI or this Permit.

9. General Requirements (§2102.04.a)

It shall be a violation of this Permit giving rise to the remedies set forth in Article XXI §2109 for any person to install, modify, replace, reconstruct, or reactivate any source or air pollution control equipment to which this Permit applies unless either:

a. The Department has first issued an Installation Permit for such source or equipment; or

b. Such action is solely a reactivation of a source with a current Operating Permit, which is approved under §2103.13 of Article XXI.

10. Conditions (§2102.04.e)

Further, the initiation of installation, modification, replacement, reconstruction, or reactivation under this

Installation Permit and any reactivation plan shall be deemed acceptance by the source of all terms and conditions specified by the Department in this permit and plan.

11. Revocation (§2102.04.f)

a. The Department may, at any time, revoke this Installation Permit if it finds that:
1) Any statement made in the permit application is not true, or that material information has not been disclosed in the application;
2) The source is not being installed, modified, replaced, reconstructed, or reactivated in the manner indicated by this permit or applicable reactivation plan;
3) Air contaminants will not be controlled to the degree indicated by this permit;
4) Any term or condition of this permit has not been complied with;
5) The Department has been denied lawful access to the premises or records, charts, instruments and the like as authorized by this Permit; or

b. Prior to the date on which construction of the proposed source has commenced the Department may, revoke this Installation Permit if a significantly better air pollution control technology has become available for such source, a more stringent regulation applicable to such source has been adopted, or any other change has occurred which requires a more stringent degree of control of air contaminants.

12. Term (§2102.04.g)

This Installation Permit shall expire in 18 months if construction has not commenced within such period or shall expire 18 months after such construction has been suspended, if construction is not resumed within such period. In any event, this Installation Permit shall expire upon completion of construction, except that this Installation Permit shall authorize temporary operation to facilitate shakedown of sources and air cleaning devices, to permit operations pending issuance of a related subsequent Operating Permit, or to permit the evaluation of the air contamination aspects of the source. Such temporary operation period shall be valid for a limited time, not to exceed 180 days, but may be extended for additional limited periods, each not to exceed 120 days, except that no temporary operation shall be authorized or extended which may circumvent the requirements of this Permit.

13. Annual Installation Permit Administrative Fee (§2102.10.c & e)

No later than 30 days after the date of issuance of this Installation Permit and on or before the last day of the month in which this permit was issued in each year thereafter, during the term of this permit until a subsequent corresponding Operating Permit or amended Operating Permit is properly applied for, the owner or operator of such source shall pay to the Department, in addition to all other applicable emission and administration fees, an Annual Installation Permit Administration Fee in an amount of $750.

14. Severability Requirement (§2103.12.l)

The provisions of this permit are severable, and if any provision of this permit is determined to by a court of competent jurisdiction to be invalid or unenforceable, such a determination will not affect the remaining provisions of this permit.

15. Reporting Requirements (§2103.12.k)

a. The permittee shall submit reports of any required monitoring at least every six (6) months. All instances of deviations from permit requirements must be clearly identified in such reports. All required reports must be certified by the Responsible Official.

b. Prompt reporting of deviations from permit requirements is required, including those attributable to upset conditions as defined in this permit and Article XXI §2108.01.c, the probable cause of such deviations, and any corrective actions or preventive measures taken.

c. All reports submitted to the Department shall comply with the certification requirements of General Condition III.4 above.

d. Semiannual reports required by this permit shall be submitted to the Department as follows:
   1) One semiannual report is due by July 31 of each year for the time period beginning January 1 and ending June 30.
   2) One semiannual report is due by February 1 of each year for the time period beginning July 1 and ending December 31.
   3) The first semiannual report shall be due July 31, 2020 for the time period beginning on the issuance date of this permit through June 30, 2020.

e. Reports may be emailed to the Department at aqreports@alleghenycounty.us in lieu of mailing a hard copy.

16. Minor Installation Permit Modifications (§2102.10.d)

Modifications to this Installation Permit may be applied for but only upon submission of an application with a fee in the amount of $300 and where:

a. No reassessment of any control technology determination is required; and
b. No reassessment of any ambient air quality impact is required.

17. Violations (§2104.06)

The violation of any emission standard established by this Permit shall be a violation of this Permit giving rise to the remedies provided by Article §2109.02.

18. Other Requirements Not Affected (§2105.02)

Compliance with the requirements of this permit shall not in any manner relieve any person from the duty to fully comply with any other applicable federal, state, or county statute, rule, regulation, or the like, including, but not limited to, any applicable NSPSs, NESHAPs, MACTs, or Generally Achievable Control Technology standards now or hereafter established by the EPA, and any applicable requirement of BACT or LAER as provided by Article XXI, any condition contained in this Installation Permit and/or any additional or more stringent requirements contained in an order issued to such person pursuant to Part I of Article XXI.

19. Other Rights and Remedies Preserved (§2109.02.b)

Nothing in this permit shall be construed as impairing any right or remedy now existing or hereafter created in equity, common law or statutory law with respect to air pollution, nor shall any court be deprived of such jurisdiction for the reason that such air pollution constitutes a violation of this permit

20. Penalties, Fines, and Interest (§2109.07.a)

A source that fails to pay any fee required under this Permit or article XXI when due shall pay a civil penalty of 50% of the fee amount, plus interest on the fee amount computed in accordance with of Article XXI §2109.06.a.4 from the date the fee was required to be paid. In addition, the source may have its permit revoked.

21. Appeals (§2109.10)

In accordance with State Law and County regulations and ordinances, any person aggrieved by an order or other final action of the Department issued pursuant to Article XXI shall have the right to appeal the action to the Director in accordance with the applicable County regulations and ordinances.

IV. SITE LEVEL TERMS AND CONDITIONS

1. Reporting of Upset Conditions (§2103.12.k.2)

The permittee shall promptly report all deviations from permit requirements, including those attributable to upset conditions as defined in Article XXI §2108.01.c, the probable cause of such deviations, and any corrective actions or preventive measures taken.

2. Visible Emissions (§2104.01.a)

Except as provided for by Article XXI §2108.01.d pertaining to a cold start, no person shall operate, or allow to be operated, any source in such manner that the opacity of visible emissions from a flue or process fugitive emissions from such source, excluding uncombined water:

a. Equal or exceed an opacity of 20% for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or,
b. Equal or exceed an opacity of 60% at any time.

3. Odor Emissions (§2104.04) (County-only enforceable)

No person shall operate, or allow to be operated, any source in such manner that emissions of malodorous matter from such source are perceptible beyond the property line.

4. Materials Handling (§2104.05)

The permittee shall not conduct, or allow to be conducted, any materials handling operation in such manner that emissions from such operation are visible at or beyond the property line.

5. Operation and Maintenance (§2105.03)

All air pollution control equipment required by this permit or any order under Article XXI, and all equivalent compliance techniques approved by the Department, shall be properly installed, maintained, and operated consistently with good air pollution control practice.

6. Open Burning (§2105.50)

No person shall conduct, or allow to be conducted, the open burning of any material, except where the Department has issued an Open Burning Permit to such person in accordance with Article XXI §2105.50 or where the open burning is conducted solely for the purpose of non-commercial preparation of food for human consumption, recreation, light, ornament, or provision of warmth for outside workers, and in a manner which contributes a negligible amount of air contaminants.

7. Shutdown of Control Equipment (§2108.01.b)

a. In the event any air pollution control equipment is shut down for reasons other than a breakdown, the person responsible for such equipment shall report, in writing, to the Department the intent to shut down such equipment at least 24 hours prior to the planned shutdown. Notwithstanding the submission of such report, the equipment shall not be shut down until the approval of the Department is obtained; provided, however, that no such report shall be required if the source(s)

served by such air pollution control equipment is also shut down at all times that such equipment is shut down.

b. The Department shall act on all requested shutdowns as promptly as possible. If the Department does not take action on such requests within ten (10) calendar days of receipt of the notice, the request shall be deemed denied, and upon request, the owner or operator of the affected source shall have a right to appeal in accordance with the provisions of Article XI.

c. The prior report required by Site Level Condition IV.7.a above shall include:

1) Identification of the specific equipment to be shut down, its location and permit number (if permitted), together with an identification of the source(s) affected;
2) The reasons for the shutdown;
3) The expected length of time that the equipment will be out of service;
4) Identification of the nature and quantity of emissions likely to occur during the shutdown;
5) Measures, including extra labor and equipment, which will be taken to minimize the length of the shutdown, the amount of air contaminants emitted, or the ambient effects of the emissions;
6) Measures which will be taken to shut down or curtail the affected source(s) or the reasons why it is impossible or impracticable to shut down or curtail the affected source(s) during the shutdown; and
7) Such other information as may be required by the Department.

d. Shutdown reports may be emailed to the Department at aqreports@alleghenycounty.us in lieu of mailing a hard copy.

8. Breakdowns (§2108.01.c)

a. In the event that any air pollution control equipment, process equipment, or other source of air contaminants breaks down in such manner as to have a substantial likelihood of causing the emission of air contaminants in violation of this permit, or of causing the emission into the open air of potentially toxic or hazardous materials, the person responsible for such equipment or source shall immediately, but in no event later than sixty (60) minutes after the commencement of the breakdown, notify the Department of such breakdown and shall, as expeditiously as possible but in no event later than seven (7) days after the original notification, provide written notice to the Department.

b. To the maximum extent possible, all oral and written notices required shall include all pertinent facts, including:

1) Identification of the specific equipment which has broken down, its location and permit number (if permitted), together with an identification of all related devices, equipment, and other sources which will be affected.
2) The nature and probable cause of the breakdown.
3) The expected length of time that the equipment will be inoperable or that the emissions will continue.
4) Identification of the specific material(s) which are being, or are likely to be emitted, together with a statement concerning its toxic qualities, including its qualities as an irritant, and its potential for causing illness, disability, or mortality.
5) The estimated quantity of each material being or likely to be emitted.

6) Measures, including extra labor and equipment, taken or to be taken to minimize the length of the breakdown, the amount of air contaminants emitted, or the ambient effects of the emissions, together with an implementation schedule.
7) Measures being taken to shut down or curtail the affected source(s) or the reasons why it is impossible or impractical to shut down the source(s), or any part thereof, during the breakdown.

c. Notices required shall be updated, in writing, as needed to advise the Department of changes in the information contained therein. In addition, any changes concerning potentially toxic or hazardous emissions shall be reported immediately. All additional information requested by the Department shall be submitted as expeditiously as practicable.

d. Unless otherwise directed by the Department, the Department shall be notified whenever the condition causing the breakdown is corrected or the equipment or other source is placed back in operation by no later than 9:00 AM on the next County business day. Within seven (7) days thereafter, written notice shall be submitted pursuant to Paragraphs a and b above.

e. Breakdown reporting shall not apply to breakdowns of air pollution control equipment which occur during the initial startup of said equipment, provided that emissions resulting from the breakdown are of the same nature and quantity as the emissions occurring prior to startup of the air pollution control equipment.

f. In no case shall the reporting of a breakdown prevent prosecution for any violation of this permit or Article XXI.

g. Breakdown reports may be emailed to the Department at aqreports@alleghenycounty.us in lieu of mailing a hard copy.

9. Cold Start (§2108.01.d)

In the event of a cold start on any fuel-burning or combustion equipment, except stationary internal combustion engines and combustion turbines used by utilities to meet peak load demands, the person responsible for such equipment shall report in writing to the Department the intent to perform such cold start at least 24 hours prior to the planned cold start. Such report shall identify the equipment and fuel(s) involved and shall include the expected time and duration of the startup. Upon written application from the person responsible for fuel-burning or combustion equipment which is routinely used to meet peak load demands and which is shown by experience not to be excessively emissive during a cold start, the Department may waive these requirements and may instead require periodic reports listing all cold starts which occurred during the report period. The Department shall make such waiver in writing, specifying such terms and conditions as are appropriate to achieve the purposes of Article XXI. Such waiver may be terminated by the Department at any time by written notice to the applicant. Cold start notifications may be emailed to the Department at aqreports@alleghenycounty.us.

10. Monitoring of Malodorous Matter Beyond Facility Boundaries (§2104.04)

The permittee shall take all reasonable action as may be necessary to prevent malodorous matter from becoming perceptible beyond facility boundaries. Further, the permittee shall perform such observations as may be deemed necessary along facility boundaries to insure that malodorous matter beyond the facility boundary in accordance with Article XXI §2107.13 is not perceptible and record all findings and corrective action measures taken.

11. Emissions Inventory Statements (§2108.01.e & g)

a. Emissions inventory statements in accordance with §2108.01.e shall be submitted to the Department by March 15 of each year for the preceding calendar year. The Department may require more frequent submittals if the Department determines that more frequent submissions are required by the EPA or that analysis of the data on a more frequent basis is necessary to implement the requirements of Article XXI or the Clean Air Act.

b. The failure to submit any report or update within the time specified, the knowing submission of false information, or the willful failure to submit a complete report shall be a violation of this permit giving rise to the remedies provided by Article XXI §2109.02.

12. Orders (§2108.01.f)

In addition to meeting the requirements Site Level Conditions IV.7 through IV.11, inclusive, the person responsible for any source shall, upon order by the Department, report to the Department such information as the Department may require in order to assess the actual and potential contribution of the source to air quality. The order shall specify a reasonable time in which to make such a report.

13. Violations (§2108.01.g)

The failure to submit any report or update thereof required by Site Level Conditions IV.7 through IV.12 above, inclusive, within the time specified, the knowing submission of false information, or the willful failure to submit a complete report shall be a violation of this permit giving rise to the remedies provided by Article XXI §2109.02.

14. Emissions Testing (§2108.02)

a. **Orders:** No later than 60 days after achieving full production or 120 days after startup, whichever is earlier, the permittee shall conduct, or cause to be conducted, such emissions tests as are specified by the Department to demonstrate compliance with the applicable requirements of this permit and shall submit the results of such tests to the Department in writing. Upon written application setting forth all information necessary to evaluate the application, the Department may, for good cause shown, extend the time for conducting such tests beyond 120 days after startup but shall not extend the time beyond 60 days after achieving full production. Emissions testing shall comply with all applicable requirements of Article XXI, §2108.02.e.

b. **Tests by the Department:** Notwithstanding any tests conducted pursuant to this permit, the Department or another entity designated by the Department may conduct emissions testing on any source or air pollution control equipment. At the request of the Department, the permittee shall provide adequate sampling ports, safe sampling platforms and adequate utilities for the performance of such tests.

c. **Testing Requirements:** No later than 45 days prior to conducting any tests required by this permit, the person responsible for the affected source shall submit for the Department's approval a written test protocol explaining the intended testing plan, including any deviations from standard testing procedures, the proposed operating conditions of the source during the test, calibration data for specific test equipment and a demonstration that the tests will be conducted under the direct supervision of persons qualified by training and experience satisfactory to the Department to conduct such tests. In addition, at least 30 days prior to conducting such tests, the person responsible shall notify the Department in writing of the time(s) and date(s) on which the tests will be conducted and shall allow Department personnel to observe such tests, record data, provide pre-weighed filters, analyze samples in a County laboratory and to take samples for independent analysis. Test results shall be comprehensively and accurately reported in the units of measurement specified by the applicable emission limitations of this permit.

d. Test methods and procedures shall conform to the applicable reference method set forth in this permit or Article XXI Part G, or where those methods are not applicable, to an alternative sampling and testing procedure approved by the Department consistent with Article XXI §2108.02.e.2.

e. **Violations:** The failure to perform tests as required by this permit or an order of the Department, the failure to submit test results within the time specified, the knowing submission of false information, the willful failure to submit complete results, or the refusal to allow the Department, upon presentation of a search warrant, to conduct tests, shall be a violation of this permit giving rise to the remedies provided by Article XXI §2109.02.

15. Abrasive Blasting (§2105.51)

a. Except where such blasting is a part of a process requiring an operating permit , no person shall conduct or allow to be conducted, abrasive blasting or power tool cleaning of any surface, structure, or part thereof, which has a total area greater than 1,000 square feet unless such abrasive blasting complies with all applicable requirements of Article XXI §2105.51.

b. In addition to complying with all applicable provisions of §2105.51, no person shall conduct, or allow to be conducted, abrasive blasting of any surface unless such abrasive blasting also complies with all other applicable requirements of Article XXI unless such requirements are specifically addressed by §2105.51.

16. Asbestos Abatement (§2105.62, §2105.63)

In the event of removal, encasement, or encapsulation of Asbestos-Containing Material (ACM) at a facility or in the event of the demolition of any facility, the permittee shall comply with all applicable provisions of Article XXI §2105.62 and §2105.63.

17. Volatile Organic Compound Storage Tanks (§2105.12.a)

No person shall place or store, or allow to be placed or stored, a volatile organic compound having a vapor pressure of 1.5 psia or greater under actual storage conditions in any aboveground stationary storage tank having a capacity equal to or greater than 2,000 gallons but less than or equal to 40,000 gallons, unless there is in operation on such tank pressure relief valves which are set to release at the higher of 0.7 psig of pressure or 0.3 psig of vacuum or at the highest possible pressure and vacuum in accordance with State or local fire codes, National Fire Prevention Association guidelines, or other national consensus standard approved in writing by the Department. Petroleum liquid storage vessels that are used to store produced crude oil and condensate prior to lease custody transfer are exempt from these requirements.

18. Permit Source Premises (§2105.40)

a. **General.** No person shall operate, or allow to be operated, any source for which a permit is required by Article XXI Part C in such manner that emissions from any open land, roadway, haul road, yard, or other premises located upon the source or from any material being transported within such source or from any source-owned access road, haul road, or parking lot over five (5) parking spaces:

1) Are visible at or beyond the property line of such source;

2) Have an opacity of 20% or more for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or

3) Have an opacity of 60% or more at any time.

b. **Deposition on Other Premises:** Visible emissions from any solid or liquid material that has been deposited by any means from a source onto any other premises shall be considered emissions from such source within the meaning of Site Level Condition IV.18.a above.

19. Parking Lots and Roadways (§2105.42)

a. The permittee shall not maintain for use, or allow to be used, any parking lot over 50 parking spaces or used by more than 50 vehicles in any day or any other roadway carrying more than 100 vehicles in any day or 15 vehicles in any hour in such manner that emissions from such parking lot or roadway:

1) Are visible at or beyond the property line;

2) Have an opacity of 20% or more for a period or periods aggregating more than three (3) minutes in any 60 minute period; or

3) Have an opacity of 60% or more at any time.

b. Visible emissions from any solid or liquid material that has been deposited by any means from a parking lot or roadway onto any other premises shall be considered emissions from such parking lot or roadway.

c. Site Level Condition IV.19.a above shall apply during any repairs or maintenance done to such parking lot or roadway.

d. Notwithstanding any other provision of this permit, the prohibitions of Site Level Condition IV.19 may be enforced by any municipal or local government unit having jurisdiction over the place where such parking lots or roadways are located. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by Article XXI §2109.02 for any violations of Site Level Condition IV.19.

20. Permit Source Transport (§2105.43)

a. No person shall transport, or allow to be transported, any solid or liquid material outside the boundary line of any source for which a permit is required by Article XXI Part C in such manner that there is any visible emission, leak, spill, or other escape of such material during transport.

b. Notwithstanding any other provision of this permit, the prohibitions of Site Level Condition IV.20 may be enforced by any municipal or local government unit having jurisdiction over the place where such visible emission, leak, spill, or other escape of material during transport occurs. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by Article XXI §2109.02 for any violation of Site Level Condition IV.20.

21. Construction and Land Clearing (§2105.45)

a. No person shall conduct, or allow to be conducted, any construction or land clearing activities in such manner that the opacity of emissions from such activities:

1) Equal or exceed 20% for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or
2) Equal or exceed 60% at any time.

b. Notwithstanding any other provision of this permit, the prohibitions of Site Level Condition IV.21 may be enforced by any municipal or local government unit having jurisdiction over the place where such construction or land clearing activities occur. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by Article XXI §2109.02 for any violations of Site Level Condition IV.21.

22. Mining (§2105.46)

No person shall conduct, or allow to be conducted, any mining activities in such manner that emissions from such activities:

a. Are visible at or beyond the property line;
b. Have an opacity of 20% or more for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or,
c. Have an opacity of 60% or more at any time.

23. Demolition (§2105.47)

a. No person shall conduct, or allow to be conducted, any demolition activities in such manner that the opacity of the emissions from such activities equal or exceed 20% for a period or periods aggregating more than three (3) minutes in any 60 minute period.

b. Notwithstanding any other provisions of this permit, the prohibitions of Site Level Condition IV.23 may be enforced by any municipal or local government unit having jurisdiction over the place where such demolition activities occur. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by Article XXI §2109.02 for any violations of Site Level Condition IV.23.

24. Fugitive Emissions (§2105.49)

The person responsible for a source of fugitive emissions, in addition to complying with all other applicable provisions of this permit shall take all reasonable actions to prevent fugitive air contaminants from becoming airborne. Such actions may include, but are not limited to:

a. The use of asphalt, oil, water, or suitable chemicals for dust control;
b. The paving and maintenance of roadways, parking lots and the like;
c. The prompt removal of earth or other material which has been deposited by leaks from transport,

erosion or other means;
d. The adoption of work or other practices to minimize emissions;
e. Enclosure of the source; and
f. The proper hooding, venting, and collection of fugitive emissions.

25. Episode Plans (§2106.02)

The permittee shall upon written request of the Department, submit a source curtailment plan, consistent with good industrial practice and safe operating procedures, designed to reduce emissions of air contaminants during air pollution episodes. Such plans shall meet the requirements of Article XXI §2106.02.

26. New Source Performance Standards (§2105.05)

a. It shall be a violation of this permit giving rise to the remedies provided by §2109.02 of Article XXI for any person to operate, or allow to be operated, any source in a manner that does not comply with all requirements of any applicable NSPS now or hereafter established by the EPA, except if such person has obtained from EPA a waiver pursuant to Section 111 or Section 129 of the Clean Air Act or is otherwise lawfully temporarily relieved of the duty to comply with such requirements.

b. Any person who operates, or allows to be operated, any source subject to any NSPS shall conduct, or cause to be conducted, such tests, measurements, monitoring and the like as is required by such standard. All notices, reports, test results and the like as are required by such standard shall be submitted to the Department in the manner and time specified by such standard. All information, data and the like which is required to be maintained by such standard shall be made available to the Department upon request for inspection and copying.

27. Miscellaneous Organic Chemical Manufacturing NESHAP (40 CFR Part 63, Subpart FFFF)

The permittee shall comply with all applicable requirements of the National Emission Standards for Hazardous Air Pollutants, 40 CFR Part 63, Subpart FFFF – the “Miscellaneous Organic Chemical Manufacturing NESHAP” or “MON”.

V. EMISSION UNIT LEVEL TERMS AND CONDITIONS

A. C-5 – Storage Tanks

1. Restrictions:

Continue to comply with all applicable regulatory and Permit requirements. [2102.04.b.5]

2. Work Practice Standard:

a. The permittee shall do the following for all storage tanks and associated equipment: [§2105.03; 25 PA Code §129.99]
   1) Perform regular maintenance considering the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The storage tanks shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

B. C-5 Operations – Pastillating Belts #1 and #2 (S055)

1. Restrictions:

Continue to comply with all applicable regulatory and Permit requirements. [2102.04.b.5]

2. Work Practice Standard:

The permittee shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices. [§2102.04.e; RACT Order #257, condition 1.7; 25 PA Code §129.99]

C. MP Poly Unit (S034)

1. Restrictions:

a. Continue to comply with all applicable regulatory and Permit requirements. [2102.04.b.5]

b. The permittee shall properly maintain and operate the condensers E-400-6, E-500-5, E-701-5, E-701-4, and E-203-4 at all times when emissions are routed to them. [§2105.03; RACT Order #257, condition 1.7; 25 PA Code §129.99]

c. The inlet coolant temperature to the condensers E-203-4 (S035) and E-701-4 (S034) shall not exceed 10°C (50°F) over any one-hour block average when emissions are routed through the condensers with the exception of activities to mitigate emergency conditions. [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.2.A; 25 PA Code §129.99]

2. Monitoring Requirements:

The permittee shall install, operate, and maintain an inlet coolant temperature instrument on E-203-4, E-701-4, and E-400-6 condensers that continuously monitors the coolant inlet temperature. The temperature probes used shall be certified by the manufacturer to be accurate to within 2% of the temperature measured in Celsius or to within 2.5°C, whichever is greater. The permittee shall record the coolant inlet temperature at least once every 15 minutes while the equipment associated with the temperature probe and transmitter is in operation. [§2102.04.b.6; §2103.12.i; RACT Order #257, condition 1.1 and 1.2; 25 PA Code §129.99]

3. Record Keeping Requirements:

The permittee shall keep and maintain records of monthly and twelve months moving polymerizate production and condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

4. Work Practice Standard:

The permittee shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices. [§2102.04.e; RACT Order #257, condition 1.7; 25 PA Code §129.99]

D. WW Poly Unit (S013, S013a, S020, S023, S027)

1. Restrictions:

a. Continue to comply with all applicable regulatory and Permit requirements. [2102.04.b.5]

b. Refrigerated vent condensers [E-200-7 (S013), E-600-9 and E-601-11 (S017), E-700-6 (S018), E-900-7 (S020), E-701-7 (S021), E-903-3 (S023), and E-901-7 (S027)]: The condensers shall be properly maintained and operated according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, conditions 1.3 and 1.4; 25 PA Code §129.99]

1) The inlet coolant temperature to each condenser shall not exceed 10°C any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions;
2) The exit vapor temperature of each condenser shall not exceed 35°C over any one-hour block average when emissions are being routed through them, except as specified in condition V.D.1.b.3) below;
3) If measured one-hour block average exit vapor temperatures exceed 35°C from a condenser, the permittee shall take the following actions:
   a) Confirm that the glycol cooler is operating properly by reviewing current operating conditions (e.g. that the chiller system is operating and circulating coolant, and that glycol coolant is being supplied at less than 10°C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°C. Exit vapor temperature exceeding 35°C due to solely to high ambient temperatures shall be documented per paragraph b.
   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 35°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 50°F (10°C), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.

   c) Periods of exit vapor temperatures in excess of 35°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

2. Monitoring Requirements:

The permittee shall install, operate, and maintain an inlet coolant temperature instrument on E-200-7, E-300-4, E-301-4, E-600-9, E-601-11, E-700-6, E-701-7, E-800-3, E-900-7, E-901-7, E-903-3, and E-1001-7 condensers that continuously monitor the coolant inlet temperature. The temperature probes used shall be certified by the manufacturer to be accurate to within 2% of the temperature measured in Celsius or to within 2.5°C, whichever is greater. The permittee shall record the coolant inlet temperature at least once every 15 minutes while the equipment associated with the temperature probe and transmitter is in operation. [§2102.04.b.6; §2103.12.i; RACT Order #257, conditions 1.1 -1.3; 25 PA Code §129.99]

3. Record Keeping Requirements:

The permittee shall keep and maintain records of monthly and twelve months moving polymerizate production and condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

4. Work Practice Standard:

The permittee shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices. [§2102.04.e; RACT Order #257, condition 1.7; 25 PA Code §129.99]

E. WW Poly Storage Tanks (S025)

1. Restrictions:

a. Continue to comply with all applicable regulatory and Permit requirements. [2102.04.b.5]

b. The inlet coolant temperature to the condensers E-201-1, E-202-1, and E-67-3 shall not exceed 10°C (50°F) over any one-hour block average when emissions are routed through the condensers with the exception of activities to mitigate emergency conditions. [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.4; 25 PA Code §129.99]

2. Record Keeping Requirements:

The permittee shall keep and maintain records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

3. Work Practice Standard:

The permittee shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices. [§2102.04.e; RACT Order #257, condition 1.7; 25 PA Code §129.99]

F. LTC Process Operations (S109, S110, S114)

1. Restrictions:

a. Continue to comply with all applicable regulatory and Permit requirements. [2102.04.b.5]

b. Cooling tower water chilled vent condensers [E-301B-E3 (S109); E-301-4 (S108); E-607-2 (S110); E-RK5-4 (S111); E-RK6-3 (S112); E-RK7-4 (S113)]: The condensers shall be properly operated and maintained according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06(b)3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.1.H; 25 PA Code §129.99]

1) The inlet coolant temperature to each condenser shall not exceed 10°F (5.6°C) above ambient air temperature over any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions and except that at no time will coolant temperature be required to be less than 50°F (10°C).
2) The exit vapor temperature of each condenser shall not exceed 40°C over any one-hour block average when emissions are being routed through them, except as specified in paragraph 3).
3) If measured one-hour block average exit vapor temperatures exceed 40°C from a condenser, the permittee shall take the following actions:
   a) Confirm that the cooling tower is operating properly by reviewing current operating conditions (e.g. that the cooling system is operating and circulating cooling water, and that cooling water is being supplied at less than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to less than 50°F (10 °C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to less than 50°F (10 °C)). Exit vapor temperature exceeding 40°C due to solely to high ambient temperatures shall be documented per paragraph b.

   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 40°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to be less than 50°F (10°C)), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.

   c) Periods of exit vapor temperatures in excess of 40°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

2. Monitoring Requirements:

a. The permittee shall monitor and record the exit vapor temperature of each of the following condensers at least once every 15 minutes when the process is in operation: S108, S109, S110, S111, S112, S113, and S124. [§2102.04.b.6, §2102.04.e., §2103.12.i; 25 PA Code §129.100]

b. The permittee shall continuously monitor when the vacuum pump for each system is in operation. [§2102.04.b.6, §2102.04.e., §2103.12.i; 25 PA Code §129.100]

3. Record Keeping Requirements:

a. The permittee shall keep and maintain the following data on-site for these operations [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]:

1) All records of monitoring required by V.F.2 above.
2) Records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment.
3) Maximum resin (lb/min) and polymerizate (gal/min) feed rates (daily).
4) Amount (lbs.) and type of resin and polymerizate (monthly, 12-month rolling total)
5) Changes in #4 LTC Vacuum System vacuum pump status (upon occurrence).
6) Any additional data/records not provided by items V.F.2.a.1) and V.F.2.a.2) above that are necessary to accurately assess emissions in accordance with the EIIP methodology.

4. Work Practice Standard:

The permittee shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices. [§2102.04.e; RACT Order #257, condition 1.7; 25 PA Code §129.99]

G. Dresinate Production Line (S085)

1. Restrictions:

Continue to comply with all applicable regulatory and Permit requirements. [2102.04.b.5]

2. Work Practice Standard:

The permittee shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices. [§2102.04.e; RACT Order #257, condition 1.7; 25 PA Code §129.99]

H. Hydrogenation Unit (S004, S007, S012)

1. Restrictions:

a. The maximum production rate for Hydrogenation Unit process shall not exceed 22 million pounds per 12-month rolling period. [§2102.04.e; 25 PA Code §129.99]

b. Refrigerated vent condensers: The condensers shall be properly maintained and operated according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, conditions 1.3 and 1.4; 25 PA Code §129.99]

1) The inlet coolant temperature to each condenser shall not exceed 10°C any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions;
2) The exit vapor temperature of each condenser shall not exceed 35°C over any one-hour block average when emissions are being routed through them, except as specified in condition V.H.1.b.3) below;
3) If measured one-hour block average exit vapor temperatures exceed 35°C from a condenser, the permittee shall take the following actions:
   a) Confirm that the glycol cooler is operating properly by reviewing current operating conditions (e.g. that the chiller system is operating and circulating coolant, and that glycol coolant is being supplied at less than 10°C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°C. Exit vapor temperature exceeding 35°C due to solely to high ambient temperatures shall be documented per paragraph b.
   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 35°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 50°F (10°C), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.

   c) Periods of exit vapor temperatures in excess of 35°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

2. Record Keeping Requirements:

The permittee shall keep and maintain production records and records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

3. Work Practice Standard:

The permittee shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices. [§2102.04.e; RACT Order #257, condition 1.7; 25 PA Code §129.99]

I. Wastewater Treatment Plant (F027, F033, F034, F035)

1. Work Practice Standard:

The permittee shall properly maintain and operate all existing process equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices.[§2102.04.e; RACT Order #257, condition 1.7; 25 PA Code §129.99]

VI. ALTERNATIVE OPERATING SCENARIOS

There are no alternative operating scenarios for this permit

ALLEGHENY COUNTY HEALTH DEPARTMENT
AIR QUALITY PROGRAM

February 7, 2020

SUBJECT: **Reasonably Available Control Technology (RACT II) Determination**
Eastman Chemical Resins, Inc.
Jefferson Site
2200 State Highway 837,
West Elizabeth, PA 15088-7311
Allegheny County

Installation Permit No. 0058-I026

TO: JoAnn Truchan, P.E.
Section Chief, Engineering

FROM: Helen O. Gurvich
Air Quality Engineer

I. Executive Summary

Eastman Chemical Resins, Inc., Jefferson Site facility (Eastman) is defined as a major source of VOC emissions and was subjected to a Reasonable Achievable Control Technology (RACT II) review by the Allegheny County Health Department (ACHD) required for the 1997 and 2008 Ozone National Ambient Air Quality Standard (NAAQS). The findings of the review established that the facility has technically feasible controls options for controlling VOC emissions from the processes, but they are deemed financially infeasible due to their high cost per ton removed.

These findings are based on the following documents:

- RACT analysis performed by ERG (Eastman Chemical RACT Evaluations_9-23-15.docs)
- RACT analysis performed by Eastman Chemical Resins, Inc. (Eastman_RACT2_Report_20200115.pdf)
- Installation Permit No. 0058-I011d dated 5/15/2019
- Installation Permit No. 0058-I018a dated 3/07/2019
- Installation Permit No. 0058-I022a dated 9/20/2019
- Installation Permit No. 0058-I023a dated 12/23/2019
- Installation Permit No. 0058-I016a dated (not issue yet)
- Installation Permit No. 0058-I012a dated 10/30/2008
- Installation Permit No. 0058-I017 dated 7/22/2010
- Consent Order and Agreement No. 257 (RACT I) dated January 14, 1997
- New Installation Permit Application submitted December 13, 2019
- New Installation Permit Application submitted January 24, 2020

II. Regulatory Basis

ACHD requested all major sources of NO_X (potential emissions of 100 tons per year or greater) and all major sources of VOC (potential emissions of 50 tons per year or greater) to reevaluate NO_X and/or VOC RACT for incorporation into Allegheny County's portion of the PA SIP. This document is the result of ACHD's determination of RACT for Eastman based on the materials submitted by the subject source and other relevant information.

III. Facility Description

The Eastman Chemical Resins, Inc., Jefferson Site facility (Eastman) produces synthetic hydrocarbon resins from C_5 feedstock, monomers, solvents and catalysts by way of cationic polymerization. Resins produced include aliphatic, aliphatic/aromatic, aromatic and liquid resins for use in adhesives, plastics, rubber, graphic arts and numerous other products.

The plant is comprised of three polymerization processes (C5, MP-Poly, and WW-Poly), a resin hydrogenation process, four finishing processes (LTC1, LTC2, and C-5), and an emulsion process, five boilers ranging from 18.6 MM Btu/hr to 38.2 MM Btu/hr, a wastewater treatment plant, a pilot plant for testing formulations and processes and approximately 200 storage tanks of various sizes.

The facility is a major source of Volatile Organic Compounds (VOC) and Hazardous Air Pollutants (HAPs) as defined in Article XXI, 2101.20. Detailed descriptions of the relevant emissions units are provided in the following tables.

Table 1 Facility Sources Subject to Case-by-Case RACT II and Their Existing RACT I Limits

Source ID	Description	Rating	VOC PTE (TPY)	VOC Presumptive Limit (RACT II)	VOC Limit (RACT I) – Consent Order No. 257
S216	Raw material tank T-50 – C-5 operations (IP #0058-I011d)	528,765 gal	2.8	Compliance with Article XXI, §2105.12	Compliance with Article XXI, §2105.12
S055	Pastillating Belts, UHF Filter – C-5 operations (IP #0058-I018a)	22,000 lbs/hr	6.21	25 Pa Code 129.99	Good operating practices
S034	Filtrate system (filtrate receiver, neutralizer, solvent wash tank, heel tank, Funda filter) – MP Poly Unit (IP #0058-I022a)	103,000,000 lbs/yr	10.33	25 Pa Code 129.99	Condensers, good operating practices
S013 & S013a	Feed dryers and regeneration – WW Poly Unit (IP #0058-I023a)	80,000,000 lbs/yr	4.86	25 Pa Code 129.99	Condensers, good operating practices
S020	West Filtrate Receiver - WW Poly Unit (IP #0058-I023a)	80,000,000 lbs/yr	5.11	25 Pa Code 129.99	Condensers, good operating practices
S023	Solvent Wash Receiver - WW Poly Unit (IP #0058-I023a)	80,000,000 lbs/yr	7.52	25 Pa Code 129.99	Good operating practices
S027	East Filtrate Receiver - WW Poly Unit (IP #0058-I023a)	80,000,000 lbs/yr	5.11	25 Pa Code 129.99	Good operating practices
S025	Storage Tanks 73/75/76/77- WW Poly Unit (IP #0058-I023a)	75,200 gal each	5.4	25 Pa Code 129.99	Good operating practices
S109	#1 Vacuum System – LTC Process (IP #0058-I016a)	67,240,000 lbs/yr	3.80	25 Pa Code 129.99	Good operating practices
S110	#2 Vacuum System – LTC Process (IP #0058-I016a)	67,240,000 lbs/yr	8.09	25 Pa Code 129.99	Good operating practices
S114	#1/#2 Pastillator Belt – LTC Process (IP #0058-I016a)	67,240,000 lbs/yr	2.80	25 Pa Code 129.99	Good operating practices
S004	Metering Tanks (tanks 103 and 104, catalyst catch tank, Mott filter, Heel tank) – Hydrogenation Unit (based on December 2019 testing by Eastman)	22,500,000 lbs/yr	13	Throughput restriction of 22.5 MM lbs/yr, 25 Pa Code 129.99	Condensers, good operating practices
S012	Storage tanks 102, 105, 106 - Hydrogenation Unit (based on December 2019 testing by Eastman)	2 - 6,000 gal each; 1 – 10,000 gal	6.3	Throughput restriction of 22.5 MM lbs/yr, 25 Pa Code 129.99	Condensers, good operating practices

Source ID	Description	Rating	VOC PTE (TPY)	VOC Presumptive Limit (RACT II)	VOC Limit (RACT I) – Consent Order No. 257
S007	Vent tanks, Autoclaves #1 and #2 - Hydrogenation Unit (based on December 2019 testing by Eastman)	Autoclaves - 1,000 gal each	15	Throughput restriction of 22.5 MM lbs/yr, 25 Pa Code 129.99	Condensers, good operating practices
F033, F034, F035	Tanks 702A, 702B, 702C – Wastewater Treatment Plant (new IP application)	50,000 gal each	8.84	25 Pa Code 129.99	Good operating practices
F027	Bio Aeration Tank - Wastewater Treatment Plant (new IP application)	157,000 gal	15.25	25 Pa Code 129.99	Good operating practices
S085	Double Drum Dryer – Dresinate Production Line (IP #0058-I012a)	500 lbs/hr	5.48	25 Pa Code 129.99	Good operating practices
	Fugitive Emissions from Equipment Leaks (valves, pumps, pipe connectors, etc.)	NA	64.10	25 Pa Code 129.99	LDAR program

Table 2 Facility Sources Subject to Presumptive RACT II per PA Code 129.97

Description	Rating	Stack ID	VOC PTE (TPY)	Basis for Presumptive	Presumptive RACT Requirement
C-5 Operations (Installation Permit #0058-I011d)					
Resin Kettles #9 and #10	140 MM lbs/yr	S053, S054	1.81	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Resin Storage Tanks (121, 123, 124, 366, 367, 601 & 602)	19,432 – 108,291 gal	S064, S066, S097, S267 – S270	1.774	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Resin Storage Tank 504 and 161	60,914 & 158,630 gal	S059, S238	2.00	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Raw material tank T-54	1,469,451 gal	S060	1.66	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Raw material tank T-55	579,586 gal	S061	1.16	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
C-5 Operations (Installation Permit #0058-I018a)					
Pastillating Belts (Fugitive)	22,000 lbs/hr	S055	1.09	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
C-5 Operations (Installation Permit #0058-I017)					
Storage tank 52	525,000 gal	S218	2.37	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
MP Polymerization Unit (Installation Permit #0058-I022a)					
Reactor	103 MM lbs/yr	S029	1.65	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the

Description	Rating	Stack ID	VOC PTE (TPY)	Basis for Presumptive	Presumptive RACT Requirement
					manufacturer's specifications and with good operating practices
WW Polymerization Unit (Installation Permit #0058-I023a)					
North and South Reactors	80 MM lbs/yr	S017	1.78	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Storage tanks 68/69/74	75,200 gal each	S024	1.4	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
WW Polymerization Unit (new IP application)					
Storage Tank 35	169,000 gal	S075	1.0	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
LTC Process Operations (Installation Permit #0058-I016a)					
#4 Vacuum System	67.24 MM lb/yr	S124	1.46	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Hydrogenation Unit (based on December 2019 testing)					
Storage tanks 100 and 101	6,000 gal each	S001	1.2	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Pilot Plant (new IP application)					
Neutralizer and reactor	21 acfm	S155	2.2	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Emulsion Process (based on stack testing in 2007)					
Tank RK2	1,000 gal	NA	1.21	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices
Other Storage Tank (new IP application)					
Storage Tank 78	169,000 gal	S232	1.0	< 2.7 TPY VOC	Install, maintain and operate the source in accordance with the manufacturer's specifications and with good operating practices

Table 3 Facility Sources Exempt from RACT II per PA Code 129.96(c) {< 1 TPY NO_X; < 1 TPY VOC}

Description	Rating	Stack ID	VOC PTE (TPY)
C-5 Operations (Installation Permit #0058-I011d)			
Thermal Oxidizer or Carbon Beds for 500 battery tanks, if TO downtime	140 MM lbs/yr	S044 S044A	0.26
Hot Oil Furnace	10.33 MMBtu/hr	S056	0.29
Resin Kettle #8	140 MM lbs/yr	S052	0.38
Sparkler Filter with condenser	140 MM lbs/yr	S312	0.05
Sparkler Precoat	140 MM lbs/yr	NA	0.01
Resin Product Loading	140 MM lbs/yr	NA	0.94
Raw material tank T-500	112,251 gal	S058	0.19
Raw material tank T-511	15,228 gal	S274	0.1

Description	Rating	Stack ID	VOC PTE (TPY)
MP Polymerization Unit (Installation Permit #0058-I022a)			
Storage tank T-301	75,202 gal	NA	0.46
Storage tank T-302	75,202 gal	NA	0.46
Storage tank T-303	75,202 gal	NA	0.46
Preblend Tank	103 MM lbs/yr	S035	0.99
Dryers regeneration, Precoat tank, Mole sieve drain tank	103 MM lbs/yr	S033	0.51
WW Polymerization Unit (Installation Permit #0058-I023a)			
East Preblend tank	80 MM lbs/yr	S014	0.57
North Preblend tank	80 MM lbs/yr	S015	0.57
Slurry tank	80 MM lbs/yr	S016	0.02
North Neutralizer	80 MM lbs/yr	S018	0.31
Funda Filter Steam Out/Flushing	80 MM lbs/yr	S019	0.01
Funda Filter Condensate Tank	80 MM lbs/yr	S019a	0.00
South Neutralizer	80 MM lbs/yr	S021	0.31
Reclaim Pot	80 MM lbs/yr	S022	0.13
Storage Tank 10	110,159 gal	S195	0.29
Storage Tank 22	15,863 gal	S206	0.03
Storage Tank 24	15,863 gal	S208	
Storage Tank 23	15,863 gal	S207	0.03
Storage Tank 25	15,863 gal	S209	
Storage Tank 27	16,257 gal	S211	0.04
Storage Tank 26	16,257 gal	S210	0.42
Storage Tank 28	16,257 gal	S212	
Storage Tank 29	16,257 gal	S213	
Storage Tank 34	169,000 gal	S074	0.27
Storage Tank 71	75,200 gal	S230	0.29
Storage Tank 72	75,200 gal	S231	0.42
Storage Tank 200	25,381 gal	S239	0.18
Storage Tank 201	25,381 gal	S240	
Storage Tank 202	25,381 gal	S241	
Storage Tank 204	41,878 gal	S300	0.04
Storage Tank 205	25,381 gal		
Storage Tank 206	25,381 gal		
Storage Tank 207	25,381 gal		
Storage Tank 66	75,200 gal	S228	0.3
Storage Tank 67	75,200 gal	S026	0.9
LTC Process Operations (Installation Permit #0058-I016a)			
Reclaim Solution Tank	67.24 MM lbs/yr	S108	0.58
Resin Kettle #5	67.24 MM lbs/yr	S111	0.32
Resin Kettle #6	67.24 MM lbs/yr	S112	0.24
Resin Kettle #7	67.24 MM lbs/yr	S113	0.68
Berndorf Belt	67.24 MM lbs/yr	S165	0.53
#1/#2 oil/water separator	67.24 MM lbs/yr	S110A	0.01
#4 oil/water separator	67.24 MM lbs/yr	S125	0.01
Drumming operation	67.24 MM lbs/yr	NA	0.18
Truck loading	67.24 MM lbs/yr	NA	0.37
LTC #2 Heater	8.8 MM Btu/hr	S107	0.25
LTC #4 Heater	10 MM Btu/hr	S119	0.28
Wastewater Treatment Plant (new IP application)			
Tanks 701A and 701B, Back Porch Sumps	Tanks – 50,000 gal ea.; sumps – 17,500 gal total	S147	0.48
Bio Clarifier	55,000 gal	F028	0.11
Sludge Batch Tank	5,200 gal	F036	0.00
Sludge Solids Handling	6,000 gal	F037	0.00

Description	Rating	Stack ID	VOC PTE (TPY)
Dresinate Production Line (Installation Permit #0058-I012a)			
Tank R-1-A	67,631 gal	S187	0.01
Tank 782	10,000 gal	S290	0.01
Emulsion Process (based on stack testing in 2007)			
Tank RK1	1,000 gal	-	0.67
Blend tanks 1, 2, 3, and 4	1,2 – 6,000 gal each; 3,4 – 5,000 gal each	S162	0.28
Other Storage Tanks (Eastman judgement, based on material stored)			
Tank 4	88,122 gal	NA	<1
Tank 80	11,982 gal	NA	<1
Tank 151	1,503,943 gal	NA	<1
Tank 208	25,379 gal	NA	<1
Tank 252	30,455 gal	NA	<1
Tank 261	20,000 gal	NA	<1
Tank 262	20,079 gal	NA	<1
Tank 263	20,726 gal	NA	<1
Tank 264	20,000 gal	NA	<1
Tank 265	21,134 gal	NA	<1
Tank 365	20,000 gal	NA	<1
Tank 511	16,356 gal	NA	<1
Tank 761	10,000 gal	NA	<1
Tank 764	17,500 gal	NA	<1
Tank 766	3,800 gal	NA	<1
Tank 775	8,768 gal	NA	<1
Tank 783	11,400 gal	NA	<1
Combustion Sources			
Unilux Boiler 1 (IP #0058-I020)	18.6 MM Btu/hr	S141	0.44
Unilux Boiler 2 (IP #0058-I020)	18.6 MM Btu/hr	S141	0.44
Unilux Boiler 3 (IP #0058-I020)	18.6 MM Btu/hr	S143	0.44
Unilux Boiler 4 (IP #0058-I020)	18.6 MM Btu/hr	S142	0.44
Boiler house emergency generator (IP #0058-I020)	250 kW	F100	0.01
Trane Boiler	38 MM Btu/hr	S144	0.92

IV. RACT Determination

Two detailed RACT Reviews were performed to evaluate the Eastman facility; one was performed by Eastman, and one by Allegheny County Health Department (ACHD). Both submissions were considered in the final RACT disposition for the Facility and findings from each were incorporated into the ACHD RACT II Determination.

It has been determined that it is not technically feasible to capture and control the following sources that are subject to case-by-case analysis:

- Raw material tank T-50 (C-5 operations): this tank is internal floating roof tank. There is no reasonable method to capture emissions from floating roof tank.
- Tanks 702A, 702B, 702C (Wastewater Treatment Plant): all of these tanks are open-top tanks used for pre-treatment prior to the biological treatment operations. There is no reasonable method to capture emissions from these open-top tanks.
- Bio Aeration Tank (Wastewater Treatment Plant): this biological treatment tank is open to the atmosphere. There is no reasonable method to capture the emissions from this operation.

The Technically Feasible Control Options for sources where is it was determined that an economic analysis is required for Eastman are detailed in Table 4. All control cost analyses were conducted pursuant to procedures provided in US EPA's Office of Air Quality Planning and Standards (OAQPS) Control Cost Manual, 7th Edition.

Table 4 – Technically Feasible VOC Control Cost Comparisons

Control Option		S109 LTC	S110 LTC	S114 LTC	S013 & S013a WW Poly	S020 WW Poly	S023 WW Poly	S027 WW Poly
Thermal Oxidation (98%)	tpy VOC Removed	3.6	7.6	2.6	4.6	4.8	7.1	4.8
	Cost	$143,908	$148,047	$311,632	$156,264	$183,607	$175,518	$175,934
	$/ton	40,137	19,443	118,251	34,162	38,176	24,798	36,653
Catalytic Oxidation (98%)	tpy VOC Removed	3.6	7.6	2.6	4.6	4.8	7.1	4.8
	Cost	$134,852	$135,637	$254,524	$138,270	$154,741	$148,790	$149,202
	$/ton	37,705	17,814	96,581	30,228	32,174	21,022	31,084
Carbon Adsorption (fixed bed) (90-95%)	tpy VOC Removed	3.5	7.4	2.4	4.4	4.7	6.9	4.7
	Cost	$181,762	$179,679	$180,804	$154,297	$156,903	$156,790	$155,442
	$/ton	52,426	24,343	74,706	34,797	33,654	22,852	33,073
Rotary Concentrator/ Oxidation (98%)	tpy VOC Removed	3.6	7.6	2.6	4.6	4.8	7.1	4.8
	Cost	$184,606	$184,634	$219,307	$184,832	$187,503	$186,464	$186,464
	$/ton	51,616	24,249	83,218	40,408	38,986	26,345	38,847
Refrigerated Condenser (95%)	tpy VOC Removed	3.5	7.4	2.6	4.4	4.7	6.9	4.7
	Cost	$136,399	$138,457	$1,296,659	$149,704	$219,179	$189,142	$192,802
	$/ton	39,342	18,758	507,565	33,761	47,011	27,567	41,022

Table 4 – Technically Feasible VOC Control Cost Comparisons (continue)

Control Option		S025 WW Poly	S055 C-5	S034 MP Poly	S004 Hydro	S007 Hydro	S012 Hydro	S085 Dresinate
Thermal Oxidation (98%)	tpy VOC Removed	5.1	5.8	9.7	12.2	14.1	5.9	5.2
	Cost	$154,798	$526,415	$177,803	$165,140	$174,148	$146,413	$345,875
	$/ton	30,178	90,761	18,288	13,536	12,335	24,692	66,816
Catalytic Oxidation (98%)	tpy VOC Removed	5.1	5.8	9.7	12.2	14.1	5.9	5.2
	Cost	$137,691	$412,727	$150,236	$142,844	$147,584	$135,286	$280,531
	$/ton	26,843	71,160	15,452	11,708	10,454	22,816	54,193
Carbon Adsorption (fixed bed) (90-95%)	tpy VOC Removed	5.0	5.4	8.9	10.3	13.0	5.4	4.8
	Cost	$156,423	$207,403	$158,992	$161,638	$161,521	$180,771	$186,358
	$/ton	31,458	38,408	17,807	15,693	12,458	33,197	39,200
Rotary Concentrator/ Oxidation (98%)	tpy VOC Removed	5.1	5.8	9.7	12.2	14.1	5.9	5.2
	Cost	$184,776	$285,728	$186,833	$185,480	$186,486	$184,620	$229,409
	$/ton	36,022	49,263	19,216	15,203	13,209	31,136	44,317
Refrigerated Condenser (95%)	tpy VOC Removed	5.0	5.7	9.4	11.5	13.7	5.7	5.0
	Cost	$146,875	$2,920,397	$193,751	$160,986	$182,016	$137,554	$1,504,896
	$/ton	29,538	512,350	20,557	13,999	13,300	23,931	299,894

ACHD has determined that thermal oxidation, catalytic oxidation, carbon adsorption (fixed bed), rotary concentrator/oxidation, and refrigerated condenser are technically feasible control options for controlling VOC emissions from the processes of the Eastman facility, but they are deemed financially infeasible due to their high cost per ton removed.

ACHD has determined that that it was unnecessary to conduct RACT evaluations on the equipment leak emissions for processes WW Poly, MP Poly, or the LTC process lines. The source is subject to the MON. Under the MON, the source is required to have a Leak Detection and Repair (LDAR) program. These requirements are relatively stringent, and ACHD does not believe more stringent requirements would be considered cost-effective. The LDAR requirements of the MON are considered RACT for the emissions from equipment leaks.

V. RACT Summary

Based on the findings in this RACT analysis, the Eastman facility has few technically feasible controls options for controlling VOC emissions from the processes, but they are deemed financially infeasible due to their high cost per ton removed.

The potential VOC emissions from the Hydro operations are based on the results of the stack test conducted in December 2019 and a throughput restriction of 22,500,000 lbs/year. Eastman proposes that RACT II for Hydro is a throughput limit of 22,500,000 lbs/year. The upcoming Installation Permit application for this process will be based on that limit.

The new RACT II conditions will not result in any additional reductions in VOC from the Eastman. The conditions of Plan Approval Order and Agreement #257 (RACT I), issued January 14, 1997, have been superseded by the case-by-case and presumptive RACT II conditions in this proposed permit. The RACT II conditions are at least as stringent as those from RACT I.

VI. RACT II Permit Conditions

Source ID	Description	Permit Condition 0058-I026	RACT II Regulations
Storage Tanks	C-5 Operations (Installation Permit #0058-I011d)	Condition V.A.2.a Condition V.A.2.b	25 PA Code §129.99 25 PA Code §129.99
S055	C-5 Operations (Installation Permit #0058-I018a)	Condition V.B.2	25 PA Code §129.99
S034	MP Poly Unit (Installation Permit #0058-I022a)	Condition V.C.1.b Condition V.C.1.c Condition V.C.2 Condition V.C.3 Condition V.C.4	25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S013, S013a, S020, S023, S027	WW Poly Unit (Installation Permit #0058-I023a)	Condition V.D.1.b Condition V.D.2 Condition V.D.3 Condition V.D.4	25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
S025	WW Poly Storage Tanks (Installation Permit #0058-I023a)	Condition V.E.1.b Condition V.E.2 Condition V.E.3	25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99

Source ID	**Description**	**Permit Condition 0058-I026**	**RACT II Regulations**
S109, S110, S114	LTC Process Operations (Installation Permit #0058-I016a)	Condition V.F.1.b Condition V.F.2.a Condition V.F.2.b Condition V.F.3.a Condition V.F.4	25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.100 25 PA Code §129.100 25 PA Code §129.99
S085	Dresinate Production Line (Installation Permit #0058-I012a)	Condition V.G.2	25 PA Code §129.99
S004, S007, S012	Hydrogenation Unit	Condition V.H.1.a Condition V.H.1.b Condition V.H.2 Condition V.H.3	25 PA Code §129.99 25 PA Code §129.99 25 PA Code §129.100 25 PA Code §129.99
F027, F033, F034, F035	Wastewater Treatment Plant	Condition V.I.1	25 PA Code §129.99

Allegheny County Health Department
Office of Air Quality

Technical Support Document (TSD) - REASONABLY AVAILABLE CONTROL TECHNOLOGY (RACT) DETERMINATION

Source Information

Source Name:	Eastman Chemical Resins, Inc.
Source Location:	220 State Route 837, West Elizabeth, PA 15088
Mailing Address:	P.O. Box 545, West Elizabeth, PA 15088
County:	Allegheny County
SIC Code:	2821 (Plastics Materials, Synthetic Resins)
NAICS Code:	325211 (Plastics Material and Resin Manufacturing)
Part 70 Permit No.:	0058
Major Source:	VOC
Permit Reviewer:	ERG/ST

The Allegheny County Health Department (ACHD) has performed the following Reasonably Available Control Technology (RACT) analyses for a major source of VOC relating to a plastics material and synthetic resin manufacturing facility, located in West Elizabeth, Pennsylvania.

Background

Allegheny County was designated marginal nonattainment for the 2008 8-hour ozone on April 30, 2012 (published in 77 FR 30160, May 21, 2012). In order to implement the 2008 NAAQS for ozone, EPA issued a proposed rulemaking in June 2013 to provide steps and standards for states to develop and submit certain materials, dependent on each state's attainment status. Although Allegheny County is designated marginal nonattainment, Pennsylvania is also a part of the Ozone Transport Region (OTR), which must meet more stringent requirements, including submitting a RACT SIP for EPA approval. As such, Allegheny County must reevaluate the NOx and VOC RACT in the existing RACT SIP for the eight-hour ozone NAAQS.

ACHD requested all major sources of NOx (potential emissions of 100 tons per year or greater) and all major sources of VOC (potential emissions of 50 tons per year or greater) to reevaluate NOx and/or VOC RACT for incorporation into Allegheny County's portion of the PA State Implementation Plan (SIP). This document is the result of ACHD's review of the RACT re-evaluations submitted by the subject source and supplemented with additional information as needed by ACHD.

RACT Summary

VOC RACT evaluations were conducted for several equipment and operations at Eastman Chemical Resins, Inc. The RACT determinations are summarized below.

Unit Description	RACT	VOC PTE Before RACT (tpy)	VOC PTE After RACT (tpy)
Liquid Thermal Contact Unit:	Continue operating as permitted, and as required by the Consent Decree.	10.2	10.2

Resin Kettles #5, #6, and #7			
C-5 Polymerization Unit: Pastillating Belts #1 and #2	Continue operating as permitted, and as required by the Consent Decree.	4.5	4.5
Hydrogenation Unit: Vent Tank	Continue operating as permitted, and as required by the Consent Decree.	7.45	7.45
Dresinate TX Production Line: Double Drum	Continue operating as permitted, and as required by the Consent Decree.	5.48	5.48
Total:		**27.6**	**27.6**
Emission Reductions			0
Emission Reductions due to equipment changes:			0

There are no provisions of the Proposed Pennsylvania Presumptive RACT that address VOC emissions from resin manufacturers.

Detailed documentation of the RACT evaluation follows.

RACT Evaluations

RACT is “the lowest emission limitation that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility.” (44 FR 53761, 9/17/1979)

ACHD provided the following guidance to the major sources of NOx and VOC in Allegheny County for performing the RACT analyses:

1. The analysis shall address all reasonably possible controls of VOCs and NOx including changes in operation and work practices.

2. All control technology that is found to be technically infeasible must be accompanied by detailed and documented reason(s) as to why the technology is not feasible. General statements about the non-applicability of control technology to your industry will not be sufficient.

3. All changes in operation and work practices that are found not to be feasible require the same documentation as the controls in step #2 above.

4. All feasible control technology, changes in operation, work practices, etc. that are found to be cost prohibitive require a cost analysis demonstrating the cost per ton of pollutant controlled.

5. The analysis shall be done according to the procedures in EPA’s OAQPS Cost Manual, EPA’s cost spreadsheets are recommended where applicable. The manual and spreadsheets may be found on the CATC/RBLC web page on EPA’s Technology Transfer Network (TTN) at http://www.epa.gov/ttn/catc/.

6. All data used in cost estimates, such as exhaust flow rates or the amount of ductwork used need proper documentation. If vendor quotes are used in the analysis for equipment

costs, they are required to be supplied. Old analyses increased for inflation will not be acceptable. VATAVUK Air Pollution Control Cost Indexes shall be used with the aforementioned cost spreadsheets.

Each RACT analysis section is organized by the following 4 steps, which incorporate the guidance elements provided by Allegheny:

Step 1 – Identify Control Options (guidance element 1)
Step 2 – Eliminate Technically Infeasible Control Options (guidance elements 2 and 3)
Step 3 – Evaluate Control Options, including costs and emission reductions (guidance elements 4, 5, and 6)
Step 4 – Select RACT (guidance element 1)

Source/Process Description

The Eastman Chemical Resins, Inc., West Elizabeth facility produces synthetic hydrocarbon resins from C5 feedstock, C9 feedstock, monomers, solvents and catalysts by way of cationic or thermal polymerization. Resins produced include aliphatic, aliphatic/aromatic, aromatic and liquid resins for use in adhesives, plastics, rubber, graphic arts and numerous other products. The plant is comprised of three polymerization processes (C-5, MP-Poly, and WW-Poly), a resin hydrogenation process, four finishing processes (LTC 1, LTC 2, LTC 4, and C-5), and an emulsion process, boilers providing process heat, a wastewater treatment plant, a pilot plant for testing formulations and processes and approximately 200 storage tanks of various sizes. The facility is a major source of Volatile Organic Compounds (VOC) and Hazardous Air Pollutants (HAPs) as defined in Article XXI, 2101.20. Detailed descriptions of the relevant emissions units are provided in the following sections.

Table 1 shows the emission units that were identified as emitting VOC from this source. This table was developed using the list of emission units included in the 2011 Consent Decree and adding any equipment listed in installation permits that were not addressed in the 2011 Consent Decree. Also, equipment or processes listed in the 2013 actual emissions report submitted by the source that did not appear in the Consent Decree or in past permits were added to the list. Given different naming conventions and especially the generic naming conventions used in the 2013 actual emissions report, it is possible that using these three sources of information has led to redundant entries in Table 1. All efforts were made to avoid redundant entries; however, the titles/descriptions of the equipment did not always have enough detail to determine whether units were the same equipment. Appendix A provides a document that shows the equipment listed in Table 1 and how it was matched with the 2013 actual emissions report.

Those equipment shown in Table 1 that are noted as coming from the "Consent Decree Tanks List" are those tanks listed in Appendix F of the Consent Decree, but are not listed elsewhere in the Consent Decree. Therefore, these tanks are identified as being located at the Eastman facility, but they were not tested as part of the Consent Decree, nor were there any additional information available about the tanks other than what was listed in Appendix F of the Consent Decree.

Table 1: Listing of Emission Units That Emit VOC

Equipment Description	Control and/or Process Device(s)	Capacity	VOC Emissions[a] (tpy)	Stack I.D.	Primary Information Source
Process Unit: Water White Polymerization Unit (WW Poly)					
Feed Dryer	Condensers E-200-6 & E-200-7		2.3	S013	2011 Consent Decree
West Pre-Blend Tank	Condenser E-301-4		0.13	S014	2011 Consent Decree
North Pre-Blend Tank	Condenser E-300-4		0.13	S015	2011 Consent Decree

Equipment Description	Control and/or Process Device(s)	Capacity	VOC Emissions[a] (tpy)	Stack I.D.	Primary Information Source
North Reactor	Condensers E-600-6 & E-600-9		1.3	S017	2011 Consent Decree
South Reactor	Condensers E-601-6 & E-601-11		1.2	S017	2011 Consent Decree
Neutralizer	Condensers E-700-4 & E-700-6		0.48	S018	2011 Consent Decree
Funda Filter Recycle Tank	Carbon Bed A-800-8		[b]	S019a	2011 Consent Decree
Funda Filter Steam Out Process	Condenser E-800-3		0.0002	S019	2011 Consent Decree
Filtrate Receiver	Condenser E-900-7		0.79	S020	2011 Consent Decree
Reclaimer	Condenser E-1001-7		0.57	S022	2011 Consent Decree
Tank 67	Condenser E-67-3	75,000 gal	0.15	S026	2011 Consent Decree
Tanks 68/69/74	Condenser E-201-1	75,000 gal (ea.)	0.12	S024	2011 Consent Decree
Tanks 73/75/76/77	Condenser E-202-1	75,000 gal (ea.)	1.3	S025	2011 Consent Decree
Tanks (Heated) 204/205/206/207	Condensers E-204-4, E-205-4, E-206-4 and E-207-4 & Carbon Beds A-204-5A and5B	25,000 gal (ea., except 204 is 40,000 gal)	0.0547[c,d]	S300	2011 Consent Decree
Equipment Leaks (Process Unit Fugitives)			8[e]		IP 93-1-0012-P
Water-White Poly Area/Slurry Tank			0.0160[c]		2013 Emissions Report
Process Unit: Multipurpose Poly Unit (MP Poly)					
Alumina Dryer	Condenser E-203-4		0.35	S035	2011 Consent Decree
Pre-Blend Tank/Calcium Chloride Dryer					2011 Consent Decree
Heel Tank/Solvent Wash Tank/Filtrate Receiver/Funda Filter	Condensers E-701-5 & E-701-4		0.39	S034	2011 Consent Decree
Reactor	Condenser E-400-6		0.13	S029	2011 Consent Decree
Neutralizer	Condensers E-500-5, E-701-5 & E-701-4		1.71	S034	2011 Consent Decree
Equipment Leaks (Process Unit Fugitives)			62.6[f]		IP-94-1-0069-P
Process Unit: Liquid Thermal Contact (LTC #1/#2/#4)					
#1 Rectification Column/ Vacuum System	Condensers E-301B-E2 & E-301B-E3	No Longer in Operation		S109	2011 Consent Decree
#2 Rectification Column/ Vacuum System	Condensers E-607-1 & E-607-2		0.003	S110	2011 Consent Decree
#4 Rectification Column / Vacuum System	Condenser		0.001	S124	2011 Consent Decree
#1/#2 LTC Pastillating Belt	Scrubber S-127-3		0.9	S114	2011 Consent Decree
Berndorf (#4 LTC) Pastillating Belt	Scrubber S-105-1		0.66	S165	2011 Consent Decree
Reclaim Solution Tank	Condenser E-301-4		0.58	S108	2011 Consent Decree

Equipment Description	Control and/or Process Device(s)	Capacity	VOC Emissions[a] (tpy)	Stack I.D.	Primary Information Source
Resin Kettle 5	Condenser E-RK5-4		3.5[g]	S111	2011 Consent Decree
Resin Kettle 6	Condenser E-RK6-5		3.46[g]	S112	2011 Consent Decree
Resin Kettle 7	Condenser E-RK7-4		3.24[g]	S113	2011 Consent Decree
Drumming Operations			0.234[h]		IP0058-I016
Equipment Leaks (Process Unit Fugitives)			12.605[h]		IP0058-I016
#1 LTC Process heater (Natural Gas)		3 MMBtu/hr	0.465[h]	S106	IP0058-I016
#2 LTC Process heater (Natural Gas)		6.6 MMBtu/hr		S107	
#4 LTC Process heater (Natural Gas)		10 MMBtu/hr		S119	
#3 LTC Unit/Flaker 4 Fume Scrubber			1.9100[c]		2013 Emissions Report
Process Unit: C-5 Polymerization					
C-5 Pastillating Belt #1	UHF Filter S-751-1 and Fume Filter Demister		4.5	S055	2011 Consent Decree
C-5 Pastillating Belt #2					2011 Consent Decree
C-5 Pastillating Belt Fugitives	Fugitives venting to outdoors		0.22	Roof vents	2011 Consent Decree
Tank 504	None		0.24	S059	2011 Consent Decree
Resin Kettle 8	None		0.2	S052	2011 Consent Decree
Tank 500	Thermal Oxidizer B-411-1 or Carbon Beds A3631-1A and 2B		0.009[i]	S044	IP0058-I011a
Tanks 501/502/503/505/506	Thermal Oxidizer B-411-1 or Carbon Beds A3631-1A and 2B				
CaCl2 Dryer	Thermal Oxidizer B-411-1, fired with natural gas				
R-302-1 Reactor					
T-401-1 #1 Neutralizer					
S-405-1A South Funda Filter					
T-40-1 Filtrate Receiver					
T-412-1 Wash Solvent Receiver					
T-502-4 Depentanizer Overheads Receiver					
S-404-11 Pre-coat Knockout Tank					
T-800-1 Reclaim Tank					
T-506-1 Inhibitor make-up tank					
R-303-1 Soaker					
T-402-1 #2 Neutralizer					
S-405-1B North Funda Filter					

Equipment Description	Control and/or Process Device(s)	Capacity	VOC Emissions[a] (tpy)	Stack I.D.	Primary Information Source
T-406-2 Filter Condensate Decanter					
T-412-1 Wash Solvent					
T-404-1 Filter Pre-coat Tank					
T-403-1 Solvent Flush Tank					
T-506-3 Inhibitor Tank					
T-402A-1#2 Neutralizer					
Tank 52 (piperylene)	Internal Floating Roof	525,000	3.6995[c,j]	S218	IP0058-I017
T-54	Floating Roof	125,000			Consent Decree Tank List
T-55	Floating Roof	500,000			Consent Decree Tank List
C5 Hot Oil Heater (natural gas)		10.33 MMBtu/hr	0.24[k]		
C-5 Finishing Area/Past Solid Handling			7.3309[c]		2013 Emissions Report
C-5 Finishing Area/Sparkler Filters			0.0225[c]		2013 Emissions Report
C-5 Finishing Area/Sparkler Precoat Tank			0.0121[c]		2013 Emissions Report
C-5 Finishing Area/Resin Kettle 9/10			0.6803[c]		2013 Emissions Report
Process Unit: Hydrogenation					
Metering Tank	Condensers E-200-6, E-201-2 (aka E-201-1)		0.02	S004	2011 Consent Decree
Tank 103 (formerly Tank. 502)	Condensers E-200-6, E-201-2 (aka E-201-1)				2011 Consent Decree
Tank 104 (formerly Tank 501)	Condensers E-501-4, E-200-6, E-201-2 (aka E-201-1)		0.015	S004	2011 Consent Decree
Autoclave #1	Condensers E-401-2, E-403-2	1000 gal.	0.15	S007	2011 Consent Decree
Autoclave #2	Condensers E-402-2, E-403-2	1000 gal.	0.09	S007	2011 Consent Decree
Vent Tank	Condensers E-303-2 (aka E-303-3), E-401-2, E-402-2, E-403-2		7.45	S007	2011 Consent Decree
Tanks 100/101	Condenser E-101-4	6,000 gal. (ea)	0.52	S001	2011 Consent Decree
Tanks 102/105/106	Condensers E-104-1, E-104-2	6,000 gal (102 & 105) 10,000 gal (106)	1.86	S012	2011 Consent Decree
Hydrogenation Hot Oil Heater (Natural Gas)		20 MMBtu/hr	0.47[k]		
Process Unit: Waste Water Treatment Plant					

Equipment Description	Control and/or Process Device(s)	Capacity	VOC Emissions[a] (tpy)	Stack I.D.	Primary Information Source
Tanks 701 A/B	Condenser E-701-3 & Carbon Beds A-701-5A and 5B		0.68	S147	2011 Consent Decree
Raw/Final/Acid Sump/Flotation	Condenser E-713-2 & Carbon Beds A-701-5A and 5B				2011 Consent Decree
Biotreatment Tank			5.3210[c]		2013 Emissions Report
T-702A,702B 702C			2.1858[c]		2013 Emissions Report
Sludge Batch Tank			0.2810[c]		2013 Emissions Report
Solids Handling Tank			0.2810[c]		2013 Emissions Report
Lime Flash Mix Tank			0.3460[c]		2013 Emissions Report
Bio Clarifier			0.2880[c]		2013 Emissions Report
Storage Tanks/C5 WWTP Storage Tanks			0.9062[c]		2013 Emissions Report
Sumps/Assorted Plant Sumps			4.9221[c]		2013 Emissions Report
Process Unit: Pilot Plant					
Pilot Plant Reactor	Condenser E-113-6 and carbon bed achieving 95% control of VOC			S155	2011 Consent Decree
Pilot Plant Neutralizer and Funda Filter	Condenser E-150-7 and carbon bed achieving 95% control of VOC			S156	2011 Consent Decree
Pilot Plant/Building Exhaust			0.0004[c]		2013 Emissions Report
Process Unit: Storage Tanks					
Tank 34	Emergency waste and storm water tank			S074	2011 Consent Decree
Tank 35		169,000 gal	0.7	S075	2011 Consent Decree
Tank 78		169,000 gal	0.16	S232	2011 Consent Decree
Tank 161		163,000	0.32	S238	2011 Consent Decree
Tanks 160/162	Out of service			N/A	2011 Consent Decree
By-Product Fuel Tank No.4	Condenser and Carbon Adsorption Unit	84,150 gal	0.03[l]	S190	IP 0058-I009
By-Product Fuel Tank No. 21		22,500 gal			
By-Product Fuel Tank No. 253		20,000 gal			
Storage Tanks/Controlled Tanks			0.6714[c]		2013 Emissions Report
Storage Tanks/Styrene Storage Tanks			0.1967[c]		2013 Emissions Report
Storage Tanks/AMS Storage Tanks			0.0904[c]		2013 Emissions Report
Storage Tanks/Toluene Storage Tanks			0.1211[c]		2013 Emissions Report
Storage Tanks/Fuel Oil Storage Tanks			0.0749[c]		2013 Emissions Report
Storage Tanks/RHS Storage Tanks			0.9437[c]		2013 Emissions Report
Storage Tanks/HVD Poly Storage Tanks			0.5645[c]		2013 Emissions Report

Equipment Description	Control and/or Process Device(s)	Capacity	VOC Emissions[a] (tpy)	Stack I.D.	Primary Information Source
Storage Tanks/RHS Poly Storage Tanks			0.5136[c]		2013 Emissions Report
Storage Tanks/SHP Storage Tanks			0.3110[c]		2013 Emissions Report
Storage Tanks/JRAF Storage Tanks			1.9325[c]		2013 Emissions Report
Storage Tanks/A-100 Storage Tanks			0.1610[c]		2013 Emissions Report
Sunpar Oil			0.1608[c]		2013 Emissions Report
PMS Tanks			0.0176[c]		2013 Emissions Report
VT Storage			0.0150[c]		2013 Emissions Report
Emulsion Waste Storage			0.1984[c]		2013 Emissions Report
CTO Storage			0.0063[c]		2013 Emissions Report
T-4-3-A (Heated)		25,000			Consent Decree Tank List
T-4-3-B (Heated)		25,000			Consent Decree Tank List
T-9		110,000			Consent Decree Tank List
T-10		110,000			Consent Decree Tank List
T-16		107,000			Consent Decree Tank List
T-22		15,500			Consent Decree Tank List
T-23		15,500			Consent Decree Tank List
T-24		15,500			Consent Decree Tank List
T-25		15,500			Consent Decree Tank List
T-26		15,000			Consent Decree Tank List
T-27		15,000			Consent Decree Tank List
T-28		15,000			Consent Decree Tank List
T-29		15,000			Consent Decree Tank List
T-50	Floating Roof	52,500			Consent Decree Tank List
T-53		525,000			Consent Decree Tank List
T-66		75,000			Consent Decree Tank List
T-71		75,000			Consent Decree Tank List
T-72		75,000			Consent Decree Tank List
T-82 (Heated)		25,000			Consent Decree Tank List
T-121		20,000			Consent Decree Tank List
T-123		20,000			Consent Decree Tank List
T-124		20,000			Consent Decree Tank List
T-200		25,000			Consent Decree Tank List
T-201		25,000			Consent Decree Tank List
T-202		25,000			Consent Decree Tank List
T-208		25,000			Consent Decree Tank List
T-252		30,000			Consent Decree Tank List
T-301		75,000			Consent Decree Tank List
T-302		75,000			Consent Decree Tank List
T-303		75,000			Consent Decree Tank List
T-365 (Heated)		20,000			Consent Decree Tank List
T-366 (Heated)		25,000			Consent Decree Tank List
T-367 (Heated)		20,000			Consent Decree Tank List
T-511		15,000			Consent Decree Tank List
T-601 (Heated)		750,000			Consent Decree Tank List
T-602 (Heated)		750,000			Consent Decree Tank List
Process Unit: DTX- Dresinate TX Production Line					
Tank R-1-A Crude Tall Oil Storage Tank			Insignificant[m]	S187	

Equipment Description	Control and/or Process Device(s)	Capacity	VOC Emissions[a] (tpy)	Stack I.D.	Primary Information Source
Tank 782 Tall Oil Rosin Storage Tank			Insignificant[m]	S290	IP0058-I012a
Double Drum Dryer			5.48[m]	S085	
Support Services					
B-U1 (Unilux water-tube boiler, Model ZF 1800HS)	Ultra-low NOx Burner - fired with natural gas	18.6 MMBtu/hr	0.44[n]	S141	IP0058-I020
B-U2 (Unilux water-tube boiler, Model ZF 1800HS)	Ultra-low NOx Burner - fired with natural gas	18.6 MMBtu/hr	0.44[n]	S141	IP0058-I020
B-U3 (Unilux water-tube boiler, Model ZF 1800HS)	Ultra-low NOx Burner - fired with natural gas	18.6 MMBtu/hr	0.44[n]	S143	IP0058-I020
B-U4 (Unilux water-tube boiler, Model ZF 1800HS)	Ultra-low NOx Burner - fired with natural gas	18.6 MMBtu/hr	0.44[n]	S143	IP0058-I020
Trane Boiler (Natural Gas)		38 MMBtu/hr	0.89[k]		
Emulsion Ethylene Glycol Heater (Natural Gas)					
Boiler house emergency diesel generator		250 kw	0.01[n]	F100	IP0058-I020
Misc. Natural Gas/Misc. Nat. Gas Usage			0.0400[c]		2013 Emissions Report
#1 & #2 LTC Unit/Truck Loading			0.0080[c]		2013 Emissions Report
Barge Dock			1.4242[c]		2013 Emissions Report
Degreasers			0.8100[c]		2013 Emissions Report

[a] Emissions are from stack tests conducted between 2012 through 2014 in response to the Consent Decree, except where otherwise indicated. The emissions shown are considered potential-to-emit except where otherwise indicated.
[b] It is not clear whether emissions from the Funda Filter Recycle Tank is included with the tested emissions from the Funda Filter Steam Out Process. The Consent Decree mentions this emission unit but does not specifically require testing.
[c] Emissions data from 2013 Emissions Report. These emissions are assumed to be actual emissions.
[d] Units called out in Consent Decree, but testing was not required. Emissions data is based on the 2013 Emissions Report for "Storage Tanks/200 Battery."
[e] Emissions for the WWPoly fugitives based on July 30, 1993 permit, IP 93-1-0012-P. Fugitives are subject to the MON (40 CFR 63, Subpart FFFF). Note that fugitives from the entire site are listed as 53.19 tpy in the 2013 Emissions Report.
[f] Emissions for the MP Poly fugitives are based on Installation Permit 94-1-0069-P issued April 13, 1995. Fugitives are subject to the MON (40 CFR 63, Subpart FFFF). Note that fugitives from the entire site are listed as 53.19 tpy in the 2013 Emissions Report.
[g] Note that these emissions are greater than permitted emissions in #0058-I016. However, these emissions were calculated based on the stack test results and assuming that the equipment is operated 8760 hours per year. Based on the permit limits for these equipment, these equipment must be operated much less than 8760 hours per year. The stack test results in lb/hr do not exceed the permitted emissions in lb/hr.
[h] Emission values are from the IP 0058-I016, issued May 31, 2011. These emission units were not found in Consent Decree.
[i] Based on a stack test conducted July 31 through August 1, 2013 and reported October 17, 2013. Testing conducted pursuant to installation permit.
[j] Emissions based on 2013 Emissions Report for "169-Storage Tanks/Piperylene Conc.." Based on IP0058-I017 issued July 22, 2010, tanks 52, 54, and 55 hold piperylene conc. In this permit emissions from tank 52 are limited to 2.37 tpy.
[k] Emissions calculated using AP-42 emission factor for VOC from boilers less than 100 MMBtu/hr (5.5 lbs of VOC per scf).
[l] Emission value based on permit limit in IP0058-I009 issued October 3, 2002.
[m] Emission values based on technical support document for IP 0058-I012a issued October 30, 2008. The actual permit limit for the dryer is 2.23 tpy but this appears to be in error, based on the discussion in the technical support document.
[n] Emission values based on permit limits in IP0058-I020 issued July 28, 2011.

RACT Analyses Conducted in this Document

This source is a major source of VOC, but is not a major source of NOx; therefore, only VOC RACT analyses have been conducted and are provided in this document.

Information was not available to assess the 36 tanks listed in Table 1 that were identified from the "Consent Decree Tanks List". The information shown in Table 1 is the only information available for these tanks. These tanks could very well overlap with the tanks listed from the 2013 Emissions Report, but the information is not available to determine if they are duplicate entries or not. Also, no information is available on what these tanks store, the design configuration of the tanks, or information on how they are used (e.g., number of turnovers, process tank or storage tank, etc.) Although, it is likely that the emissions from these tanks are relatively low, this could not be confirmed. A RACT evaluation was not conducted for these 26 tanks due to lack of information.

A RACT evaluation for the equipment listed in Table 1 that were identified from the "2013 Emissions Report" was also not conducted. There is no information available on these equipment, other than what is listed in Table 1 and it is unclear if these equipment are already included in other units listed in Table 1. It is very possible that the storage tanks and wastewater treatment equipment are subject to the National Emission Standards for Hazardous Air Pollutants (NESHAP): Miscellaneous Organic Chemical Manufacturing, 40 CFR 63, Subpart FFFF, often referred to as the "MON". The MON contains emission control requirements for certain tanks and wastewater streams; however, there is not enough information to determine which of the equipment are covered by the MON. If the MON applies, compliance with the MON would likely be RACT. There is also no information available to calculate potential-to-emit or determine the mechanism by which the emissions are released to determine possible control scenarios. RACT evaluations for the equipment listed in Table 1 that were identified from the "2013 Emissions Report" were not conducted due to lack of information.

ACHD determined that many of the equipment shown in Table 1 have relatively low emissions and considers it unlikely that additional controls would be technically and economically feasible for these emission units. Therefore, RACT for these equipment is compliance with current regulations, permit conditions, and the 2011 Consent Decree. A potential-to-emit of 15 pounds per day or 2.74 tons per year was used to assess equipment where the emissions were relatively low.

ACHD determined that it was unnecessary to conduct RACT evaluations on the equipment leak emissions for processes WW Poly, MP Poly, or the LTC process lines. The source is subject to the MON. Under the MON, the source is required to have a Leak Detection and Repair (LDAR) program. These requirements are relatively stringent and ACHD does not believe more stringent requirements would be considered cost effective. The LDAR requirements of the MON are considered RACT for the emissions from equipment leaks.

The RACT evaluations that were conducted are included in the sections indicated below:

A. RACT for VOC – Liquid Thermal Contact Unit: Resin Kettle 5 and Resin Kettle 6
B. RACT for VOC – C-5 Polymerization Unit: C-5 Pastillating Belts #1 and #2
C. RACT for VOC – Hydrogenation Unit: Vent Tank
D. RACT for VOC – Dresinate TX Production Line: Double Drum Dryer

A. RACT for VOC – Liquid Thermal Contact Unit: Resin Kettles #5, #6, and #7

In this section, ACHD examines the feasibility of controlling emissions from the three resin kettles at the liquid thermal contact unit with one control device.

In the Liquid Thermal Contact Unit, heated resin product is initially charged to the kettles, then transferred to the pastillating belts where it is cooled in a pastillated form, and then packaged for final shipment and delivery. The Liquid Thermal Contact Unit has three (3) resin kettles (#5, #6, and #7). The VOC emissions from these operations are characterized by a low VOC concentration and multiple emission constituents. The VOC emissions from resin kettles #5, #6, and #7 are currently controlled by condensers (Condenser E-RK5-4, Condenser E-RK6-5, and Condenser E-RK7-4, respectively).

VOC emissions from these three resin kettles are limited in Installation Permit 0058-I016, issued on May 31, 2011, as shown in Table 2. A stack test was conducted on the kettles on August 2 through 24, 2012. The results of stack testing are shown in Table 2.

Table 2. Emission Limits and Stack Test Results for Resin Kettles #5, #6, and #7

Emission Unit	Permit Limit (lb/hr)	Permit Limit (ton/yr)	Stack Test (lb/hr)	PTE Based on Stack Test (ton/yr)[a]
Resin Kettle #5	0.94	0.010	0.92	3.5
Resin Kettle #6	0.94		0.83	3.46
Resin Kettle #7	2.376	0.218	0.74	3.24
Total	**4.256**	**0.228**	**1.77**	**10.2**

[a] The PTE was calculated assuming 8,760 hours of operation per year per kettle and using the lb/hr stack test results. However, given the difference between the lb/hr and ton/yr emission limits in the Installation Permit 0058-I016. It is likely that these units do not operate 8760 hours per year and that the PTE is actually equal to the Permit Limit. A RACT evaluation was conducted assuming the PTE calculated from the stack test results.

The Installation Permit 0058-I016 requires that emissions from these three resin kettles shall be exhausted through a cooling tower water-chilled condenser at all times. The permit also requires that exit vapor temperature from the condenser shall not exceed 45 degrees Celcius (113 degrees Fahrenheit) at any time when emissions are being routed through it, and that the exit vapor temperature of each of the condensers shall be continuously monitored when the process is in operation.

The data on inlet and outlet VOC concentrations from the stack test results from the testing conducted on August 2 through 24, 2012 indicated that the VOC removal efficiency of the condensers on Resin Kettles #5 and #7 are about 19% and 49%, respectively. The stack testing showed that the condenser on Resin Kettle #6 did not reduce VOC emissions.

<u>Step 1 – Identify Control Options</u>

According to information available in EPA's *Control Techniques for Volatile Compound Emissions from Stationary Sources*[1] and *Control of Volatile Organic Compound Emissions from Reactor Processes and Distillation Operations Processes in the Synthetic Organic Chemical Manufacturing*

[1] US EPA, EPA 453/R-92-018.

Industry[2], remaining VOC emissions from the resin kettles after the exhaust exits the condensers could be controlled further using any number of controls including:

(a) Condenser
(b) Thermal Oxidation
(c) Catalytic Oxidation
(d) Carbon Adsorption
(e) Concentrator/Oxidation
(f) Absorption (scrubbing)

A description of each of these technologies follows.

(a) A refrigerated condenser is a control device that is used to cool an emission stream having organic vapors in it and to change the vapors to a liquid. The condensed organic vapors can be recovered, refined, and might be reused, preventing their release to the ambient air. A refrigerated condenser works best on emission streams containing high concentrations of volatile organic emissions. A refrigerated condenser works best in situations where the air stream is saturated with the organic compound, the organic vapor containment system limits air flow, and the required air flow does not overload a refrigeration system with heat. The removal efficiency of a condenser is directly related to lowest temperature that can be achieved in the condenser. Removal efficiencies range from 50-98%.

(b) Thermal oxidizers are refractory lined enclosures with one or more burners in which the waste gas stream is routed through a high temperature combustion zone where it is heated and the combustible materials are burned. Thermal oxidizers typically operate at 1200 to 2100 degrees Fahrenheit with residence times typically ranging from 0.5 to 2 seconds. An efficient thermal oxidizer design must provide adequate residence time for complete combustion, sufficiently high temperatures for VOC destruction, and adequate velocities to ensure proper mixing without quenching combustion. The type of burners and their arrangement affect combustion rates and residence time; the more thorough the contact between the flame and VOC, the shorter the time required for complete combustion. Natural gas is required to ignite the flue gas mixtures and maintain combustion temperatures. Thermal oxidizers achieve 98% or more VOC reduction.

(c) Catalytic oxidizers are similar to thermal oxidizers - the units are enclosed structures that use heat to oxidize the combustible materials. However, in a catalytic oxidizer, a catalyst is used to lower the operating temperature needed to oxidize the VOCs by lowering the activation energy for oxidation. When a preheated gas stream is passed through a catalytic oxidizer, the catalyst bed initiates and promotes the oxidation of the VOC without being permanently altered itself. Note that steps must be taken to ensure complete combustion. The types of catalysts used include platinum, platinum alloys, copper chromate, copper oxide, chromium, manganese, and nickel. These catalysts are deposited in thin layers on an inert substrate, usually a honeycomb shaped ceramic. VOC destruction efficiency is dependent upon VOC composition and concentration, operating temperature, and the velocity of the gas passing through the bed. As the velocity increases, VOC destruction efficiency decreases. As temperature increases, VOC destruction efficiency increases. Catalytic oxidizers can achieve 98% or more VOC reduction.

(d) Carbon adsorption is a process by which VOC is retained on a granular carbon surface, which is highly porous and has a very large surface-to-volume ratio. Organic vapors retained on the adsorbent are thereafter desorbed and both the adsorbate and absorbent are recovered. Carbon adsorption systems operated in two phases: adsorption and desorption. Adsorption is rapid and removes most of the VOC in the stream. Eventually, the adsorbent becomes saturated with the vapors and the system's efficiency drops. Regulatory

[2] US EPA, EPA-450/4-91-031.

considerations dictate that the adsorbent be regenerated or replaced soon after efficiency begins to decline. In regenerative systems, the adsorbent is reactivated with steam or hot air and the absorbate (solvent) is recovered for reuse or disposal. Non-regenerative systems require the removal of the adsorbent and replacement with fresh or previously regenerated carbon. Carbon adsorbers achieve 98% or more VOC reduction.

(e) Concentrator/oxidation systems combine the actions of carbon adsorption systems with thermal oxidizers and are used when vent gas has a low concentration of organics. Vapors pass through an adsorbing surface, and are collected. When the adsorber is saturated, the surface is desorbed, and the absorbate is oxidized in a thermal oxidizer. Concentrator/oxidation systems can achieve 98% or more VOC reduction.

(f) Absorption devices work by dissolving the soluble components of a gaseous mixture in a liquid. A gas may be removed from an emissions stream by entering into solution or by chemically-reacting with the absorbing solvent. The absorbing liquids (solvents) used must be carefully chosen for high solute (VOC) solubility and include liquids such as water, mineral oils, non-volatile hydrocarbon oils, and aqueous solutions of oxidizing agents like sodium carbonate and sodium hydroxide. Absorption may occur in spray towers, venturi scrubbers, packed columns, and plate columns. High removal efficiencies occur when the ratio of solvent to solute is high, and the surface area for reactions is high. In absorption systems, the solvent must be stripped of solute prior to reuse. Absorption devices can achieve 70% or more VOC reduction.

Step 2 – Eliminate Technically Infeasible Control Options

It was determined that condensation, thermal oxidation, catalytic oxidation, carbon adsorption, and concentrator/oxidation are technically feasible control options for controlling VOC emissions from the resin kettles at the Liquid Thermal Contact Unit. Absorption is not technically feasible for controlling organic emission streams with a wide range of constituents. Therefore, absorption is determined to be not technically feasible for controlling VOC from this source.

Step 3 - Evaluate Control Options

Emissions and Emission Reductions

The resin kettles at the Liquid Thermal Contact Unit have a potential to emit VOC as shown in Table 2 above. The technically feasible control options for the combined emissions from the resin kettles for the Liquid Thermal Contact Unit with their estimated control efficiency are shown in Table 3.

Table 3. Technically Feasible Control Options for Resin Kettles #5, #6, and #7

Control Technology	Type	Control Efficiency
Condensation	Removal/recovery	90%
Thermal Oxidation	Destruction	98%
Catalytic Oxidation	Destruction	98%
Carbon Adsorption	Removal/recovery	98%
Concentrator/Oxidation	Destruction	98%

These estimated efficiencies are based on information provided in the references cited in Step 1.

Economic Analysis

A thorough economic analysis of the technically feasible control options to control the combined VOC emissions from the resin kettles at the Liquid Thermal Contact Unit was conducted. See Appendix B for more information. The analysis estimates the total costs associated with the VOC control equipment, including the total capital investment of the various components intrinsic to the complete system, the estimated annual operating costs, and indirect annual costs. All costs, except for capital costs, were calculated using the methodology described in Section 6, Chapter 1 of the “EPA Air Pollution Control Cost Manual, Sixth Edition” (document # EPA 452-02-001). Capital costs are based on cost spreadsheets using the costing algorithms contained in the Cost Manual and EPA spreadsheets that were previously available from EPA. Information on exhaust stream physical properties (e.g. flowrate, temperature, density, heat content, etc) used in estimating the capital and annual costs of control came from stack test reports or, when not available, values used for performing the Neville Chemical RACT analyses were used, since Neville Chemical has a similar operation to Eastman's. Annualized costs are based on an interest rate of 7% and an equipment life of 15 years. The ductwork costs estimate only the capital cost for straight ductwork, and does not include costs for any structural supports, fire propagation prevention measures, exhaust mixing controls, engineering design, and other items.

The basis of cost effectiveness, used to evaluate the control option, is the ratio of the annualized cost to the amount of VOC (tons) removed per year. A summary of the cost figures determined in the analysis is provided in the Table 4.

Table 4. Cost Analysis Summary for Resin Kettles at the Liquid Thermal Contact Unit

Control Option	Total Capital Investment ($)	Total Annualized Cost ($/yr)	Potential Additional VOC Removal from Add-on Control (ton/yr)	Cost Effectiveness ($/ton VOC Removed)
Condenser	263,000	149,000	9.2	16,200
Thermal Oxidation	151,000	127,000	10.0	12,700
Catalytic Oxidation	81,800	111,000	10.0	11,100
Carbon Adsorption	1,300,000	415,000	10.0	41,500
Concentrator/ Oxidation	397,000	152,000	10.0	15,200

Step 4 – Select RACT

Based on the economic analysis summarized in Table 4, it is not cost effective to control the three resin kettles at the Liquid Thermal Contact Unit. ACHD has determined that RACT is continued compliance with existing requirements for the Liquid Thermal Contact Unit as specified in Installation Permit 0058-I016, and with the terms of the Consent Decree.

B. RACT for VOC – C-5 Polymerization Unit: C-5 Pastillating Belts #1 and #2

At the C-5 Polymerization Unit's Pastillating Belts #1 and #2, resin product is formed into a solid pastillated form for shipment and delivery. Heated resin is initially charged to a resin kettle then transferred to the pastillating belts for pastillating where it is cooled, solidified, and placed in bags or supersacks. Emissions from the C-5 Polymerization Unit's Pastillating Belts #1 and #2 are vented to the UHF Filter S-751-1 and Fume Filter Demister. The VOC emissions from these operations are characterized by a low VOC concentration and multiple emission constituents.

VOC emissions from the C-5 Polymerization Unit's Pastillating Belt #2 are limited to 1.0 pounds per hour and 4.34 tons per year by Installation Permit 0058-I015, issued August 25, 2008, and Installation Permit 0058-I018, issued May 9, 2011. Pastillating Belt #1 does not appear to have a permit limit. Minimum capture efficiency of the UHF Filter/ Fume Filter Demister is to be 90% and VOC control efficiency of the UHF Filter/Fume Filter Demister is to be 90%. A stack test was conducted on the UHF Filter/Fume Filter Demister controlling emissions from the Pastillating Belts #1 and #2 on May 22, 2012. The results of stack testing are shown in Table 5. The data on inlet and outlet VOC concentrations from the stack test results from the testing conducted on May 22, 2012 indicated that the VOC control efficiency of the UHF Filter and the Fume Filter Demister is 39.4%.

Table 5. Emission Limits and Stack Test Results for C-5 Pastillating Belt UHF Filter Vent

Emission Unit	Emission Limit (lb/hr)	Emission Limit (ton/yr)	Stack Test Results (lb/hr)	PTE Based on Stack Test (ton/yr)[a]
C-5 Pastillating Belt #1	-	-	1.03	4.5
C-5 Pastillating Belt #2	1.0	4.34		

[a] Assuming 8,760 hours of operation per year.

Step 1 – Identify Control Options

According to information available in EPA's *Control Techniques for Volatile Compound Emissions from Stationary Sources*[3] and *Control of Volatile Organic Compound Emissions from Reactor Processes and Distillation Operations Processes in the Synthetic Organic Chemical Manufacturing Industry*[4], VOC emissions from the C-5 Polymerization Unit's Pastillating Belts #1 and #2 could be controlled using any number of controls including:

(a) Thermal Oxidation
(b) Catalytic Oxidation
(c) Carbon Adsorption
(d) Concentrator/Oxidation
(e) Condensation
(f) Absorption (scrubbing)

A description of each of these control technologies is provided in RACT Section A.

Step 2 – Eliminate Technically Infeasible Control Options

It was determined that thermal oxidation, catalytic oxidation, carbon adsorption, concentrator/oxidation, and condensation are technically feasible control options for controlling VOC

[3] US EPA, EPA 453/R-92-018.
[4] US EPA, EPA-450/4-91-031.

emissions from the C-5 Polymerization Unit's Pastillating Belts #1 and #2. Absorption is not technically feasible for controlling organic emission streams with a wide range of constituents. Therefore, absorption is determined to be not technically feasible for controlling VOC from this source.

Step 3 - Evaluate Control Options

Emissions and Emission Reductions

The C-5 Polymerization Unit's Pastillating Belts #1 and #2 has a potential to emit VOC as shown in Table 5 above. These potential emissions are based on limits in the installation permit and stack test results. The technically feasible control options with their estimated control efficiency are as shown Table 6.

Table 6. Technically Feasible Control Options for the C-5 Polymerization Unit's Pastillating Belts #1 and #2

Control Technology	Type	Control Efficiency
Thermal Oxidation	Destruction	98%
Catalytic Oxidation	Destruction	98%
Carbon Adsorption	Removal/recovery	98%
Concentrator/Oxidation	Destruction	98%
Condensation	Removal/recovery	90%

These estimated efficiencies are based on information provided in the references cited in Step 1.

Economic Analysis

A thorough economic analysis of the technically feasible control options to control the combined VOC emissions from the C-5 Polymerization Unit's Pastillating Belts #1 and #2 was conducted. See Appendix C for more information. The analysis estimates the total costs associated with the VOC control equipment, including the total capital investment of the various components intrinsic to the complete system, the estimated annual operating costs, and indirect annual costs. All costs, except for capital costs, were calculated using the methodology described in Section 6, Chapter 1 of the "EPA Air Pollution Control Cost Manual, Sixth Edition" (document # EPA 452-02-001). Capital costs are based on cost spreadsheets using the costing algorithms contained in the Cost Manual and EPA spreadsheets that were previously available from EPA. Information on exhaust stream physical properties (e.g. flowrate, temperature, density, heat content, etc) used in estimating the capital and annual costs of control came from stack test reports or, when not available, values used for performing the Neville Chemical RACT analyses were used, since Neville Chemical has a similar operation to Eastman's. Annualized costs are based on an interest rate of 7% and an equipment life of 15 years. The ductwork costs estimate only the capital cost for straight ductwork, and does not include costs for any structural supports, fire propagation prevention measures, exhaust mixing controls, engineering design, and other items.

The basis of cost effectiveness, used to evaluate the control option, is the ratio of the annualized cost to the amount of VOC (tons) removed per year. A summary of the cost figures determined in the analysis is provided in the Table 7.

Table 7. Cost Analysis Summary for C-5 Polymerization Unit's Pastillating Belts #1 and #2

Control Option	Total Capital Investment ($)	Total Annualized Cost ($/yr)	Potential Additional VOC Removal from Add-on Control (ton/yr)	Cost Effectiveness ($/ton VOC Removed)
Thermal Oxidation	394,000	1,010,000	4.4	230,000
Catalytic Oxidation	429,000	623,000	4.4	141,000
Carbon Adsorption	796,000	449,000	4.4	102,000
Concentrator/Oxidation	572,000	364,000	4.4	82,600
Condensation	3,280,000	1,930,000	4.1	476,000

Step 4 – Select RACT

Based on the economic analysis summarized in Table 7, it is not cost effective to control the C-5 Polymerization Unit's Pastillating Belts #1 and #2.

ACHD has determined that RACT for the C-5 Polymerization Unit's Pastillating Belts #1 and #2 is continued compliance with existing requirements for the C-5 Polymerization Unit's Pastillating Belts #1 and #2 as specified in Installation Permit 0058-I015, Installation Permit 0058-I018, and with the terms of the Consent Decree.

C. RACT for VOC – Hydrogenation Unit: Vent Tank

The Hydrogenation Unit takes resins produced at the Water White Polymerization and Multipurpose Polymerization Processing units and further hydrogenates these resins to improve color and stability. Hydrogenation is a batch process. Feed is preheated, pumped into a metering tank, and then into an autoclave where hydrogen and a metal catalyst are added from the catalyst mix tank to react with the resin. Once the reaction is complete, the product is sent to the Vent Tank and then to tanks where the catalyst and solvents are filtered out. Emissions from the Vent Tank are vented to Condenser E-303-3 and then to Condensers E-401-2, Condenser E-402-2, and Condenser E-403-2 before being vented to the atmosphere via stack S007. This RACT analysis is for emissions from the Vent Tank.

There are no existing permits that specifically limit VOC emissions from the Hydrogenation Unit's Vent Tank. A stack test was conducted on the four condensers controlling VOC emissions from the Hydrogenation Unit's Vent Tank on April 10 and 11, 2013. VOC emissions at the inlet to the control devices were tested at 4.0 pounds per hour and VOC emissions at the outlet of the control devices were 1.7 pounds per hour. PTE for this unit is based on the stack testing results after the effect of controls.

Table 8. Stack Test Results for Hydrogenation Unit's Vent Tank

Emission Unit	Stack Test Results (lb/hr)	PTE Based on Stack Test (ton/yr)[a]
Hydrogenation Unit's Vent Tank	1.7	7.45

[a] Assuming 8,760 hours of operation per year.

Step 1 – Identify Control Options

According to information available in EPA's *Control Techniques for Volatile Compound Emissions from Stationary Sources*[5] and *Control of Volatile Organic Compound Emissions from Reactor Processes and Distillation Operations Processes in the Synthetic Organic Chemical Manufacturing Industry*[6], VOC emissions from the Hydrogenation Unit's Vent Tank could be controlled using any number of controls including:

(a) Thermal Oxidation
(b) Catalytic Oxidation
(c) Carbon Adsorption
(d) Concentrator/Oxidation
(e) Condensation
(f) Absorption (scrubbing)

A description of each of these control technologies is provided in RACT Section A.

Step 2 – Eliminate Technically Infeasible Control Options

It was determined that thermal oxidation, catalytic oxidation, carbon adsorption, concentrator/oxidation, and condensation are technically feasible control options for controlling VOC emissions from the Hydrogenation Unit's Vent Tank. Absorption is not technically feasible for controlling organic emission streams with a wide range of constituents. Therefore, absorption is determined to be not technically feasible for controlling VOC from this source.

[5] US EPA, EPA 453/R-92-018.
[6] US EPA, EPA-450/4-91-031.

Step 3 - Evaluate Control Options

Emissions and Emission Reductions

The Hydrogenation Unit's Vent Tank has a potential to emit VOC as shown in Table 8 above. These potential emissions are based on limits in the installation permit and stack test results. The technically feasible control options with their estimated control efficiency are as shown Table 9.

Table 9. Technically Feasible Control Options for the Hydrogenation Unit's Vent Tank

Control Technology	Type	Control Efficiency
Thermal Oxidation	Destruction	98%
Catalytic Oxidation	Destruction	98%
Carbon Adsorption	Removal/recovery	98%
Concentrator/Oxidation	Destruction	98%
Condensation	Removal/recovery	90%

These estimated efficiencies are based on information provided in the references cited in Step 1.

Economic Analysis

A thorough economic analysis of the technically feasible control options to control the combined VOC emissions from the Hydrogenation Unit's Vent Tank was conducted. See Appendix D for more information. The analysis estimates the total costs associated with the VOC control equipment, including the total capital investment of the various components intrinsic to the complete system, the estimated annual operating costs, and indirect annual costs. All costs, except for capital costs, were calculated using the methodology described in Section 6, Chapter 1 of the "EPA Air Pollution Control Cost Manual, Sixth Edition" (document # EPA 452-02-001). Capital costs are based on cost spreadsheets using the costing algorithms contained in the Cost Manual and EPA spreadsheets that were previously available from EPA. Information on exhaust stream physical properties (e.g. flowrate, temperature, density, heat content, etc) used in estimating the capital and annual costs of control came from stack test reports or, when not available, values used for performing the Neville Chemical RACT analyses were used, since Neville Chemical has a similar operation to Eastman's. Annualized costs are based on an interest rate of 7% and an equipment life of 15 years. The ductwork costs estimate only the capital cost for straight ductwork, and does not include costs for any structural supports, fire propagation prevention measures, exhaust mixing controls, engineering design, and other items.

The basis of cost effectiveness, used to evaluate the control option, is the ratio of the annualized cost to the amount of VOC (tons) removed per year. A summary of the cost figures determined in the analysis is provided in the Table 10.

Table 10. Cost Analysis Summary for Hydrogenation Unit's Vent Tank

Control Option	Total Capital Investment ($)	Total Annualized Cost ($/yr)	Potential Additional VOC Removal from Add-on Control (ton/yr)	Cost Effectiveness ($/ton VOC Removed)
Thermal Oxidation	122,000	118,000	7.3	16,200
Catalytic Oxidation	70,500	107,000	7.3	14,700
Carbon Adsorption	1,620,000	483,000	7.3	66,200
Concentrator/Oxidation	397,000	151,000	7.3	20,600
Condensation	213,000	137,000	6.7	20,400

Step 4 – Select RACT

Based on the economic analysis summarized in Table 10, it is not cost effective to control the Hydrogenation Unit's Vent Tank using either a thermal oxidizer, catalytic oxidizer, carbon absorption, a concentrator/oxidizer, or a condenser. ACHD has determined that RACT for the Hydrogenation Unit's Vent Tank is continued compliance with the terms of the Consent Decree.

D. RACT for VOC – Dresinate TX Production Line: Double Drum Dryer

The Dresinate TX Production Line's Double Drum Dryer drys liquid crude tall oil and tall oil rosin prior to grinding and packaging. Emissions from the Dresinate TX Production Line: Double Drum Dryer are not controlled. VOC emissions from the Dresinate TX Production Line are limited in Installation Permit 0058-I012, issued on September 13, 2006, and amended in Installation Permit 0058-I012a, issued October 30, 2008, as shown in Table 11.

Table 11. Emission Limits for Dresinate TX Production Line

Emission Unit	Emission Limit (lb/hr)	Emission Limit (ton/yr)
Dresinate TX Production Line	1.25	5.5

Step 1 – Identify Control Options

According to information available in EPA's *Control Techniques for Volatile Compound Emissions from Stationary Sources*[7] and *Control of Volatile Organic Compound Emissions from Reactor Processes and Distillation Operations Processes in the Synthetic Organic Chemical Manufacturing Industry*[8], VOC emissions from the Dresinate TX Production Line: Double Drum Dryer could be controlled using any number of controls including:

(a) Thermal Oxidation
(b) Catalytic Oxidation
(c) Carbon Adsorption
(d) Concentrator/Oxidation
(e) Condensation
(f) Absorption (scrubbing)

A description of each of these control technologies is provided in RACT Section A.

Step 2 – Eliminate Technically Infeasible Control Options

It was determined that thermal oxidation, catalytic oxidation, carbon adsorption, concentrator/oxidation, and condensation are technically feasible control options for controlling VOC emissions from the Dresinate TX Production Line: Double Drum Dryer. Absorption is not technically feasible for controlling organic emission streams with a wide range of constituents. Therefore, absorption is determined to be not technically feasible for controlling VOC from this source.

Step 3 - Evaluate Control Options

Emissions and Emission Reductions

The Dresinate TX Production Line: Double Drum Dryer has a potential to emit VOC as shown in Table 11 above. These potential emissions are based on limits in the installation permit. The technically feasible control options with their estimated control efficiency are as shown Table 12.

[7] US EPA, EPA 453/R-92-018.
[8] US EPA, EPA-450/4-91-031.

Table 12. Technically Feasible Control Options for the Dresinate TX Production Line: Double Drum Dryer

Control Technology	Type	Control Efficiency
Thermal Oxidation	Destruction	98%
Catalytic Oxidation	Destruction	98%
Carbon Adsorption	Removal/recovery	98%
Concentrator/Oxidation	Destruction	98%
Condensation	Removal/recovery	90%

These estimated efficiencies are based on information provided in the references cited in Step 1.

Economic Analysis

A thorough economic analysis of the technically feasible control options to control the combined VOC emissions from the Dresinate TX Production Line: Double Drum Dryer was conducted. See Appendix E for more information. The analysis estimates the total costs associated with the VOC control equipment, including the total capital investment of the various components intrinsic to the complete system, the estimated annual operating costs, and indirect annual costs. All costs, except for capital costs, were calculated using the methodology described in Section 6, Chapter 1 of the "EPA Air Pollution Control Cost Manual, Sixth Edition" (document # EPA 452-02-001). Capital costs are based on cost spreadsheets using the costing algorithms contained in the Cost Manual and EPA spreadsheets that were previously available from EPA. Information on exhaust stream physical properties (e.g. flowrate, temperature, density, heat content, etc) used in estimating the capital and annual costs of control came from stack test reports or, when not available, values used for performing the Neville Chemical RACT analyses were used, since Neville Chemical has a similar operation to Eastman's. Annualized costs are based on an interest rate of 7% and an equipment life of 15 years. The ductwork costs estimate only the capital cost for straight ductwork, and does not include costs for any structural supports, fire propagation prevention measures, exhaust mixing controls, engineering design, and other items.

The basis of cost effectiveness, used to evaluate the control option, is the ratio of the annualized cost to the amount of VOC (tons) removed per year. A summary of the cost figures determined in the analysis is provided in Table 13.

Table 13. Cost Analysis Summary for Dresinate TX Production Line: Double Drum Dryer

Control Option	Total Capital Investment ($)	Total Annualized Cost ($/yr)	Potential Additional VOC Removal from Add-on Control (ton/yr)	Cost Effectiveness ($/ton VOC Removed)
Thermal Oxidation	338,000	534,000	5.4	99,000
Catalytic Oxidation	305,000	338,000	5.4	62,700
Carbon Adsorption	805,000	344,000	5.4	63,900
Concentrator/Oxidation	480,000	252,000	5.4	46,800
Condensation	2,410,000	1,100,000	4.95	221,000

Step 4 – Select RACT

Based on the economic analysis summarized in Table 13, it is not cost effective to control the Dresinate TX Production Line: Double Drum Dryer using either a thermal oxidizer, catalytic oxidizer, carbon absorption, a concentrator/oxidizer, or a condenser. ACHD has determined that RACT for the Dresinate TX Production Line: Double Drum Dryer is continued compliance with the terms of Installation Permit 0058-I012a and the Consent Decree.

VOC RACT2 Analysis
Eastman Chemical Resins, Inc. – Jefferson Site

Introduction

The Eastman Chemical Resins (Eastman) facility located in West Elizabeth, Pennsylvania, is classified as a major stationary source of both nitrogen oxides (NOx) and volatile organic compounds (VOC) emissions. As such, the facility is subject to the Reasonably Available Control Technology (RACT) rules enacted in Pennsylvania on April 23, 2016, outlined in 25 Pa. Code §§129.96 – 129.100, *Additional RACT Requirements for Major Sources of NOx and VOCs*, referred to as RACT2. The RACT2 rule requires all existing major facilities of NOx and VOC emissions to assess the need to install new or additional emission controls, or implement work practice measures to reduce emissions of those two pollutants.

An initial RACT2 assessment of the Eastman facility was conducted by the Allegheny County Health Department (ACHD) in 2015. The results of that assessment were never incorporated into Allegheny County's portion of the Pennsylvania State Implementation Plan (SIP). In late 2019, ACHD requested that Eastman prepare and submit a re-evaluation of NO_X and VOC RACT2 for the current operations at the facility. The remainder of this document contains Eastman's RACT2 evaluation of VOC-emitting sources.

VOC Potential to Emit (PTE) and RACT2 Applicability Table

Attachment 1 contains a table listing all VOC-emitting sources at the Eastman facility and includes the source PTE, exhaust flow rate (where known), determination of applicability to RACT2, and explanatory comments. The source of the PTE values is indicated in the comments.

VOC sources with a PTE less than 1 ton/year are exempt from RACT2 requirements. Refer to the table in Attachment 1 to see which sources were determined to be exempt.

Any VOC sources with a PTE above 1 ton/year, but less than 2.7 tons/year, are subject to presumptive RACT2, pursuant §129.97(c)(2). This presumptive RACT requirement is: "The facility shall install, maintain, and operate the source in accordance with manufacturer's specifications and with good operating practices." Eastman interprets this to mean maintaining compliance with all pertinent requirements of the particular source's Installation and/or Operating Permit. The sources in Table 1 below are subject to this presumptive requirement:

Table 1: Presumptive RACT2 Sources

Source	Process	Stack ID
#4 Vacuum System	LTC	S124
North & South Reactors	WW Poly	S017
Tanks 68, 69 & 74	WW Poly	S024
Tank 35	WW Poly	S075
Resin Kettle #10	C5 Process	n/a
Reactor	MP Poly	S029
Tanks 301, 302 & 303	MP Poly	n/a
Neutralizer and Reactor	Pilot Plant	S155
Resin Kettles and Blend Tanks	Emulsion	S162

Any VOC source with PTE of 2.7 tons/year or greater is subject to a case-by-case technical and economic analysis to determine if additional emission control is feasible and reasonable. The sources in Table 2 below are subject to the case-by-case analysis requirement:

Table 2: Sources subject to Case-by-case Analysis

Source	Process	Stack ID
#1 Vacuum System	LTC	S109
#2 Vacuum System	LTC	S110
#1 & #2 Pastillator Belts	LTC	S114
Feed Dryers and Regeneration	WW Poly	S013 & S013a
Filtrate Receiver	WW Poly	S020
Solvent Wash Receiver	WW Poly	S023
Tanks 73, 75, 76 & 77	WW Poly	S025
East Filtrate Receiver	WW Poly	S027
Tanks 50, 52, 53, 54, 55 & 500	C5 Process	Fugitive
#1 & #2 Pastillator Belts	C5 Process	S055
Various MP Poly sources	MP Poly	S034
Pretreated Tanks 702A, 702B & 702C	WWTP	Fugitive
Bio Aeration Tank	WWTP	Fugitive
Various process and storage tanks	Hydro	S004 & S001
Autoclaves and Vent Tank	Hydro	S007
Product Tanks 102, 105 & 106	Hydro	S012
Double Drum Dryer and tanks	Dresinate	S085

Technical Feasibility of Capture and Control Technologies

Except for the sources noted below, in all instances where it was determined that Case-by-case (Alternative) RACT analysis was required, it was assumed that additional capture and control of VOC emissions was technically feasible. It is quite possible that further, in-depth analysis would show that to not be the case for some of the sources.

It has been determined that it is not technically feasible to capture and control the following sources that are subject to case-by-case analysis:

- *C5 Operation Raw Material Tanks 50, 52, 53, 54, 55, and 500*: all of these tanks are internal floating roof tanks. There is no reasonable method to capture emissions from floating roof tanks.
- *Wastewater Treatment Plant Tanks 702A, 702B and 702C*: all of these tanks are open-top tanks used for pre-treatment prior to the biological treatment operations. There is no reasonable method to capture emissions from these open-top tanks.
- *Wastewater Treatment Plant Bio-Aeration Tank*: this biological treatment tank is open to the atmosphere. There is no reasonable method to capture the emissions from this operation.

Economic Analysis Procedures

For sources where it was determined that an economic analysis is required, it was assumed, for the sake of simplicity, that each of the following control technologies was technically feasible. In actuality, that won't always be the case (depending on exhaust flow rates and types of chemicals being controlled).

- Thermal oxidation
- Catalytic oxidation
- Rotary concentrator with oxidation
- Carbon adsorption, with and without on-site regeneration

Note that any combined source exhausts are based mainly on proximity to each other. Full scale engineering studies would be needed to determine the actual technical feasibility from an operational standpoint.

For the sake of simplicity and in the interest of time, also note that the control cost analyses do not take into account any equipment and installation costs associated with capturing and routing source exhausts to add-on control devices. Auxiliary equipment, such as accumulators to gather emissions from batch source vents, is also not included in this study. Some of these non-included costs can be significant and would serve to increase the resulting costs/ton demonstrated in this analysis.

All control cost analyses were conducted pursuant to procedures provided in USEPA's OAQPS Control Cost Manual, 7th Edition (the most recent edition).

Economic Analysis Results

The economic analysis tables are provided in Attachment 2. A summary of the results is provided in Table 3 below.

Table 3: Summary of Economic Analyses

Source	Process	Control Costs ($/ton of VOC removed)						
		Thermal Ox.	Catalytic Ox	Rotary Conc Oxidizer	RTO	Refrig. Condenser	Carbon (fixed bed)	Carbon (drum)
#1 Vacuum System	LTC	40,237	37,705	51,616	59,746	39,342	52,426	46,386
#2 Vacuum System	LTC	19,443	17,814	24,249	27,956	18,758	24,343	25,799
#1 & #2 Pastillator Belts	LTC	118,251	96,581	83,218	102,474	507,565	74,706	96,052
Feed Dryers and Regeneration	WW Poly	34,162	30,228	40,408	46,758	33,761	34,797	94,151
Filtrate Receiver	WW Poly	38,176	32,174	38,986	45,473	47,011	33,654	66,130
Solvent Wash Receiver	WW Poly	24,798	21,022	26,345	30,563	27,567	22,852	56,657
Tanks 73, 75, 76 & 77	WW Poly	30,178	26,843	36,022	41,653	29,538	31,458	70,147
East Filtrate Receiver	WW Poly	33,925	28,770	35,955	41,791	38,352	30,920	74,948
#1 & #2 Pastillator Belts	C5 Process	75,176	58,940	40,804	53,683	430,223	32,251	46,868
Various MP Poly sources	MP Poly	18,288	15,452	19,216	22,260	20,557	17,807	35,325
Various process and storage tanks	Hydro	12,356	10,688	13,878	15,950	12,426	13,169	32,192
Autoclaves and Vent Tank	Hydro	12,335	10,454	13,209	15,218	13,300	12,458	34,939

Source	Process	Control Costs ($/ton of VOC removed)						
		Thermal Ox.	Catalytic Ox	Rotary Conc Oxidizer	RTO	Refrig. Condenser	Carbon (fixed bed)	Carbon (drum)
Product Tanks 102, 105 & 106	Hydro	24,692	22,816	31,136	35,956	23,931	33,197	74,607
Double Drum Dryer and tanks	Dresinate	66,816	54,193	44,317	55,288	299,894	39,200	70,716

Proposed RACT2

As shown in Table 3 above, there is not one single control option that is less than $10,000 per ton of VOC removed. It is Eastman's contention that it is not economically feasible to install additional controls on any of these sources.

Eastman's proposed RACT2 requirements for <u>all</u> non-exempt sources are:

1. The facility shall install, maintain, and operate the sources in accordance with manufacturer's specifications and with good operating practices.
2. Attain and maintain compliance with all pertinent requirements of the particular source's current Installation and/or Operating Permit.
3. The potential VOC emissions from the Hydro operations are based on the results of the stack test conducted in December 2019 and a throughput restriction of 22,500,000 lbs/year. In addition to items 1 and 2 above, Eastman proposes that RACT2 for Hydro is a throughput limit of 22,500,000 lbs/year. The upcoming Installation Permit application for this process will be based on that limit.

ATTACHMENT 1
Source Emissions & RACT2 Applicability

VOC RACT2 Analysis - Emissions and Applicability
Eastman Chemical Resins, Inc. - Jefferson Plant

VOC Process & Source Names	Existing VOC Controls	Stack ID	Flow (acfm)	VOC PTE (tpy)	RACT2 Applicability	PTE Basis/Other Notes
LTC						PTE values from IP-16a TSD from ACHD
#1 Vacuum System	condenser	S109	0.8	**3.80**	Case-by-case Analysis req'd	None of the exhaust points can reasonably be combined and routed to a common control device, due either to the possiblity of cross-contamination or to too great a distance between them. Therefore, RACT applicability is based on the PTE of each individual source.
#2 Vacuum System	condenser	S110	3.3	**8.09**	Case-by-case Analysis req'd	
#4 Vacuum System	condenser	S124	2.2	**1.46**	Presumptive RACT; no cost analysis	
Reclaim Solution Tank	condenser	S108	1.1	**0.58**	exempt due to VOC < 1 tpy	
Resin Kettle 5	condenser	S111	14.4	**0.32**	exempt due to VOC < 1 tpy	
Resin Kettle 6	condenser	S112	14.4	**0.24**	exempt due to VOC < 1 tpy	
Resin Kettle 7	condenser	S113	3.7	**0.68**	exempt due to VOC < 1 tpy	
#1/#2 LTC Pastillator Belt	venturi scrubber	S114	3100	**2.80**	Case-by-case Analysis req'd	
Berndorf Belt	venturi scrubber	S165	2500	**0.53**	exempt due to VOC < 1 tpy	
Truck Loading	none	N/A	1123	**0.37**	exempt due to VOC < 1 tpy	
Drumming	none	N/A	400	**0.18**	exempt due to VOC < 1 tpy	
LTC2 Barometric Tank	carbon bed	S110A	100	**0.01**	exempt due to VOC < 1 tpy	
LTC4 Oil/Water Separator	carbon bed	S125	100	**0.01**	exempt due to VOC < 1 tpy	

VOC Process & Source Names	Existing VOC Controls	Stack ID	Flow (acfm)	VOC PTE (tpy)	RACT2 Applicability	PTE Basis/Other Notes
WW Poly						PTE from IP-23 permit and ACHD TSD
Feed Dryers	condenser	S013	15	**4.85**	Case-by-case Analysis req'd	Combine S013 & S013a for cost analysis; contaminants prevent combining with any other vents
Feed Dryer Regeneration	none	S013a	6	**0.01**		
East Pre-Blend Tank	condenser	S014	6	**0.57**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
North Pre-Blend Tank	condenser	S015	6	**0.57**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Slurry Tank	none	S016	4.6	**0.02**	exempt due to VOC < 1 tpy	PM in exhaust could contaminate polymerizate
North & South Reactors	condenser	S017		**1.78**	Presumptive RACT; no cost analysis	Can't combine with other vents due to presence of BF3
North Neutralizer	condenser	S018	45	**0.31**	exempt due to VOC < 1 tpy	PM in exhaust could contaminate polymerizate
Funda Filter Steam Out/Flushing	condenser	S019	4.8	**0.01**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Funda Condensate Tank	carbon bed	S019a	1.3	**0.00**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Filtrate Receiver	condenser	S020	260	**5.11**	Case-by-case Analysis req'd	Cross-contamination prevents combining with other vents
South Neutralizer	condenser	S021	45	**0.31**	exempt due to VOC < 1 tpy	PM in exhaust could contaminate polymerizate
Reclaim Pot	condenser	S022	4.6	**0.13**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Solvent Wash Receiver	condenser	S023	167	**7.52**	Case-by-case Analysis req'd	Cross-contamination prevents combining with other vents
Storage Tanks 68/69/74	condenser	S024	1.8	**1.37**	Presumptive RACT; no cost analysis	Vents need to be separate to prevent RHS/HVD contamination
Storage Tanks 73/75/76/77	condenser	S025	3.6	**5.45**	Case-by-case Analysis req'd	Vents need to be separate to prevent RHS/HVD contamination
Storage Tank 67	condenser	S026	0.4	**0.20**	exempt due to VOC < 1 tpy	Vents need to be separate to prevent RHS/HVD contamination
East Filtrate Receiver	condenser	S027	167	**5.51**	Case-by-case Analysis req'd	Cross-contamination prevents combining with other vents
T-66	none	S228	4.4	**0.30**	exempt due to VOC < 1 tpy	Vents need to be separate to prevent RHS/HVD contamination
T-10	none	S195	2	**0.29**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
T-22	none	S206		**0.03**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
T-24	none	S208				
T-23	none	S207		**0.03**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
T-25	none	S209				
T-27	none	S211	7.4	**0.04**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
T-26	none	S210	34	**0.42**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
T-28	none	S212	34			
T-29	none	S213	34			
T-34	none	S074	2	**0.27**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Tank 35	none	S075	5	**1**	Presumptive RACT; no cost analysis	PTE from Misc Equipment IP Application of 12/2019
T-71	none	S230		**0.29**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
T-72	none	S231		**0.42**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents

VOC RACT2 Analysis - Emissions and Applicability
Eastman Chemical Resins, Inc. - Jefferson Plant

VOC Process & Source Names	Existing VOC Controls	Stack ID	Flow (acfm)	VOC PTE (tpy)	RACT2 Applicability	PTE Basis/Other Notes
T-200	none	S239	2			
T-201	none	S240	2	**0.18**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
T-202	none	S241	2			
Tanks 204/205/206/207	carbon bed	S300	18.8	**0.04**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
C5						PTE from IP-11d
C5 Poly Operations & 500 Series Tanks	thermal oxidizer	S044	20	**0.26**	exempt due to VOC < 1 tpy	Tanks include 501, 502, 503, 505 & 506 (all controlled by T.O.)
Resin Kettle #8	none	S052	0.22	**0.38**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Resin Kettle #9	none	n/a	3.3	**0.74**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Resin Kettle #10	none	n/a	3.3	**1.07**	Presumptive RACT; no cost analysis	Cross-contamination prevents combining with other vents
Sparkler Filter	condenser	S312		**0.05**	exempt due to VOC < 1 tpy	Distance makes combining impractical.
Sparkler Precoat	none	n/a		**0.01**	exempt due to VOC < 1 tpy	Only emissions are fugitive when changing filters. Not feasible to capture.
Raw Material Tanks (50, 52, 53, 54, 55 and 500)	floating roof tanks	n/a	20	**7.81**	Case-by-case Analysis req'd	No reasonable way to capture and control floating roof tanks
Resin Storage Tanks (121, 123, 124, 161, 366, 367, 504, 601 & 602)	none	n/a	36	**3.78**	exempt due to VOC < 1 tpy	Cross-contamination and distance prevents combining with other vents. Each tank is less than 1 tpy.
#1 & #2 Pastillating Belts & Drumming from Kettle 8	UHF Filter	S055	9000	**7.44**	Case-by-case Analysis req'd	
Truck/Railcar Loading from Kettles 9 & 10	none	n/a		**0.80**	exempt due to VOC < 1 tpy	Cross-contamination and distance prevents combining with other vents
MP Poly						PTE from IP-22 TSD from ACHD
Reactor	scrubber	S029	NA	**1.65**	Presumptive RACT; no cost analysis	Can't combine with other vents due to presence of BF3
Precoat Tk/Mole Sieve Drain Tk/ Contaminated Dryer Solv. Tk	none	S033	28 to 200	**0.51**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Neutralizer/Heel Tank/Solvent Wash Tank/Filt.Rec./Funda Filter	condenser	S034	113 to 200	**10.33**	Case-by-case Analysis req'd	Cross-contamination prevents combining with other vents
Pre-Blend Tank/CaCl2 Dryer/Alumina Dryer	condenser	S035	5	**0.99**	exempt due to VOC < 1 tpy	Cross-contamination prevents combining with other vents
Tanks 301/302/303	none		15	**1.37**	Presumptive RACT; no cost analysis	Cross-contamination and distance prevents combining with other vents. Each tank is less than 1 tpy.
WWTP						PTE values from WWTP IP application, Jan 2020
Tanks T-701A & T-701B and Back Porch Sumps	carbon bed	S147	9.5	**0.48**	exempt due to VOC < 1 tpy	Can't combine with any other WWTP source (all fugitive)
Tanks T-702A , T-702B, T-702C	none	F033, F034, F035	12	**8.84**	Case-by-case Analysis req'd	Open top tanks - not feasible to capture emissions
Bio Aeration Tank	none	F027		**15.25**	Case-by-case Analysis req'd	Open top tanks - not feasible to capture emissions
Bio Clarifier	none	F028		**0.11**	exempt due to VOC < 1 tpy	Open top tanks - not feasible to capture emissions
Sludge Batch Tank	none	F036		**0**	exempt due to VOC < 1 tpy	Open top tanks - not feasible to capture emissions
Sludge Solids Handling	none	F037		**0**	exempt due to VOC < 1 tpy	Open top tanks - not feasible to capture emissions
Pilot Plant						
Neutralizer & Reactor	carbon bed	S155	21	**2.2**		PTE from Misc Equipment IP Application of 12/2019
		Totals:	**21**	**2.2**	Presumptive RACT; no cost analysis	VOC > 1 tpy, but < 2.7 tpy

VOC RACT2 Analysis - Emissions and Applicability
Eastman Chemical Resins, Inc. - Jefferson Plant

VOC Process & Source Names	Existing VOC Controls	Stack ID	Flow (acfm)	VOC PTE (tpy)	RACT2 Applicability	PTE Basis/Other Notes
Hydro						Preliminary PTE based on Dec 2019 testing, per Janice Kane email of 1/15/2020
Metering Tank/Tanks 103&104/Catalyst Catch Tank/Mott Filter/Heel Tank	condenser	S004	78	**13**	Case-by-case Analysis req'd	For purposes of RACT applicability and cost analyses, assume vents S004 amd S001 can be combined.
Storage Tanks 100/101	condenser	S001	1	**1.2**		
Storage Tanks 102/105/106	condenser	S012	2	**6.3**	Case-by-case Analysis req'd	Can't combine S012 with other vents due to contamination risk (102 and 105 are finished product tanks).
Vent Tank/Autoclave #1/Autoclave #2	condenser	S007	169	**15**	Case-by-case Analysis req'd	Can't combine with other vents due to presence of hydrogen (flammability and pressure issues)
Emulsion						PTE based on stack testing in 2007
RK1		unknown		**0.67**		Assume all vents can be combined
RK2		unknown		**1.21**		Assume all vents can be combined
Blend Tanks 1, 2, 3, and 4		S162		**0.28**		Assume all vents can be combined
		Totals:		**2.16**	Presumptive RACT; no cost analysis	VOC > 1 tpy, but < 2.7 tpy
Dresinate TX						
Double Drum Dryer	fume scrubber	S085	4000	**5.48**		Limit in IP-12a
Tank R-1-A	none	S187		**0.01**		
Tank 782	none	S290		**0.01**		
		Totals:		**5.50**	Case-by-case Analysis req'd	VOC > 2.7 tpy
Other Storage Tanks						
4	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
78	none	S232	5	**< 1**	exempt due to VOC < 1 tpy	PTE from Misc Equipment IP Application of 12/2019
80	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
151	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
208	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
252	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
261	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
262	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
263	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
264	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
265	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
365	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
511	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
761	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
764	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
766	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
775	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
783	none			**< 1**	exempt due to VOC < 1 tpy	Eastman judgement, based on material stored
Combustion Sources						PTE_Combustion_Sources_draft_20191127.xlsx
Unilux Boiler 1	none	S141		**0.45**	exempt due to VOC < 1 tpy	
Unilux Boiler 2	none	S141		**0.45**	exempt due to VOC < 1 tpy	

VOC RACT2 Analysis - Emissions and Applicability
Eastman Chemical Resins, Inc. - Jefferson Plant

VOC Process & Source Names	Existing VOC Controls	Stack ID	Flow (acfm)	VOC PTE (tpy)	RACT2 Applicability	PTE Basis/Other Notes
Unilux Boiler 3	none	S143		**0.45**	exempt due to VOC < 1 tpy	
Unilux Boiler 4	none	S143		**0.45**	exempt due to VOC < 1 tpy	
Trane Boiler	none	S144		**0.92**	exempt due to VOC < 1 tpy	
LTC 2 Heater	none	S107		**0.16**	exempt due to VOC < 1 tpy	
LTC 4 Heater	none	S119		**0.24**	exempt due to VOC < 1 tpy	
C5 Hot Oil Heater	none	S056		**0.25**	exempt due to VOC < 1 tpy	
C5 Oxidizer	none	S044		**0.26**	exempt due to VOC < 1 tpy	
Hydro Heater	none			**0.48**	exempt due to VOC < 1 tpy	

ATTACHMENT 2
Economic Analysis Tables

LTC Sources

Table 1. **VOC Control Technology Cost Analysis, LTC Operations, #1 Vacuum System** **Stack ID: S109**

Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	3.7	3.6
2.	Catalytic Oxidation	98.0	98.0	96.0	3.7	3.6
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	3.7	3.6
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	3.7	3.6
5.	Refrigerated Condenser	95.0	98.0	93.1	3.7	3.5
6.	Carbon Adsorption (Fixed Bed)	95.0	98.0	93.1	3.7	3.5
7.	Carbon Adsorption (Canister)	95.0	98.0	93.1	3.7	3.5
					*VOC Baseline =	**3.8 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	4,410	425	119	134,852	**37,705**
2.	Refrigerated Condenser	14,851	1,431	413	136,399	**39,342**
3.	Thermal Oxidation	66,296	6,387	1,786	143,908	**40,237**
4.	Carbon Adsorption (Canister)	16,831	2,180	629	160,824	**46,386**
5.	Rotary Concentrator/Oxidizer	344,383	33,179	9,277	184,606	**51,616**
6.	Carbon Adsorption (Fixed Bed)	258,296	33,450	9,648	181,762	**52,426**
7.	Regenerative Thermal Oxidizer	548,250	52,820	14,768	213,682	**59,746**

* PTE based on ACHD's TSD for IP-16a.

** Note that these costs <u>do not</u> include the purchase and installation cost of ductwork associated with the controls.

Table 2. Total Annual Cost Spreadsheet - Thermal Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	0.8	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	92662.0	based on Toluene
Waste gas heat content (BTU/scf):	392.6	Equation 2.16
Waste gas heat content (BTU/lb):	5312.1	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane
CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	0.000	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	1	
Pressure drop (in. w.c.):	12.0	Table 2.13
CALCULATED CAPITAL COSTS		
Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	16,136	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	16,136	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	35,559	=Base cost x inflation factor
Purchased Equipment Cost (B):	41,959	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**66,296**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	
CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	2	
Electricity	1	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	3,315	
Capital recovery	6,387	=CRF x TCI
Total Annual Cost	**143,908**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	1	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	392.57	Equation 2.16
Waste gas heat content (BTU/lb):	5312.1	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	-0.015	Equation 2.21
	(scfm):	-0.36	
	(mcf/yr):	(188.6)	
Total Maximum Exhaust Gas Flowrate:	(scfm):	0	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	266,406	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	266,406	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	294,063	=Base cost x inflation factor
Purchased Equipment Cost (B):	346,994	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**548,250**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	(754)	
Electricity	1	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,413	
Capital recovery	52,820	=CRF x TCI
Total Annual Cost	**213,682**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	1	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	392.57	Equation 2.16
Waste gas heat content (BTU/lb):	5312.12	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.000	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	1	
Catalyst Volume (ft3):	0.0	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	1,073	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	1,073	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	2,365	=Base cost x inflation factor
Purchased Equipment Cost (B):	2,791	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**4,410**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	1	
Electricity	1	Section 2.5.2.1
Catalyst replacement	1	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	221	
Capital recovery	425	=CRF x TCI
Total Annual Cost	**134,852**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996	
Current Date:	1/15/2020	
Years since Cost Base Date:	24	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.81	

PARAMETERS

Flowrate (cfm)	1	
Control device input mass (tons/year)	3.7	
Concentration (avg. ppmv)	92,661.96	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.0	Section 2.5.2.1
Fuel usage (Btu/hr)	120	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	97,120	
Escalated Equipment Cost (A)	175,663	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	279,036	sty-cost.wk3
Total Capital Investment (TCI), ($)	344,383	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	4	
Electricity	1	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,219	
Capital recovery	33,179	=CRF x TCI
Total Annual Cost	**184,606**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**

Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	1	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.092662	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	7.6830	Equation 2.6
Condensation temperature, Tc (oF):	35.8	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0113	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.001	Equation 2.10
VOC condensed (lb-moles/hr):	0.010	inlet - outlet
(lb/hr):	0.9	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	16,763	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	234	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	7	Equation 2.16
Enthalpy change, air (BTU/hr):	127	Equation 2.17
Condenser heat load (BTU/hr):	368	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	59.7	Equation 2.19
Condenser surface area (ft2):	0.3	Equation 2.18
Coolant flowrate (lb/hr):	23	Equation 2.22
Refrigeration capacity (tons):	0.03	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	5,547	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	0	Equation 2.28
Total equipment cost ($)--base:	6,934	Equation 2.29
Total equipment cost ($)--escalated:	8,041	inflation adjusted
Purchased Equipment Cost ($):	8,685	Equation 2.30
Total Capital Investment ($):	**14,851**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	23
Overhead	50,326
Taxes, insurance, administrative	743
Capital recovery	1,431
Total Annual Cost (without credits)	136,399
Recovery credits	0
Total Annual Cost (with credits)	**136,399**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:		
Inlet stream flowrate (acfm):	1	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	0.85	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	9.27E-02	
VOC inlet concentration (ppmv):	92662.0	
VOC inlet partial pressure (psia):	1.3618	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	3.72	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:		
Carbon adsorptivity (lb Toluene/lb carbon):	0.570	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.285	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	54	Equation 1.14
Carbon requirement per vessel (lb):	18	
Gas flowrate per adsorbing vessel (acfm):	0	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	0.08	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	116.86	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	30.27	Equation 1.24
Carbon bed depth (ft):	111.753	Equation 1.31
Carbon bed pressure drop (in. w.c.):	378.942	Equation 1.30

CAPITAL COSTS:		
Adsorber vessels	15,004	Equation 1.25
Carbon	67	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	90,356	Equation 1.27
Total equipment cost ($)--escalated:	151,760	apply inflation factor
Purchased Equipment Cost ($):	174,524	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**258,296**	Table 1.4

ANNUAL COST INPUTS:		
Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:		
Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	707	Section 1.8.1.3
Steam	130	Equation 1.28
Cooling water	317	Equation 1.29
Carbon replacement	39	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	12,915	
Capital recovery	33,450	
Total Annual Cost (without credits)	181,762	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**181,762**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018
Current Date:	1/15/2020
Years since Cost Base Date:	2
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.05

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	1	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	0.85	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	9.27E-02	
VOC inlet concentration (ppmv):	92662.0	
VOC inlet partial pressure (psia):	1.3618	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	3.72	
Total Adsorption time per canister (hr):	500	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.570	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.285	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	1,492	Equation 1.14 (at 500 adsorption hrs/cycle)
Number of carbon replacements per year:	18	
Minimum carbon requirement (lbs carbon/yr)	26,848	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	1,570	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	9,413	Equation 1.27
Total equipment cost ($)--escalated:	9,889	apply inflation factor
Purchased Equipment Cost ($):	11,373	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**16,831**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	707	Section 1.8.1.3
Carbon replacement	22,893	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	842	
Capital recovery	2,180	
Total Annual Cost (without credits)	160,824	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**160,824**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Table 1. **VOC Control Technology Cost Analysis, LTC Operations, #2 Vacuum System** **Stack ID: S110**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	7.9	7.6
2.	Catalytic Oxidation	98.0	98.0	96.0	7.9	7.6
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	7.9	7.6
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	7.9	7.6
5.	Refrigerated Condenser	95.0	98.0	93.1	7.9	7.4
6.	Carbon Adsorption (Fixed Bed)	95.0	98.0	93.1	7.9	7.4
7.	Carbon Adsorption (Canister)	95.0	98.0	93.1	7.9	7.4
					*VOC Baseline =	**8.1 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	9,717	936	123	135,637	**17,814**
2.	Refrigerated Condenser	28,589	2,754	373	138,457	**18,758**
3.	Thermal Oxidation	94,508	9,105	1,196	148,047	**19,443**
4.	Rotary Concentrator/Oxidizer	344,461	33,186	4,358	184,634	**24,249**
5.	Carbon Adsorption (Fixed Bed)	242,352	31,386	4,252	179,679	**24,343**
6.	Carbon Adsorption (Canister)	12,786	1,656	224	190,426	**25,799**
7.	Regenerative Thermal Oxidizer	548,311	52,826	6,938	212,866	**27,956**

* PTE based on ACHD's TSD for IP-16a.
** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	3	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	47823.6	based on Toluene
Waste gas heat content (BTU/scf):	202.6	Equation 2.16
Waste gas heat content (BTU/lb):	2741.6	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.000	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	3	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	23,002	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	23,002	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	50,691	=Base cost x inflation factor
Purchased Equipment Cost (B):	59,815	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**94,508**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	10	
Electricity	4	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	4,725	
Capital recovery	9,105	=CRF x TCI
Total Annual Cost	**148,047**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016
Current Date:	1/15/2020
Years since Cost Base Date:	4
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.10

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	3	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	202.61	Equation 2.16
Waste gas heat content (BTU/lb):	2741.6	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	-0.031	Equation 2.21
	(scfm):	-0.75	
	(mcf/yr):	(395.8)	
Total Maximum Exhaust Gas Flowrate:	(scfm):	3	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	266,436	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	266,436	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	294,095	=Base cost x inflation factor
Purchased Equipment Cost (B):	347,032	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**548,311**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	(1,583)	
Electricity	5	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,416	
Capital recovery	52,826	=CRF x TCI
Total Annual Cost	**212,866**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

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Table 4. **Total Annual Cost Spreadsheet - Catalytic Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	3	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	202.61	Equation 2.16
Waste gas heat content (BTU/lb):	2741.63	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.000	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	3	
Catalyst Volume (ft3):	0.0	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	2,365	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	2,365	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	5,212	=Base cost x inflation factor
Purchased Equipment Cost (B):	6,150	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**9,717**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	6	
Electricity	4	Section 2.5.2.1
Catalyst replacement	2	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	486	
Capital recovery	936	=CRF x TCI
Total Annual Cost	**135,637**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

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Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996	
Current Date:	1/15/2020	
Years since Cost Base Date:	24	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.81	

PARAMETERS		
Flowrate (cfm)	3	
Control device input mass (tons/year)	7.9	
Concentration (avg. ppmv)	47,823.62	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	
ENERGY CALCULATIONS		
Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.0	Section 2.5.2.1
Fuel usage (Btu/hr)	495	Equation 2.21
CAPITAL COSTS		
Equipment cost (EC), (Durr budgetary costs, 3/15/96)	97,141	
Escalated Equipment Cost (A)	175,701	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	279,101	sty-cost.wk3
Total Capital Investment (TCI), ($)	344,461	sty-cost.wk3

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	
ANNUAL OPERATING COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	17	
Electricity	4	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,223	
Capital recovery	33,186	=CRF x TCI
Total Annual Cost	**184,634**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**

Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	
INPUT PARAMETERS:		
Inlet stream flowrate (scfm):	3	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.047824	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value
DESIGN PARAMETERS:		
Outlet VOC partial pressure (mm Hg):	3.7981	Equation 2.6
Condensation temperature, Tc (oF):	16.6	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0242	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.002	Equation 2.10
VOC condensed (lb-moles/hr):	0.022	inlet - outlet
(lb/hr):	2.0	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	16,975	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	519	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	17	Equation 2.16
Enthalpy change, air (BTU/hr):	613	Equation 2.17
Condenser heat load (BTU/hr):	1,148	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	64.7	Equation 2.19
Condenser surface area (ft2):	0.9	Equation 2.18
Coolant flowrate (lb/hr):	71	Equation 2.22
Refrigeration capacity (tons):	0.10	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:		
Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	10,679	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	0	Equation 2.28
Total equipment cost ($)--base:	13,348	Equation 2.29
Total equipment cost ($)--escalated:	15,480	inflation adjusted
Purchased Equipment Cost ($):	16,718	Equation 2.30
Total Capital Investment ($):	**28,589**	Table 2.3
ANNUAL COST INPUTS:		
Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	
ANNUAL COSTS:		
Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	71	
Overhead	50,326	
Taxes, insurance, administrative	1,429	
Capital recovery	2,754	
Total Annual Cost (without credits)	138,457	
Recovery credits	0	
Total Annual Cost (with credits)	**138,457**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	3	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.81	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	4.78E-02	
VOC inlet concentration (ppmv):	47823.6	
VOC inlet partial pressure (psia):	0.7028	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	7.93	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.530	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.265	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	123	Equation 1.14
Carbon requirement per vessel (lb):	41	
Gas flowrate per adsorbing vessel (acfm):	2	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	0.17	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	67.09	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	35.32	Equation 1.24
Carbon bed depth (ft):	62.030	Equation 1.31
Carbon bed pressure drop (in. w.c.):	210.780	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	16,920	Equation 1.25
Carbon	154	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	84,778	Equation 1.27
Total equipment cost ($)--escalated:	142,392	apply inflation factor
Purchased Equipment Cost ($):	163,751	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**242,352**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	930	Section 1.8.1.3
Steam	277	Equation 1.28
Cooling water	676	Equation 1.29
Carbon replacement	89	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	12,118	
Capital recovery	31,386	
Total Annual Cost (without credits)	179,679	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**179,679**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018
Current Date:	1/15/2020
Years since Cost Base Date:	2
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.05

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	3	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.81	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	4.78E-02	
VOC inlet concentration (ppmv):	47823.6	
VOC inlet partial pressure (psia):	0.7028	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	7.93	
Total Adsorption time per canister (hr):	350	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.530	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.265	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	2,391	Equation 1.14 (at 350 adsorption hrs/cycle)
Number of carbon replacements per year:	26	
Minimum carbon requirement (lbs carbon/yr)	62,154	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	1,440	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	7,150	Equation 1.27
Total equipment cost ($)--escalated:	7,512	apply inflation factor
Purchased Equipment Cost ($):	8,639	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**12,786**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	930	Section 1.8.1.3
Carbon replacement	52,998	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	639	
Capital recovery	1,656	
Total Annual Cost (without credits)	190,426	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**190,426**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Table 1. **VOC Control Technology Cost Analysis, LTC #1 and #2 Pastillation Belts** **Stack ID: S114**

Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	2.7	2.6
2.	Catalytic Oxidation	98.0	98.0	96.0	2.7	2.6
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	2.7	2.6
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	2.7	2.6
5.	Refrigerated Condenser	95.0	98.0	93.1	2.7	2.6
6.	Carbon Adsorption (Fixed Bed)	90.0	98.0	88.2	2.7	2.4
7.	Carbon Adsorption (Canister)	90.0	98.0	88.2	2.7	2.4
					*VOC Baseline =	**2.8 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Carbon Adsorption (Fixed Bed)	255,487	33,087	13,671	180,804	**74,706**
2.	Rotary Concentrator/Oxidizer	442,303	42,612	16,170	219,307	**83,218**
3.	Carbon Adsorption (Canister)	304,382	39,419	16,287	232,465	**96,052**
4.	Catalytic Oxidation	443,144	42,284	16,045	254,524	**96,581**
5.	Regenerative Thermal Oxidizer	637,930	61,460	23,321	270,055	**102,474**
6.	Thermal Oxidation	525,682	50,645	19,218	311,632	**118,251**
7.	Refrigerated Condenser	3,997,791	385,156	150,766	1,296,659	**507,565**

* PTE based on sum of #1 and #2 LTC Belts; taken from ACHD's TSD for IP-16a.

** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	3,100	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	17.6	based on Toluene
Waste gas heat content (BTU/scf):	1.0	Equation 2.16
Waste gas heat content (BTU/lb):	13.5	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane
CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	1.881	Equation 2.21
(scfm):	46.1	
Total Gas Flowrate (scfm):	3,146	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS		
Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	127,944	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	127,944	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	281,958	=Base cost x inflation factor
Purchased Equipment Cost (B):	332,710	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**525,682**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	96,952	
Electricity	3,547	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	26,284	
Capital recovery	50,645	=CRF x TCI
Total Annual Cost	**311,632**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	3,100	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	1.00	Equation 2.16
Waste gas heat content (BTU/lb):	13.5	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	0.717	Equation 2.21
	(scfm):	17.57	
	(mcf/yr):	9,232.6	
Total Maximum Exhaust Gas Flowrate:	(scfm):	3,118	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	309,984	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	309,984	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	342,164	=Base cost x inflation factor
Purchased Equipment Cost (B):	403,753	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**637,930**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	36,930	
Electricity	5,565	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	31,897	
Capital recovery	61,460	=CRF x TCI
Total Annual Cost	**270,055**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	3,100	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	1.00	Equation 2.16
Waste gas heat content (BTU/lb):	13.53	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	0.960	Equation 2.21
(scfm):	23.5	
Total Gas Flowrate (scfm):	3,124	
Catalyst Volume (ft3):	6.0	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS		
Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	107,855	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	107,855	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	237,687	=Base cost x inflation factor
Purchased Equipment Cost (B):	280,471	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**443,144**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	49,487	
Electricity	4,108	Section 2.5.2.1
Catalyst replacement	2,284	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	22,157	
Capital recovery	42,284	=CRF x TCI
Total Annual Cost	**254,524**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996
Current Date:	1/15/2020
Years since Cost Base Date:	24
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.81

PARAMETERS

Flowrate (cfm)	3,100	
Control device input mass (tons/year)	2.7	
Concentration (avg. ppmv)	17.62	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	8.5	Section 2.5.2.1
Fuel usage (Btu/hr)	465,154	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	123,101	
Escalated Equipment Cost (A)	222,657	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	359,475	sty-cost.wk3
Total Capital Investment (TCI), ($)	442,303	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	16,299	
Electricity	4,077	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	22,115	
Capital recovery	42,612	=CRF x TCI
Total Annual Cost	**219,307**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	3,100	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.000018	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.0013	Equation 2.6
Condensation temperature, Tc (oF):	-116.8	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0084	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.001	Equation 2.10
VOC condensed (lb-moles/hr):	0.008	inlet - outlet
(lb/hr):	0.7	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	18,346	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	227	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	10	Equation 2.16
Enthalpy change, air (BTU/hr):	1,044,559	Equation 2.17
Condenser heat load (BTU/hr):	1,044,796	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	96.7	Equation 2.19
Condenser surface area (ft2):	540.4	Equation 2.18
Coolant flowrate (lb/hr):	64,295	Equation 2.22
Refrigeration capacity (tons):	87.07	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	11.7	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	0	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	630,817	Equation 2.27
-- Multistage refrigeration unit:	1,493,300	Equation 2.28
Total equipment cost ($)--base:	1,866,625	Equation 2.29
Total equipment cost ($)--escalated:	2,164,712	inflation adjusted
Purchased Equipment Cost ($):	2,337,889	Equation 2.30
Total Capital Investment ($):	**3,997,791**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	577,410
Overhead	50,326
Taxes, insurance, administrative	199,890
Capital recovery	385,156
Total Annual Cost (without credits)	1,296,659
Recovery credits	0
Total Annual Cost (with credits)	**1,296,659**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:		
Inlet stream flowrate (acfm):	3,100	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	0.63	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	1.76E-05	
VOC inlet concentration (ppmv):	17.6	
VOC inlet partial pressure (psia):	0.0003	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	2.74	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:		
Carbon adsorptivity (lb Toluene/lb carbon):	0.222	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.111	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	102	Equation 1.14
Carbon requirement per vessel (lb):	34	
Gas flowrate per adsorbing vessel (acfm):	1,550	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	5.13	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	5.05	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	122.79	Equation 1.24
Carbon bed depth (ft):	0.055	Equation 1.31
Carbon bed pressure drop (in. w.c.):	1.184	Equation 1.30

CAPITAL COSTS:		
Adsorber vessels	44,607	Equation 1.25
Carbon	127	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	89,373	Equation 1.27
Total equipment cost ($)--escalated:	150,110	apply inflation factor
Purchased Equipment Cost ($):	172,626	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**255,487**	Table 1.4

ANNUAL COST INPUTS:		
Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:		
Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	336	Section 1.8.1.3
Steam	96	Equation 1.28
Cooling water	234	Equation 1.29
Carbon replacement	74	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	12,774	
Capital recovery	33,087	
Total Annual Cost (without credits)	180,804	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**180,804**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018
Current Date:	1/15/2020
Years since Cost Base Date:	2
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.05

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	3,100	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	0.63	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	1.76E-05	
VOC inlet concentration (ppmv):	17.6	
VOC inlet partial pressure (psia):	0.0003	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	2.74	
Total Adsorption time per canister (hr):	1,000	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.222	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.111	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	5,641	Equation 1.14 (at 1000 adsorption hrs/cycle)
Number of carbon replacements per year:	9	
Minimum carbon requirement (lbs carbon/yr)	50,767	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	85,200	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	170,220	Equation 1.27
Total equipment cost ($)--escalated:	178,838	apply inflation factor
Purchased Equipment Cost ($):	205,663	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**304,382**	Table 1.4

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	336	Section 1.8.1.3
Carbon replacement	43,288	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	15,219	
Capital recovery	39,419	
Total Annual Cost (without credits)	232,465	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**232,465**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

WW Poly Sources

Table 1. **VOC Control Technology Cost Analysis, WW Poly, Feed Dryers and Regeneration** **Stack ID: S013 & S013a**

Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	4.8	4.6
2.	Catalytic Oxidation	98.0	98.0	96.0	4.8	4.6
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	4.8	4.6
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	4.8	4.6
5.	Refrigerated Condenser	95.0	98.0	93.1	4.8	4.4
6.	Carbon Adsorption (Fixed Bed)	95.0	98.0	93.1	4.8	4.4
7.	Carbon Adsorption (Canister)	95.0	98.0	93.1	4.8	4.4
					*VOC Baseline =	**4.9 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	27,266	2,624	574	138,270	**30,228**
2.	Refrigerated Condenser	103,560	9,977	2,250	149,704	**33,761**
3.	Thermal Oxidation	150,160	14,467	3,163	156,264	**34,162**
4.	Carbon Adsorption (Fixed Bed)	107,591	13,933	3,142	154,297	**34,797**
5.	Rotary Concentrator/Oxidizer	345,018	33,240	7,267	184,832	**40,408**
6.	Regenerative Thermal Oxidizer	548,832	52,876	11,560	213,879	**46,758**
7.	Carbon Adsorption (Canister)	1,312,009	169,911	38,319	417,479	**94,151**

* PTE based on ACHD's TSD for IP-23.

** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	21.0	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	4514.7	based on Toluene
Waste gas heat content (BTU/scf):	19.1	Equation 2.16
Waste gas heat content (BTU/lb):	258.8	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane
CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	0.001	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	21	
Pressure drop (in. w.c.):	12.0	Table 2.13
CALCULATED CAPITAL COSTS		
Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	36,547	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	36,547	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	80,541	=Base cost x inflation factor
Purchased Equipment Cost (B):	95,038	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**150,160**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	63	
Electricity	24	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	7,508	
Capital recovery	14,467	=CRF x TCI
Total Annual Cost	**156,264**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	21	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	19.13	Equation 2.16
Waste gas heat content (BTU/lb):	258.8	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	-0.013	Equation 2.21
	(scfm):	-0.32	
	(mcf/yr):	(169.5)	
Total Maximum Exhaust Gas Flowrate:	(scfm):	21	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	266,689	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	266,689	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	294,375	=Base cost x inflation factor
Purchased Equipment Cost (B):	347,362	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**548,832**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	(678)	
Electricity	37	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,442	
Capital recovery	52,876	=CRF x TCI
Total Annual Cost	**213,879**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	21	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	19.13	Equation 2.16
Waste gas heat content (BTU/lb):	258.82	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.001	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	21	
Catalyst Volume (ft3):	0.0	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	6,636	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	6,636	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	14,624	=Base cost x inflation factor
Purchased Equipment Cost (B):	17,257	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**27,266**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	37	
Electricity	28	Section 2.5.2.1
Catalyst replacement	15	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	1,363	
Capital recovery	2,624	=CRF x TCI
Total Annual Cost	**138,270**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996
Current Date:	1/15/2020
Years since Cost Base Date:	24
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.81

PARAMETERS

Flowrate (cfm)	21	
Control device input mass (tons/year)	4.8	
Concentration (avg. ppmv)	4,514.66	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.1	Section 2.5.2.1
Fuel usage (Btu/hr)	3,151	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	97,288	
Escalated Equipment Cost (A)	175,968	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	279,558	sty-cost.wk3
Total Capital Investment (TCI), ($)	345,018	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	110	
Electricity	28	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,251	
Capital recovery	33,240	=CRF x TCI
Total Annual Cost	**184,832**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	21	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.004515	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.3445	Equation 2.6
Condensation temperature, Tc (oF):	-36.7	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0145	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.001	Equation 2.10
VOC condensed (lb-moles/hr):	0.013	inlet - outlet
(lb/hr):	1.2	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	17,544	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	345	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	13	Equation 2.16
Enthalpy change, air (BTU/hr):	5,264	Equation 2.17
Condenser heat load (BTU/hr):	5,622	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	78.0	Equation 2.19
Condenser surface area (ft2):	3.6	Equation 2.18
Coolant flowrate (lb/hr):	346	Equation 2.22
Refrigeration capacity (tons):	0.47	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	38,683	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	27,030	Equation 2.28
Total equipment cost ($)--base:	48,353	Equation 2.29
Total equipment cost ($)--escalated:	56,075	inflation adjusted
Purchased Equipment Cost ($):	60,561	Equation 2.30
Total Capital Investment ($):	**103,560**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	345
Overhead	50,326
Taxes, insurance, administrative	5,178
Capital recovery	9,977
Total Annual Cost (without credits)	149,704
Recovery credits	0
Total Annual Cost (with credits)	**149,704**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	21	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.09	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	4.51E-03	
VOC inlet concentration (ppmv):	4514.7	
VOC inlet partial pressure (psia):	0.0663	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	4.76	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.409	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.204	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	96	Equation 1.14
Carbon requirement per vessel (lb):	32	
Gas flowrate per adsorbing vessel (acfm):	11	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	0.42	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	12.60	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	16.99	Equation 1.24
Carbon bed depth (ft):	7.592	Equation 1.31
Carbon bed pressure drop (in. w.c.):	26.674	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	9,575	Equation 1.25
Carbon	120	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	37,637	Equation 1.27
Total equipment cost ($)--escalated:	63,214	apply inflation factor
Purchased Equipment Cost ($):	72,696	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**107,591**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	138	Section 1.8.1.3
Steam	167	Equation 1.28
Cooling water	406	Equation 1.29
Carbon replacement	70	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	5,380	
Capital recovery	13,933	
Total Annual Cost (without credits)	154,297	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**154,297**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018	
Current Date:	1/15/2020	
Years since Cost Base Date:	2	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.05	

INPUT PARAMETERS:		
Inlet stream flowrate (acfm):	21	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.09	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	4.51E-03	
VOC inlet concentration (ppmv):	4514.7	
VOC inlet partial pressure (psia):	0.0663	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	4.76	
Total Adsorption time per canister (hr):	1,750	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

ANNUAL COST INPUTS:	
Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

DESIGN PARAMETERS:		
Carbon adsorptivity (lb Toluene/lb carbon):	0.409	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.204	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	9,309	Equation 1.14 (at 1750 adsorption hrs/cycle)
Number of carbon replacements per year:	6	
Minimum carbon requirement (lbs carbon/yr)	55,854	Lbs per replacement times number of replacements

CAPITAL COSTS:		
Adsorber vessels (includes cost of carbon)	189,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	733,719	Equation 1.27
Total equipment cost ($)--escalated:	770,863	apply inflation factor
Purchased Equipment Cost ($):	886,493	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**1,312,009**	Table 1.4

ANNUAL COSTS:		
Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	138	Section 1.8.1.3
Carbon replacement	47,626	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	65,600	
Capital recovery	169,911	
Total Annual Cost (without credits)	417,479	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**417,479**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Table 1. **VOC Control Technology Cost Analysis, WW Poly, Filtrate Receiver** **Stack ID: S020**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	5.0	4.8
2.	Catalytic Oxidation	98.0	98.0	96.0	5.0	4.8
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	5.0	4.8
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	5.0	4.8
5.	Refrigerated Condenser	95.0	98.0	93.1	5.0	4.7
6.	Carbon Adsorption (Fixed Bed)	95.0	98.0	93.1	5.0	4.7
7.	Carbon Adsorption (Canister)	95.0	98.0	93.1	5.0	4.7
					*VOC Baseline =	**5.1 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	111,246	10,683	2,221	154,741	**32,174**
2.	Carbon Adsorption (Fixed Bed)	121,953	15,793	3,388	156,903	**33,654**
3.	Thermal Oxidation	282,705	27,236	5,663	183,607	**38,176**
4.	Rotary Concentrator/Oxidizer	352,537	33,964	7,062	187,503	**38,986**
5.	Regenerative Thermal Oxidizer	555,755	53,543	11,133	218,702	**45,473**
6.	Refrigerated Condenser	548,251	52,820	11,329	219,179	**47,011**
7.	Carbon Adsorption (Canister)	655,711	84,918	18,214	308,314	**66,130**

* PTE based on ACHD's TSD for IP-23.
** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

C:\Users\mschooley1\Desktop\Eastman_RACT\WW_Poly\WWPoly_FiltrateReceiver_CostAnalysis_20200114.xlsx

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	260.0	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	383.4	based on Toluene
Waste gas heat content (BTU/scf):	1.6	Equation 2.16
Waste gas heat content (BTU/lb):	22.0	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane
CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	0.150	Equation 2.21
(scfm):	3.7	
Total Gas Flowrate (scfm):	264	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS		
Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	68,807	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	68,807	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	151,633	=Base cost x inflation factor
Purchased Equipment Cost (B):	178,927	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**282,705**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	7,735	
Electricity	297	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	14,135	
Capital recovery	27,236	=CRF x TCI
Total Annual Cost	**183,607**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	260	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	1.62	Equation 2.16
Waste gas heat content (BTU/lb):	22.0	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	0.052	Equation 2.21
	(scfm):	1.28	
	(mcf/yr):	675.4	
Total Maximum Exhaust Gas Flowrate:	(scfm):	261	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	270,053	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	270,053	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	298,088	=Base cost x inflation factor
Purchased Equipment Cost (B):	351,744	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**555,755**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	2,702	
Electricity	466	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,788	
Capital recovery	53,543	=CRF x TCI
Total Annual Cost	**218,702**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	260	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	1.62	Equation 2.16
Waste gas heat content (BTU/lb):	21.98	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.073	Equation 2.21
(scfm):	1.8	
Total Gas Flowrate (scfm):	262	
Catalyst Volume (ft3):	0.5	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	27,076	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	27,076	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	59,669	=Base cost x inflation factor
Purchased Equipment Cost (B):	70,409	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**111,246**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	3,757	
Electricity	344	Section 2.5.2.1
Catalyst replacement	191	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	5,562	
Capital recovery	10,683	=CRF x TCI
Total Annual Cost	**154,741**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996
Current Date:	1/15/2020
Years since Cost Base Date:	24
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.81

PARAMETERS

Flowrate (cfm)	260	
Control device input mass (tons/year)	5.0	
Concentration (avg. ppmv)	383.40	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.7	Section 2.5.2.1
Fuel usage (Btu/hr)	39,013	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	99,283	
Escalated Equipment Cost (A)	179,575	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	285,735	sty-cost.wk3
Total Capital Investment (TCI), ($)	352,537	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	1,367	
Electricity	342	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,627	
Capital recovery	33,964	=CRF x TCI
Total Annual Cost	**187,503**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6.

Total Annual Cost Spreadsheet - Packaged Condenser
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	260	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.000383	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.0291	Equation 2.6
Condensation temperature, Tc (oF):	-77.9	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0153	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.002	Equation 2.10
VOC condensed (lb-moles/hr):	0.014	inlet - outlet
(lb/hr):	1.3	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	17,964	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	390	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	16	Equation 2.16
Enthalpy change, air (BTU/hr):	76,846	Equation 2.17
Condenser heat load (BTU/hr):	77,252	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	87.7	Equation 2.19
Condenser surface area (ft2):	44.0	Equation 2.18
Coolant flowrate (lb/hr):	4,754	Equation 2.22
Refrigeration capacity (tons):	6.44	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	167,923	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	204,789	Equation 2.28
Total equipment cost ($)--base:	255,986	Equation 2.29
Total equipment cost ($)--escalated:	296,865	inflation adjusted
Purchased Equipment Cost ($):	320,615	Equation 2.30
Total Capital Investment ($):	**548,251**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	4,744
Overhead	50,326
Taxes, insurance, administrative	27,413
Capital recovery	52,820
Total Annual Cost (without credits)	219,179
Recovery credits	0
Total Annual Cost (with credits)	**219,179**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7. **Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	260	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.14	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	3.83E-04	
VOC inlet concentration (ppmv):	383.4	
VOC inlet partial pressure (psia):	0.0056	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	5.01	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.312	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.156	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	132	Equation 1.14
Carbon requirement per vessel (lb):	44	
Gas flowrate per adsorbing vessel (acfm):	130	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	1.49	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	5.85	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	30.75	Equation 1.24
Carbon bed depth (ft):	0.846	Equation 1.31
Carbon bed pressure drop (in. w.c.):	3.860	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	15,192	Equation 1.25
Carbon	165	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	42,661	Equation 1.27
Total equipment cost ($)--escalated:	71,653	apply inflation factor
Purchased Equipment Cost ($):	82,400	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**121,953**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	110	Section 1.8.1.3
Steam	175	Equation 1.28
Cooling water	427	Equation 1.29
Carbon replacement	96	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	6,098	
Capital recovery	15,793	
Total Annual Cost (without credits)	156,903	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**156,903**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018
Current Date:	1/15/2020
Years since Cost Base Date:	2
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.05

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	260	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.14	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	3.83E-04	
VOC inlet concentration (ppmv):	383.4	
VOC inlet partial pressure (psia):	0.0056	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	5.01	
Total Adsorption time per canister (hr):	1,000	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.312	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.156	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	7,336	Equation 1.14 (at 1000 adsorption hrs/cycle)
Number of carbon replacements per year:	9	
Minimum carbon requirement (lbs carbon/yr)	66,024	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	132,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	366,695	Equation 1.27
Total equipment cost ($)--escalated:	385,259	apply inflation factor
Purchased Equipment Cost ($):	443,048	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**655,711**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	110	Section 1.8.1.3
Carbon replacement	56,297	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	32,786	
Capital recovery	84,918	
Total Annual Cost (without credits)	308,314	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**308,314**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Table 1. **VOC Control Technology Cost Analysis, WW Poly, Solvent Wash Receiver** **Stack ID: S023**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	7.4	7.1
2.	Catalytic Oxidation	98.0	98.0	96.0	7.4	7.1
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	7.4	7.1
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	7.4	7.1
5.	Refrigerated Condenser	95.0	98.0	93.1	7.4	6.9
6.	Carbon Adsorption (Fixed Bed)	95.0	98.0	93.1	7.4	6.9
7.	Carbon Adsorption (Canister)	95.0	98.0	93.1	7.4	6.9
					*VOC Baseline =	**7.5 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	86,800	8,341	1,178	148,790	**21,022**
2.	Carbon Adsorption (Fixed Bed)	119,334	15,454	2,252	156,790	**22,852**
3.	Thermal Oxidation	252,912	24,366	3,443	175,518	**24,798**
4.	Rotary Concentrator/Oxidizer	349,610	33,682	4,759	186,464	**26,345**
5.	Refrigerated Condenser	355,406	34,241	4,991	189,142	**27,567**
6.	Regenerative Thermal Oxidizer	553,054	53,283	7,528	216,318	**30,563**
7.	Carbon Adsorption (Canister)	995,797	128,960	18,796	388,732	**56,657**

* PTE based on ACHD's TSD for IP-23.
** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	167.0	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	878.4	based on Toluene
Waste gas heat content (BTU/scf):	3.7	Equation 2.16
Waste gas heat content (BTU/lb):	50.4	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.080	Equation 2.21
(scfm):	2.0	
Total Gas Flowrate (scfm):	169	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	61,555	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	61,555	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	135,653	=Base cost x inflation factor
Purchased Equipment Cost (B):	160,071	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**252,912**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	4,112	
Electricity	190	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	12,646	
Capital recovery	24,366	=CRF x TCI
Total Annual Cost	**175,518**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	167	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	3.72	Equation 2.16
Waste gas heat content (BTU/lb):	50.4	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	0.017	Equation 2.21
	(scfm):	0.42	
	(mcf/yr):	220.3	
Total Maximum Exhaust Gas Flowrate:	(scfm):	167	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	268,741	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	268,741	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	296,639	=Base cost x inflation factor
Purchased Equipment Cost (B):	350,034	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**553,054**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	881	
Electricity	299	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,653	
Capital recovery	53,283	=CRF x TCI
Total Annual Cost	**216,318**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	167	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	3.72	Equation 2.16
Waste gas heat content (BTU/lb):	50.36	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.030	Equation 2.21
(scfm):	0.7	
Total Gas Flowrate (scfm):	168	
Catalyst Volume (ft3):	0.3	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	21,126	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	21,126	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	46,556	=Base cost x inflation factor
Purchased Equipment Cost (B):	54,937	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**86,800**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	1,563	
Electricity	221	Section 2.5.2.1
Catalyst replacement	123	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	4,340	
Capital recovery	8,341	=CRF x TCI
Total Annual Cost	**148,790**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5.

Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996
Current Date:	1/15/2020
Years since Cost Base Date:	24
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.81

PARAMETERS			***ANNUAL COST INPUTS***		
Flowrate (cfm)	167		Operating factor (hr/yr):	8,760	
Control device input mass (tons/year)	7.4		Operating labor rate ($/hr):	48.00	
Concentration (avg. ppmv)	878.43	based on Toluene	Maintenance labor rate ($/hr):	49.00	
Facility operating schedule (hours/year)	8,760		Operating labor factor (hr/sh):	0.50	Table 2.12
Thermal oxidizer temperature (F)	1,400		Maintenance labor factor (hr/sh):	0.50	Table 2.12
Fuel cost, ($/million BTU)	4.00		Electricity price ($/kwh):	0.055	
Electricity cost, ($/kwhr)	0.055		Natural gas price ($/mscf):	4.00	
			Annual interest rate (fraction):	0.05	
ENERGY CALCULATIONS			Control system life (years):	15	
Heat recovery (%)	50		Capital recovery factor:	0.0963	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)	Taxes, insurance, admin. factor:	0.05	
Electrical power (kW)	0.5	Section 2.5.2.1			
Fuel usage (Btu/hr)	25,058	Equation 2.21			
			ANNUAL OPERATING COSTS		
CAPITAL COSTS			Operating labor	26,280	
Equipment cost (EC), (Durr budgetary costs, 3/15/96)	98,506		Supervisory labor	3,942	Table 2.12
Escalated Equipment Cost (A)	178,171	inflation adjustment	Maintenance labor	26,828	
Other equipment:	0		Maintenance materials	26,828	Table 2.12
Total Direct Cost (TDC), ($)	283,331	sty-cost.wk3	Natural gas	878	
Total Capital Investment (TCI), ($)	349,610	sty-cost.wk3	Electricity	220	
			Overhead	50,326	Table 2.12
			Taxes, insurance, administrative	17,481	
			Capital recovery	33,682	=CRF x TCI
			Total Annual Cost	**186,464**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries*, EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	167	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.000878	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.0668	Equation 2.6
Condensation temperature, Tc (oF):	-65.3	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0225	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.002	Equation 2.10
VOC condensed (lb-moles/hr):	0.020	inlet - outlet
(lb/hr):	1.9	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	17,837	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	562	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	22	Equation 2.16
Enthalpy change, air (BTU/hr):	47,092	Equation 2.17
Condenser heat load (BTU/hr):	47,676	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	84.8	Equation 2.19
Condenser surface area (ft2):	28.1	Equation 2.18
Coolant flowrate (lb/hr):	2,934	Equation 2.22
Refrigeration capacity (tons):	3.97	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	119,406	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	132,755	Equation 2.28
Total equipment cost ($)--base:	165,944	Equation 2.29
Total equipment cost ($)--escalated:	192,444	inflation adjusted
Purchased Equipment Cost ($):	207,840	Equation 2.30
Total Capital Investment ($):	**355,406**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	2,928
Overhead	50,326
Taxes, insurance, administrative	17,770
Capital recovery	34,241
Total Annual Cost (without credits)	189,142
Recovery credits	0
Total Annual Cost (with credits)	**189,142**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	167	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.68	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	8.78E-04	
VOC inlet concentration (ppmv):	878.4	
VOC inlet partial pressure (psia):	0.0129	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	7.37	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.341	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.171	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	177	Equation 1.14
Carbon requirement per vessel (lb):	59	
Gas flowrate per adsorbing vessel (acfm):	84	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	1.19	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	6.77	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	27.55	Equation 1.24
Carbon bed depth (ft):	1.769	Equation 1.31
Carbon bed pressure drop (in. w.c.):	6.981	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	13,946	Equation 1.25
Carbon	222	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	41,745	Equation 1.27
Total equipment cost ($)--escalated:	70,114	apply inflation factor
Purchased Equipment Cost ($):	80,631	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**119,334**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	151	Section 1.8.1.3
Steam	258	Equation 1.28
Cooling water	628	Equation 1.29
Carbon replacement	129	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	5,967	
Capital recovery	15,454	
Total Annual Cost (without credits)	156,790	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**156,790**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018	
Current Date:	1/15/2020	
Years since Cost Base Date:	2	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.05	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	167	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.68	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	8.78E-04	
VOC inlet concentration (ppmv):	878.4	
VOC inlet partial pressure (psia):	0.0129	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	7.37	
Total Adsorption time per canister (hr):	1,000	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.341	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.171	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	9,855	Equation 1.14 (at 1000 adsorption hrs/cycle)
Number of carbon replacements per year:	9	
Minimum carbon requirement (lbs carbon/yr)	88,693	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	189,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	556,882	Equation 1.27
Total equipment cost ($)--escalated:	585,075	apply inflation factor
Purchased Equipment Cost ($):	672,836	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**995,797**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	151	Section 1.8.1.3
Carbon replacement	75,628	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	49,790	
Capital recovery	128,960	
Total Annual Cost (without credits)	388,732	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**388,732**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Table 1. **VOC Control Technology Cost Analysis, WW Poly, Tanks 73/75/76/77** **Stack ID: S025**

Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	5.3	5.1
2.	Catalytic Oxidation	98.0	98.0	96.0	5.3	5.1
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	5.3	5.1
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	5.3	5.1
5.	Refrigerated Condenser	95.0	98.0	93.1	5.3	5.0
6.	Carbon Adsorption (Fixed Bed)	95.0	98.0	93.1	5.3	5.0
7.	Carbon Adsorption (Canister)	95.0	98.0	93.1	5.3	5.0
					*VOC Baseline =	**5.5 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	23,430	2,255	440	137,691	**26,843**
2.	Refrigerated Condenser	84,796	8,169	1,643	146,875	**29,538**
3.	Thermal Oxidation	140,283	13,515	2,635	154,798	**30,178**
4.	Carbon Adsorption (Fixed Bed)	118,761	15,380	3,093	156,423	**31,458**
5.	Rotary Concentrator/Oxidizer	344,861	33,225	6,477	184,776	**36,022**
6.	Regenerative Thermal Oxidizer	548,686	52,862	10,305	213,658	**41,653**
7.	Carbon Adsorption (Canister)	950,071	123,039	24,744	348,802	**70,147**

* PTE based on ACHD's TSD for IP-23.

** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	16.0	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	6644.8	based on Toluene
Waste gas heat content (BTU/scf):	28.2	Equation 2.16
Waste gas heat content (BTU/lb):	380.9	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane
CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	0.001	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	16	
Pressure drop (in. w.c.):	12.0	Table 2.13
CALCULATED CAPITAL COSTS		
Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	34,143	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	34,143	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	75,243	=Base cost x inflation factor
Purchased Equipment Cost (B):	88,787	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**140,283**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	48	
Electricity	18	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	7,014	
Capital recovery	13,515	=CRF x TCI
Total Annual Cost	**154,798**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	16	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	28.15	Equation 2.16
Waste gas heat content (BTU/lb):	380.9	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	-0.017	Equation 2.21
	(scfm):	-0.41	
	(mcf/yr):	(217.2)	
Total Maximum Exhaust Gas Flowrate:	(scfm):	16	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	266,618	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	266,618	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	294,296	=Base cost x inflation factor
Purchased Equipment Cost (B):	347,270	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**548,686**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	(869)	
Electricity	28	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,434	
Capital recovery	52,862	=CRF x TCI
Total Annual Cost	**213,658**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	16	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	28.15	Equation 2.16
Waste gas heat content (BTU/lb):	380.93	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane
CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	0.001	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	16	
Catalyst Volume (ft3):	0.0	
Pressure drop (in. w.c.):	14.0	Table 2.13
CALCULATED CAPITAL COSTS		
Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	5,703	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	5,703	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	12,567	=Base cost x inflation factor
Purchased Equipment Cost (B):	14,829	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**23,430**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	
CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	28	
Electricity	21	Section 2.5.2.1
Catalyst replacement	12	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	1,172	
Capital recovery	2,255	=CRF x TCI
Total Annual Cost	**137,691**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996
Current Date:	1/15/2020
Years since Cost Base Date:	24
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.81

PARAMETERS

Flowrate (cfm)	16	
Control device input mass (tons/year)	5.3	
Concentration (avg. ppmv)	6,644.84	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.0	Section 2.5.2.1
Fuel usage (Btu/hr)	2,401	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	97,246	
Escalated Equipment Cost (A)	175,892	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	279,429	sty-cost.wk3
Total Capital Investment (TCI), ($)	344,861	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	84	
Electricity	21	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,243	
Capital recovery	33,225	=CRF x TCI
Total Annual Cost	**184,776**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	16	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.006645	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.5080	Equation 2.6
Condensation temperature, Tc (oF):	-29.1	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0163	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.002	Equation 2.10
VOC condensed (lb-moles/hr):	0.015	inlet - outlet
(lb/hr):	1.3	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	17,465	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	382	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	14	Equation 2.16
Enthalpy change, air (BTU/hr):	3,874	Equation 2.17
Condenser heat load (BTU/hr):	4,270	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	76.1	Equation 2.19
Condenser surface area (ft2):	2.8	Equation 2.18
Coolant flowrate (lb/hr):	263	Equation 2.22
Refrigeration capacity (tons):	0.36	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	31,674	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	21,012	Equation 2.28
Total equipment cost ($)--base:	39,592	Equation 2.29
Total equipment cost ($)--escalated:	45,915	inflation adjusted
Purchased Equipment Cost ($):	49,588	Equation 2.30
Total Capital Investment ($):	**84,796**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	262
Overhead	50,326
Taxes, insurance, administrative	4,240
Capital recovery	8,169
Total Annual Cost (without credits)	146,875
Recovery credits	0
Total Annual Cost (with credits)	**146,875**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	16	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.22	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	6.64E-03	
VOC inlet concentration (ppmv):	6644.8	
VOC inlet partial pressure (psia):	0.0977	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	5.34	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.427	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.213	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	103	Equation 1.14
Carbon requirement per vessel (lb):	34	
Gas flowrate per adsorbing vessel (acfm):	8	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	0.37	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	15.72	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	18.41	Equation 1.24
Carbon bed depth (ft):	10.708	Equation 1.31
Carbon bed pressure drop (in. w.c.):	37.215	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	10,193	Equation 1.25
Carbon	129	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	41,544	Equation 1.27
Total equipment cost ($)--escalated:	69,777	apply inflation factor
Purchased Equipment Cost ($):	80,244	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**118,761**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	184	Section 1.8.1.3
Steam	187	Equation 1.28
Cooling water	455	Equation 1.29
Carbon replacement	75	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	5,938	
Capital recovery	15,380	
Total Annual Cost (without credits)	156,423	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**156,423**	

Table 8.

Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018
Current Date:	1/15/2020
Years since Cost Base Date:	2
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.05

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	16	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.22	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	6.64E-03	
VOC inlet concentration (ppmv):	6644.8	
VOC inlet partial pressure (psia):	0.0977	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	5.34	
Total Adsorption time per canister (hr):	1,500	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.427	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.213	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	8,575	Equation 1.14 (at 1500 adsorption hrs/cycle)
Number of carbon replacements per year:	6	
Minimum carbon requirement (lbs carbon/yr)	51,452	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	132,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	531,311	Equation 1.27
Total equipment cost ($)--escalated:	558,209	apply inflation factor
Purchased Equipment Cost ($):	641,940	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**950,071**	Table 1.4

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	184	Section 1.8.1.3
Carbon replacement	43,873	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	47,504	
Capital recovery	123,039	
Total Annual Cost (without credits)	348,802	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**348,802**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Table 1. **VOC Control Technology Cost Analysis, WW Poly, East Filtrate Receiver** **Stack ID: S027**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	5.4	5.2
2.	Catalytic Oxidation	98.0	98.0	96.0	5.4	5.2
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	5.4	5.2
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	5.4	5.2
5.	Refrigerated Condenser	95.0	98.0	93.1	5.4	5.0
6.	Carbon Adsorption (Fixed Bed)	95.0	98.0	93.1	5.4	5.0
7.	Carbon Adsorption (Canister)	95.0	98.0	93.1	5.4	5.0
					*VOC Baseline =	**5.5 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	86,855	8,346	1,609	149,202	**28,770**
2.	Carbon Adsorption (Fixed Bed)	113,537	14,704	2,925	155,442	**30,920**
3.	Thermal Oxidation	252,984	24,373	4,700	175,934	**33,925**
4.	Rotary Concentrator/Oxidizer	349,610	33,682	6,495	186,464	**35,955**
5.	Refrigerated Condenser	380,118	36,621	7,285	192,802	**38,352**
6.	Regenerative Thermal Oxidizer	553,060	53,283	10,274	216,725	**41,791**
7.	Carbon Adsorption (Canister)	995,797	128,960	25,652	376,778	**74,948**

* PTE based on ACHD's TSD for IP-23.
** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	167.0	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	643.6	based on Toluene
Waste gas heat content (BTU/scf):	2.7	Equation 2.16
Waste gas heat content (BTU/lb):	36.9	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.088	Equation 2.21
(scfm):	2.1	
Total Gas Flowrate (scfm):	169	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	61,573	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	61,573	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	135,692	=Base cost x inflation factor
Purchased Equipment Cost (B):	160,116	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**252,984**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	4,518	
Electricity	191	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	12,649	
Capital recovery	24,373	=CRF x TCI
Total Annual Cost	**175,934**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016
Current Date:	1/15/2020
Years since Cost Base Date:	4
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.10

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	167	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	2.73	Equation 2.16
Waste gas heat content (BTU/lb):	36.9	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	0.025	Equation 2.21
	(scfm):	0.61	
	(mcf/yr):	321.6	
Total Maximum Exhaust Gas Flowrate:	(scfm):	168	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	268,743	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	268,743	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	296,642	=Base cost x inflation factor
Purchased Equipment Cost (B):	350,038	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**553,060**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	1,286	
Electricity	299	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,653	
Capital recovery	53,283	=CRF x TCI
Total Annual Cost	**216,725**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	167	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	2.73	Equation 2.16
Waste gas heat content (BTU/lb):	36.90	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.038	Equation 2.21
(scfm):	0.9	
Total Gas Flowrate (scfm):	168	
Catalyst Volume (ft3):	0.3	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	21,139	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	21,139	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	46,586	=Base cost x inflation factor
Purchased Equipment Cost (B):	54,972	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**86,855**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	1,966	
Electricity	221	Section 2.5.2.1
Catalyst replacement	123	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	4,343	
Capital recovery	8,346	=CRF x TCI
Total Annual Cost	**149,202**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996	
Current Date:	1/15/2020	
Years since Cost Base Date:	24	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.81	

PARAMETERS

Flowrate (cfm)	167	
Control device input mass (tons/year)	5.4	
Concentration (avg. ppmv)	643.64	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.5	Section 2.5.2.1
Fuel usage (Btu/hr)	25,058	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	98,506	
Escalated Equipment Cost (A)	178,171	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	283,331	sty-cost.wk3
Total Capital Investment (TCI), ($)	349,610	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	878	
Electricity	220	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,481	
Capital recovery	33,682	=CRF x TCI
Total Annual Cost	**186,464**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	167	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.000644	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.0489	Equation 2.6
Condensation temperature, Tc (oF):	-70.2	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0165	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.002	Equation 2.10
VOC condensed (lb-moles/hr):	0.015	inlet - outlet
(lb/hr):	1.4	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	17,886	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	415	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	17	Equation 2.16
Enthalpy change, air (BTU/hr):	47,967	Equation 2.17
Condenser heat load (BTU/hr):	48,399	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	85.9	Equation 2.19
Condenser surface area (ft2):	28.2	Equation 2.18
Coolant flowrate (lb/hr):	2,978	Equation 2.22
Refrigeration capacity (tons):	4.03	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	128,486	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	141,986	Equation 2.28
Total equipment cost ($)--base:	177,482	Equation 2.29
Total equipment cost ($)--escalated:	205,825	inflation adjusted
Purchased Equipment Cost ($):	222,291	Equation 2.30
Total Capital Investment ($):	**380,118**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	2,972
Overhead	50,326
Taxes, insurance, administrative	19,006
Capital recovery	36,621
Total Annual Cost (without credits)	192,802
Recovery credits	0
Total Annual Cost (with credits)	**192,802**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7. **Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	167	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.23	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	6.44E-04	
VOC inlet concentration (ppmv):	643.6	
VOC inlet partial pressure (psia):	0.0095	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	5.40	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.330	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.165	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	134	Equation 1.14
Carbon requirement per vessel (lb):	45	
Gas flowrate per adsorbing vessel (acfm):	84	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	1.19	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	6.34	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	25.95	Equation 1.24
Carbon bed depth (ft):	1.341	Equation 1.31
Carbon bed pressure drop (in. w.c.):	5.535	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	13,311	Equation 1.25
Carbon	168	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	39,717	Equation 1.27
Total equipment cost ($)--escalated:	66,708	apply inflation factor
Purchased Equipment Cost ($):	76,714	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**113,537**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	111	Section 1.8.1.3
Steam	189	Equation 1.28
Cooling water	460	Equation 1.29
Carbon replacement	98	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	5,677	
Capital recovery	14,704	
Total Annual Cost (without credits)	155,442	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**155,442**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018
Current Date:	1/15/2020
Years since Cost Base Date:	2
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.05

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	167	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.23	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	6.44E-04	
VOC inlet concentration (ppmv):	643.6	
VOC inlet partial pressure (psia):	0.0095	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	5.40	
Total Adsorption time per canister (hr):	1,250	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.330	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.165	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	9,340	Equation 1.14 (at 1250 adsorption hrs/cycle)
Number of carbon replacements per year:	8	
Minimum carbon requirement (lbs carbon/yr)	74,720	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	189,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	556,882	Equation 1.27
Total equipment cost ($)--escalated:	585,075	apply inflation factor
Purchased Equipment Cost ($):	672,836	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**995,797**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	111	Section 1.8.1.3
Carbon replacement	63,713	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	49,790	
Capital recovery	128,960	
Total Annual Cost (without credits)	376,778	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**376,778**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

C5 Sources

Table 1. **VOC Control Technology Cost Analysis, C5 #1 and #2 Pastillation Belts** **Stack ID: S055**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	7.3	7.0
2.	Catalytic Oxidation	98.0	98.0	96.0	7.3	7.0
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	7.3	7.0
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	7.3	7.0
5.	Refrigerated Condenser	95.0	98.0	93.1	7.3	6.8
6.	Carbon Adsorption (Fixed Bed)	90.0	98.0	88.2	7.3	6.4
7.	Carbon Adsorption (Canister)	90.0	98.0	88.2	7.3	6.4
					*VOC Baseline =	**7.4 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Carbon Adsorption (Fixed Bed)	396,446	51,342	7,984	207,403	**32,251**
2.	Rotary Concentrator/Oxidizer	631,171	60,808	8,684	285,728	**40,804**
3.	Carbon Adsorption (Canister)	279,035	36,136	5,619	301,402	**46,868**
4.	Regenerative Thermal Oxidizer	808,636	77,906	11,125	375,915	**53,683**
5.	Catalytic Oxidation	802,788	76,155	10,875	412,727	**58,940**
6.	Thermal Oxidation	686,335	66,123	9,443	526,415	**75,176**
7.	Refrigerated Condenser	7,549,361	727,323	107,147	2,920,397	**430,223**

* PTE based on sum of #1 and #2 Pastillating Belts at C5; taken from IP-11d.
** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	9,000	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	16.1	based on Toluene
Waste gas heat content (BTU/scf):	1.0	Equation 2.16
Waste gas heat content (BTU/lb):	13.5	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	5.462	Equation 2.21
(scfm):	133.9	
Total Gas Flowrate (scfm):	9,134	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	167,045	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	167,045	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	368,126	=Base cost x inflation factor
Purchased Equipment Cost (B):	434,389	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**686,335**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	281,475	
Electricity	10,298	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	34,317	
Capital recovery	66,123	=CRF x TCI
Total Annual Cost	**526,415**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	9,000	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	1.00	Equation 2.16
Waste gas heat content (BTU/lb):	13.5	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	2.081	Equation 2.21
	(scfm):	51.00	
	(mcf/yr):	26,804.3	
Total Maximum Exhaust Gas Flowrate:	(scfm):	9,051	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	392,933	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	392,933	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	433,724	=Base cost x inflation factor
Purchased Equipment Cost (B):	511,795	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**808,636**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	107,217	
Electricity	16,157	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	40,432	
Capital recovery	77,906	=CRF x TCI
Total Annual Cost	**375,915**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. **Total Annual Cost Spreadsheet - Catalytic Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	9,000	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	1.00	Equation 2.16
Waste gas heat content (BTU/lb):	13.53	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	2.788	Equation 2.21
(scfm):	68.3	
Total Gas Flowrate (scfm):	9,068	
Catalyst Volume (ft3):	17.6	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	195,388	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	195,388	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	430,588	=Base cost x inflation factor
Purchased Equipment Cost (B):	508,094	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**802,788**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	143,672	
Electricity	11,928	Section 2.5.2.1
Catalyst replacement	6,631	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	40,139	
Capital recovery	76,155	=CRF x TCI
Total Annual Cost	**412,727**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

W:\Eastman_Chemical\19.056_RACT2_Analysis\Cost_Analysis_Tables\C5\C5_Pastillators_CostAnalysis_20200114.xlsx

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996
Current Date:	1/15/2020
Years since Cost Base Date:	24
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.81

PARAMETERS

Flowrate (cfm)	9,000	
Control device input mass (tons/year)	7.3	
Concentration (avg. ppmv)	16.13	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	24.6	Section 2.5.2.1
Fuel usage (Btu/hr)	1,350,448	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	173,266	
Escalated Equipment Cost (A)	313,391	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	514,590	sty-cost.wk3
Total Capital Investment (TCI), ($)	631,171	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	47,320	
Electricity	11,838	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	31,559	
Capital recovery	60,808	=CRF x TCI
Total Annual Cost	**285,728**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	9,000	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.000016	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.0012	Equation 2.6
Condensation temperature, Tc (oF):	-117.7	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0222	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.002	Equation 2.10
VOC condensed (lb-moles/hr):	0.020	inlet - outlet
(lb/hr):	1.8	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	18,355	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	605	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	26	Equation 2.16
Enthalpy change, air (BTU/hr):	3,041,789	Equation 2.17
Condenser heat load (BTU/hr):	3,042,421	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	96.9	Equation 2.19
Condenser surface area (ft2):	1570.0	Equation 2.18
Coolant flowrate (lb/hr):	187,226	Equation 2.22
Refrigeration capacity (tons):	253.54	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	11.7	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	0	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	1,241,275	Equation 2.27
-- Multistage refrigeration unit:	2,819,922	Equation 2.28
Total equipment cost ($)--base:	3,524,903	Equation 2.29
Total equipment cost ($)--escalated:	4,087,807	inflation adjusted
Purchased Equipment Cost ($):	4,414,831	Equation 2.30
Total Capital Investment ($):	**7,549,361**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	1,681,403
Overhead	50,326
Taxes, insurance, administrative	377,468
Capital recovery	727,323
Total Annual Cost (without credits)	2,920,397
Recovery credits	0
Total Annual Cost (with credits)	**2,920,397**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	9,000	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.66	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	1.61E-05	
VOC inlet concentration (ppmv):	16.1	
VOC inlet partial pressure (psia):	0.0002	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	7.29	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.220	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.110	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	272	Equation 1.14
Carbon requirement per vessel (lb):	91	
Gas flowrate per adsorbing vessel (acfm):	4,500	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	8.74	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	5.05	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	258.68	Equation 1.24
Carbon bed depth (ft):	0.050	Equation 1.31
Carbon bed pressure drop (in. w.c.):	1.170	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	79,646	Equation 1.25
Carbon	341	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	138,683	Equation 1.27
Total equipment cost ($)--escalated:	232,929	apply inflation factor
Purchased Equipment Cost ($):	267,869	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**396,446**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	962	Section 1.8.1.3
Steam	255	Equation 1.28
Cooling water	621	Equation 1.29
Carbon replacement	198	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	19,822	
Capital recovery	51,342	
Total Annual Cost (without credits)	207,403	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**207,403**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**

Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018	
Current Date:	1/15/2020	
Years since Cost Base Date:	2	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.05	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	9,000	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.66	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	1.61E-05	
VOC inlet concentration (ppmv):	16.1	
VOC inlet partial pressure (psia):	0.0002	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	7.29	
Total Adsorption time per canister (hr):	500	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.220	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.110	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	7,567	Equation 1.14 (at 500 adsorption hrs/cycle)
Number of carbon replacements per year:	18	
Minimum carbon requirement (lbs carbon/yr)	136,215	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	90,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	156,045	Equation 1.27
Total equipment cost ($)--escalated:	163,945	apply inflation factor
Purchased Equipment Cost ($):	188,537	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**279,035**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	962	Section 1.8.1.3
Carbon replacement	116,149	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	13,952	
Capital recovery	36,136	
Total Annual Cost (without credits)	301,402	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**301,402**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

MP Poly Sources

Table 1. **VOC Control Technology Cost Analysis, Various MP Poly Operations** **Stack ID: S034**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	10.1	9.7
2.	Catalytic Oxidation	98.0	98.0	96.0	10.1	9.7
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	10.1	9.7
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	10.1	9.7
5.	Refrigerated Condenser	95.0	98.0	93.1	10.1	9.4
6.	Carbon Adsorption (Fixed Bed)	90.0	98.0	88.2	10.1	8.9
7.	Carbon Adsorption (Canister)	90.0	98.0	88.2	10.1	8.9
					*VOC Baseline =	**10.3 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	95,946	9,217	948	150,236	**15,452**
2.	Carbon Adsorption (Fixed Bed)	129,184	16,730	1,874	158,992	**17,807**
3.	Thermal Oxidation	264,542	25,487	2,621	177,803	**18,288**
4.	Rotary Concentrator/Oxidizer	350,649	33,782	3,475	186,833	**19,216**
5.	Refrigerated Condenser	383,110	36,910	3,916	193,751	**20,557**
6.	Regenerative Thermal Oxidizer	554,002	53,374	5,490	216,423	**22,260**
7.	Carbon Adsorption (Canister)	438,261	56,757	6,357	315,413	**35,325**

* PTE based on sum of all emission sources within the MP Poly operations that vent to S034
** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	200	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	1007.6	based on Toluene
Waste gas heat content (BTU/scf):	4.3	Equation 2.16
Waste gas heat content (BTU/lb):	57.8	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.090	Equation 2.21
(scfm):	2.2	
Total Gas Flowrate (scfm):	202	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	64,386	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	64,386	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	141,891	=Base cost x inflation factor
Purchased Equipment Cost (B):	167,432	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**264,542**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	4,658	
Electricity	228	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	13,227	
Capital recovery	25,487	=CRF x TCI
Total Annual Cost	**177,803**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	200	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	4.27	Equation 2.16
Waste gas heat content (BTU/lb):	57.8	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	0.015	Equation 2.21
	(scfm):	0.38	
	(mcf/yr):	197.1	
Total Maximum Exhaust Gas Flowrate:	(scfm):	200	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	269,201	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	269,201	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	297,148	=Base cost x inflation factor
Purchased Equipment Cost (B):	350,634	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**554,002**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	788	
Electricity	358	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,700	
Capital recovery	53,374	=CRF x TCI
Total Annual Cost	**216,423**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. **Total Annual Cost Spreadsheet - Catalytic Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	200	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	4.27	Equation 2.16
Waste gas heat content (BTU/lb):	57.76	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane
CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	0.031	Equation 2.21
(scfm):	0.8	
Total Gas Flowrate (scfm):	201	
Catalyst Volume (ft3):	0.4	
Pressure drop (in. w.c.):	14.0	Table 2.13
CALCULATED CAPITAL COSTS		
Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	23,352	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	23,352	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	51,462	=Base cost x inflation factor
Purchased Equipment Cost (B):	60,725	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**95,946**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	
CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	1,607	
Electricity	264	Section 2.5.2.1
Catalyst replacement	147	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	4,797	
Capital recovery	9,217	=CRF x TCI
Total Annual Cost	**150,236**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996
Current Date:	1/15/2020
Years since Cost Base Date:	24
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.81

PARAMETERS

Flowrate (cfm)	200	
Control device input mass (tons/year)	10.1	
Concentration (avg. ppmv)	1,007.58	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.5	Section 2.5.2.1
Fuel usage (Btu/hr)	30,010	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	98,782	
Escalated Equipment Cost (A)	178,669	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	284,184	sty-cost.wk3
Total Capital Investment (TCI), ($)	350,649	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	1,052	
Electricity	263	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,532	
Capital recovery	33,782	=CRF x TCI
Total Annual Cost	**186,833**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	200	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.001008	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.0766	Equation 2.6
Condensation temperature, Tc (oF):	-63.1	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0308	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.003	Equation 2.10
VOC condensed (lb-moles/hr):	0.028	inlet - outlet
(lb/hr):	2.6	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	17,815	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	769	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	30	Equation 2.16
Enthalpy change, air (BTU/hr):	55,923	Equation 2.17
Condenser heat load (BTU/hr):	56,722	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	84.3	Equation 2.19
Condenser surface area (ft2):	33.7	Equation 2.18
Coolant flowrate (lb/hr):	3,491	Equation 2.22
Refrigeration capacity (tons):	4.73	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	122,830	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	143,104	Equation 2.28
Total equipment cost ($)--base:	178,880	Equation 2.29
Total equipment cost ($)--escalated:	207,445	inflation adjusted
Purchased Equipment Cost ($):	224,041	Equation 2.30
Total Capital Investment ($):	**383,110**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	3,483
Overhead	50,326
Taxes, insurance, administrative	19,156
Capital recovery	36,910
Total Annual Cost (without credits)	193,751
Recovery credits	0
Total Annual Cost (with credits)	**193,751**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999
Current Date:	1/15/2020
Years since Cost Base Date:	21
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.68

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	200	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	2.31	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	1.01E-03	
VOC inlet concentration (ppmv):	1007.6	
VOC inlet partial pressure (psia):	0.0148	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	10.12	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.347	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.173	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	240	Equation 1.14
Carbon requirement per vessel (lb):	80	
Gas flowrate per adsorbing vessel (acfm):	100	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	1.30	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	7.00	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	31.32	Equation 1.24
Carbon bed depth (ft):	1.998	Equation 1.31
Carbon bed pressure drop (in. w.c.):	7.758	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	15,410	Equation 1.25
Carbon	300	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	45,191	Equation 1.27
Total equipment cost ($)--escalated:	75,902	apply inflation factor
Purchased Equipment Cost ($):	87,287	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**129,184**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	208	Section 1.8.1.3
Steam	354	Equation 1.28
Cooling water	863	Equation 1.29
Carbon replacement	174	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	6,459	
Capital recovery	16,730	
Total Annual Cost (without credits)	158,992	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**158,992**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018	
Current Date:	1/15/2020	
Years since Cost Base Date:	2	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.05	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	200	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	2.31	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	1.01E-03	
VOC inlet concentration (ppmv):	1007.6	
VOC inlet partial pressure (psia):	0.0148	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	10.12	
Total Adsorption time per canister (hr):	500	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.347	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.173	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	6,667	Equation 1.14 (at 500 adsorption hrs/cycle)
Number of carbon replacements per year:	18	
Minimum carbon requirement (lbs carbon/yr)	120,011	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	85,200	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	245,090	Equation 1.27
Total equipment cost ($)--escalated:	257,498	apply inflation factor
Purchased Equipment Cost ($):	296,122	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**438,261**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	208	Section 1.8.1.3
Carbon replacement	102,332	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	21,913	
Capital recovery	56,757	
Total Annual Cost (without credits)	315,413	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**315,413**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Hydrogenation Sources

Table 1. **VOC Control Technology Cost Analysis, Hydrogenation Operations, Combination of Stacks S004 and S001**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	13.9	13.4
2.	Catalytic Oxidation	98.0	98.0	96.0	13.9	13.4
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	13.9	13.4
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	13.9	13.4
5.	Refrigerated Condenser	95.0	98.0	93.1	13.9	13.0
6.	Carbon Adsorption (Fixed Bed)	90.0	98.0	88.2	13.9	12.3
7.	Carbon Adsorption (Canister)	90.0	98.0	88.2	13.9	12.3
					*VOC Baseline =	**14.2 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	57,070	5,488	411	142,844	**10,688**
2.	Thermal Oxidation	209,180	20,153	1,508	165,140	**12,356**
3.	Refrigerated Condenser	174,084	16,772	1,295	160,986	**12,426**
4.	Carbon Adsorption (Fixed Bed)	140,301	18,170	1,480	161,638	**13,169**
5.	Rotary Concentrator/Oxidizer	346,842	33,416	2,500	185,480	**13,878**
6.	Regenerative Thermal Oxidizer	550,487	53,035	3,968	213,174	**15,950**
7.	Carbon Adsorption (Canister)	768,280	99,496	8,106	395,118	**32,192**

* PTE based on sum of following emission sources within the Hydro operations:

Metering Tank/Tanks 103&104/Catalyst Catch Tank/Mott Filter/Heel Tank (S004)

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	79	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	3506.5	based on Toluene
Waste gas heat content (BTU/scf):	14.9	Equation 2.16
Waste gas heat content (BTU/lb):	201.0	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.005	Equation 2.21
(scfm):	0.1	
Total Gas Flowrate (scfm):	79	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	50,912	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	50,912	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	112,197	=Base cost x inflation factor
Purchased Equipment Cost (B):	132,393	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**209,180**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	236	
Electricity	89	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	10,459	
Capital recovery	20,153	=CRF x TCI
Total Annual Cost	**165,140**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	79	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	14.86	Equation 2.16
Waste gas heat content (BTU/lb):	201.0	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	-0.034	Equation 2.21
	(scfm):	-0.82	
	(mcf/yr):	(432.0)	
Total Maximum Exhaust Gas Flowrate:	(scfm):	78	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	267,493	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	267,493	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	295,262	=Base cost x inflation factor
Purchased Equipment Cost (B):	348,409	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**550,487**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	(1,728)	
Electricity	140	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,524	
Capital recovery	53,035	=CRF x TCI
Total Annual Cost	**213,174**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	79	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	14.86	Equation 2.16
Waste gas heat content (BTU/lb):	201.02	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.003	Equation 2.21
(scfm):	0.1	
Total Gas Flowrate (scfm):	79	
Catalyst Volume (ft3):	0.2	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	13,890	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	13,890	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	30,610	=Base cost x inflation factor
Purchased Equipment Cost (B):	36,120	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**57,070**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	138	
Electricity	104	Section 2.5.2.1
Catalyst replacement	58	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	2,853	
Capital recovery	5,488	=CRF x TCI
Total Annual Cost	**142,844**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5.

Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996	
Current Date:	1/15/2020	
Years since Cost Base Date:	24	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.81	

PARAMETERS		
Flowrate (cfm)	79	
Control device input mass (tons/year)	13.9	
Concentration (avg. ppmv)	3,506.46	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS		
Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.2	Section 2.5.2.1
Fuel usage (Btu/hr)	11,854	Equation 2.21

CAPITAL COSTS		
Equipment cost (EC), (Durr budgetary costs, 3/15/96)	97,772	
Escalated Equipment Cost (A)	176,843	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	281,056	sty-cost.wk3
Total Capital Investment (TCI), ($)	346,842	sty-cost.wk3

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	415	
Electricity	104	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,342	
Capital recovery	33,416	=CRF x TCI
Total Annual Cost	**185,480**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	79	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.003506	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.2673	Equation 2.6
Condensation temperature, Tc (oF):	-41.5	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0424	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.004	Equation 2.10
VOC condensed (lb-moles/hr):	0.038	inlet - outlet
(lb/hr):	3.5	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	17,594	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	1,017	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	38	Equation 2.16
Enthalpy change, air (BTU/hr):	20,224	Equation 2.17
Condenser heat load (BTU/hr):	21,279	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	79.1	Equation 2.19
Condenser surface area (ft2):	13.4	Equation 2.18
Coolant flowrate (lb/hr):	1,309	Equation 2.22
Refrigeration capacity (tons):	1.77	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	65,026	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	62,275	Equation 2.28
Total equipment cost ($)--base:	81,282	Equation 2.29
Total equipment cost ($)--escalated:	94,263	inflation adjusted
Purchased Equipment Cost ($):	101,804	Equation 2.30
Total Capital Investment ($):	**174,084**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	1,307
Overhead	50,326
Taxes, insurance, administrative	8,704
Capital recovery	16,772
Total Annual Cost (without credits)	160,986
Recovery credits	0
Total Annual Cost (with credits)	**160,986**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7. **Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:		
Inlet stream flowrate (acfm):	79	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	3.18	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	3.51E-03	
VOC inlet concentration (ppmv):	3506.5	
VOC inlet partial pressure (psia):	0.0515	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	13.92	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:		
Carbon adsorptivity (lb Toluene/lb carbon):	0.398	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.199	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	288	Equation 1.14
Carbon requirement per vessel (lb):	96	
Gas flowrate per adsorbing vessel (acfm):	40	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	0.82	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	11.07	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	29.53	Equation 1.24
Carbon bed depth (ft):	6.062	Equation 1.31
Carbon bed pressure drop (in. w.c.):	21.503	Equation 1.30

CAPITAL COSTS:		
Adsorber vessels	14,719	Equation 1.25
Carbon	360	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	49,079	Equation 1.27
Total equipment cost ($)--escalated:	82,433	apply inflation factor
Purchased Equipment Cost ($):	94,798	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**140,301**	Table 1.4

ANNUAL COST INPUTS:		
Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:		
Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	368	Section 1.8.1.3
Steam	487	Equation 1.28
Cooling water	1,186	Equation 1.29
Carbon replacement	209	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	7,015	
Capital recovery	18,170	
Total Annual Cost (without credits)	161,638	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**161,638**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018
Current Date:	1/15/2020
Years since Cost Base Date:	2
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.05

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	79	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	3.18	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	3.51E-03	
VOC inlet concentration (ppmv):	3506.5	
VOC inlet partial pressure (psia):	0.0515	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	13.92	
Total Adsorption time per canister (hr):	500	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.398	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.199	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	7,990	Equation 1.14 (at 500 adsorption hrs/cycle)
Number of carbon replacements per year:	18	
Minimum carbon requirement (lbs carbon/yr)	143,825	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	132,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	429,648	Equation 1.27
Total equipment cost ($)--escalated:	451,399	apply inflation factor
Purchased Equipment Cost ($):	519,108	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**768,280**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	368	Section 1.8.1.3
Carbon replacement	122,637	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	38,414	
Capital recovery	99,496	
Total Annual Cost (without credits)	395,118	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**395,118**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Table 1. **VOC Control Technology Cost Analysis, Hydrogenation Autoclaves and Vent Tank** **Stack ID: S007**

Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	14.7	14.1
2.	Catalytic Oxidation	98.0	98.0	96.0	14.7	14.1
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	14.7	14.1
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	14.7	14.1
5.	Refrigerated Condenser	95.0	98.0	93.1	14.7	13.7
6.	Carbon Adsorption (Fixed Bed)	90.0	98.0	88.2	14.7	13.0
7.	Carbon Adsorption (Canister)	90.0	98.0	88.2	14.7	13.0
					*VOC Baseline =	**15.0 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	87,202	8,379	594	147,584	**10,454**
2.	Thermal Oxidation	253,402	24,413	1,729	174,148	**12,335**
3.	Carbon Adsorption (Fixed Bed)	139,217	18,029	1,391	161,521	**12,458**
4.	Rotary Concentrator/Oxidizer	349,673	33,688	2,386	186,486	**13,209**
5.	Refrigerated Condenser	307,104	29,587	2,162	182,016	**13,300**
6.	Regenerative Thermal Oxidizer	553,092	53,286	3,774	214,847	**15,218**
7.	Carbon Adsorption (Canister)	994,221	128,756	9,931	452,995	**34,939**

* PTE based on sum of following emission sources within the Hydro operations:

Vent Tank/Autoclave #1/Autoclave #2

** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	169	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	1731.5	based on Toluene
Waste gas heat content (BTU/scf):	7.3	Equation 2.16
Waste gas heat content (BTU/lb):	99.3	
Gas heat capacity (BTU/lb-oF):	0.255	air (hydrogen?)
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.052	Equation 2.21
(scfm):	1.3	
Total Gas Flowrate (scfm):	170	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	61,675	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	61,675	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	135,916	=Base cost x inflation factor
Purchased Equipment Cost (B):	160,381	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**253,402**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	
0.255		

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	2,669	
Electricity	192	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	12,670	
Capital recovery	24,413	=CRF x TCI
Total Annual Cost	**174,148**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:		2016	
Current Date:		1/15/2020	
Years since Cost Base Date:		4	
Average inflation rate/year, %:		2.5	
Inflation adjustment factor:		1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	169	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	7.34	Equation 2.16
Waste gas heat content (BTU/lb):	99.3	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	-0.012	Equation 2.21
	(scfm):	-0.28	
	(mcf/yr):	(149.4)	
Total Maximum Exhaust Gas Flowrate:	(scfm):	169	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	268,759	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	268,759	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	296,659	=Base cost x inflation factor
Purchased Equipment Cost (B):	350,058	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**553,092**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	(598)	
Electricity	301	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,655	
Capital recovery	53,286	=CRF x TCI
Total Annual Cost	**214,847**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	169	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	7.34	Equation 2.16
Waste gas heat content (BTU/lb):	99.26	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.006	Equation 2.21
(scfm):	0.1	
Total Gas Flowrate (scfm):	169	
Catalyst Volume (ft3):	0.3	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	21,224	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	21,224	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	46,772	=Base cost x inflation factor
Purchased Equipment Cost (B):	55,191	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**87,202**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	295	
Electricity	222	Section 2.5.2.1
Catalyst replacement	124	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	4,360	
Capital recovery	8,379	=CRF x TCI
Total Annual Cost	**147,584**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996	
Current Date:	1/15/2020	
Years since Cost Base Date:	24	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.81	

PARAMETERS		
Flowrate (cfm)	169	
Control device input mass (tons/year)	14.7	
Concentration (avg. ppmv)	1,731.46	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS		
Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.5	Section 2.5.2.1
Fuel usage (Btu/hr)	25,358	Equation 2.21

CAPITAL COSTS		
Equipment cost (EC), (Durr budgetary costs, 3/15/96)	98,523	
Escalated Equipment Cost (A)	178,201	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	283,382	sty-cost.wk3
Total Capital Investment (TCI), ($)	349,673	sty-cost.wk3

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	889	
Electricity	222	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,484	
Capital recovery	33,688	=CRF x TCI
Total Annual Cost	**186,486**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	169	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.001731	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.1318	Equation 2.6
Condensation temperature, Tc (oF):	-54.1	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0448	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.004	Equation 2.10
VOC condensed (lb-moles/hr):	0.040	inlet - outlet
(lb/hr):	3.7	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	17,723	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	1,099	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	43	Equation 2.16
Enthalpy change, air (BTU/hr):	45,603	Equation 2.17
Condenser heat load (BTU/hr):	46,744	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	82.1	Equation 2.19
Condenser surface area (ft2):	28.5	Equation 2.18
Coolant flowrate (lb/hr):	2,877	Equation 2.22
Refrigeration capacity (tons):	3.90	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	101,377	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	114,713	Equation 2.28
Total equipment cost ($)--base:	143,391	Equation 2.29
Total equipment cost ($)--escalated:	166,290	inflation adjusted
Purchased Equipment Cost ($):	179,593	Equation 2.30
Total Capital Investment ($):	**307,104**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	2,870
Overhead	50,326
Taxes, insurance, administrative	15,355
Capital recovery	29,587
Total Annual Cost (without credits)	182,016
Recovery credits	0
Total Annual Cost (with credits)	**182,016**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	169	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	3.36	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	1.73E-03	
VOC inlet concentration (ppmv):	1731.5	
VOC inlet partial pressure (psia):	0.0254	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	14.70	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.368	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.184	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	328	Equation 1.14
Carbon requirement per vessel (lb):	109	
Gas flowrate per adsorbing vessel (acfm):	85	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	1.20	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	8.24	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	33.25	Equation 1.24
Carbon bed depth (ft):	3.235	Equation 1.31
Carbon bed pressure drop (in. w.c.):	11.941	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	16,144	Equation 1.25
Carbon	410	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	48,700	Equation 1.27
Total equipment cost ($)--escalated:	81,796	apply inflation factor
Purchased Equipment Cost ($):	94,065	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**139,217**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	321	Section 1.8.1.3
Steam	515	Equation 1.28
Cooling water	1,253	Equation 1.29
Carbon replacement	238	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	6,961	
Capital recovery	18,029	
Total Annual Cost (without credits)	161,521	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**161,521**	

Table 8.

Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018	
Current Date:	1/15/2020	
Years since Cost Base Date:	2	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.05	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	169	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	3.36	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	1.73E-03	
VOC inlet concentration (ppmv):	1731.5	
VOC inlet partial pressure (psia):	0.0254	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	14.70	
Total Adsorption time per canister (hr):	500	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.368	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.184	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	9,122	Equation 1.14 (at 500 adsorption hrs/cycle)
Number of carbon replacements per year:	18	
Minimum carbon requirement (lbs carbon/yr)	164,190	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	189,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	556,001	Equation 1.27
Total equipment cost ($)--escalated:	584,149	apply inflation factor
Purchased Equipment Cost ($):	671,771	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**994,221**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	321	Section 1.8.1.3
Carbon replacement	140,003	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	49,711	
Capital recovery	128,756	
Total Annual Cost (without credits)	452,995	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**452,995**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Table 1. **VOC Control Technology Cost Analysis, Hydrogenation Operations, Product Tanks 102, 105 & 106** **Stack: S012**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	6.2	5.9
2.	Catalytic Oxidation	98.0	98.0	96.0	6.2	5.9
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	6.2	5.9
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	6.2	5.9
5.	Refrigerated Condenser	95.0	98.0	93.1	6.2	5.7
6.	Carbon Adsorption (Fixed Bed)	90.0	98.0	88.2	6.2	5.4
7.	Carbon Adsorption (Canister)	90.0	98.0	88.2	6.2	5.4
					*VOC Baseline =	**6.3 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Catalytic Oxidation	7,350	708	119	135,286	**22,816**
2.	Refrigerated Condenser	22,574	2,175	378	137,554	**23,931**
3.	Thermal Oxidation	83,378	8,033	1,355	146,413	**24,692**
4.	Rotary Concentrator/Oxidizer	344,420	33,182	5,596	184,620	**31,136**
5.	Carbon Adsorption (Fixed Bed)	250,081	32,387	5,947	180,771	**33,197**
6.	Regenerative Thermal Oxidizer	548,278	52,822	8,908	213,201	**35,956**
7.	Carbon Adsorption (Canister)	1,252,758	162,238	29,793	406,272	**74,607**

* PTE based on sum of following emission sources within the Hydro operations:

C:\Users\mschooley1\Desktop\Eastman_RACT\Hydro\Hydro_Vent_S012_CostAnalysis_20200115.xlsx

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS		
Gas flowrate (scfm):	2	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	61449.5	based on Toluene
Waste gas heat content (BTU/scf):	260.3	Equation 2.16
Waste gas heat content (BTU/lb):	3522.8	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane
CALCULATED PARAMETERS		
Auxiliary Fuel Needed (lb/min):	0.000	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	2	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS		
Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	20,293	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	20,293	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	44,721	=Base cost x inflation factor
Purchased Equipment Cost (B):	52,771	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**83,378**	=1.58B (Table 2.10)

ANNUAL COST INPUTS		
Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS		
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	6	
Electricity	2	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	4,169	
Capital recovery	8,033	=CRF x TCI
Total Annual Cost	**146,413**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	2	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	260.34	Equation 2.16
Waste gas heat content (BTU/lb):	3522.8	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	-0.024	Equation 2.21
	(scfm):	-0.59	
	(mcf/yr):	(310.3)	
Total Maximum Exhaust Gas Flowrate:	(scfm):	1	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	266,420	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	266,420	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	294,078	=Base cost x inflation factor
Purchased Equipment Cost (B):	347,011	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**548,278**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	(1,241)	
Electricity	3	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	27,414	
Capital recovery	52,822	=CRF x TCI
Total Annual Cost	**213,201**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988
Current Date:	1/15/2020
Years since Cost Base Date:	32
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	2.20

INPUT PARAMETERS

Gas flowrate (scfm):	2	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	260.34	Equation 2.16
Waste gas heat content (BTU/lb):	3522.77	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	0.000	Equation 2.21
(scfm):	0.0	
Total Gas Flowrate (scfm):	2	
Catalyst Volume (ft3):	0.0	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	1,789	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	1,789	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	3,942	=Base cost x inflation factor
Purchased Equipment Cost (B):	4,652	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**7,350**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	3	
Electricity	3	Section 2.5.2.1
Catalyst replacement	1	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	368	
Capital recovery	708	=CRF x TCI
Total Annual Cost	**135,286**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5. **Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996
Current Date:	1/15/2020
Years since Cost Base Date:	24
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.81

PARAMETERS

Flowrate (cfm)	2	
Control device input mass (tons/year)	6.2	
Concentration (avg. ppmv)	61,449.51	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	0.0	Section 2.5.2.1
Fuel usage (Btu/hr)	300	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	97,130	
Escalated Equipment Cost (A)	175,681	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	279,067	sty-cost.wk3
Total Capital Investment (TCI), ($)	344,420	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	11	
Electricity	3	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	17,221	
Capital recovery	33,182	=CRF x TCI
Total Annual Cost	**184,620**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	2	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.061450	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	4.9436	Equation 2.6
Condensation temperature, Tc (oF):	23.6	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0188	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.002	Equation 2.10
VOC condensed (lb-moles/hr):	0.017	inlet - outlet
(lb/hr):	1.6	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	16,898	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	398	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	12	Equation 2.16
Enthalpy change, air (BTU/hr):	352	Equation 2.17
Condenser heat load (BTU/hr):	763	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	62.9	Equation 2.19
Condenser surface area (ft2):	0.6	Equation 2.18
Coolant flowrate (lb/hr):	47	Equation 2.22
Refrigeration capacity (tons):	0.06	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	1.3	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	8,432	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	0	Equation 2.27
-- Multistage refrigeration unit:	0	Equation 2.28
Total equipment cost ($)--base:	10,540	Equation 2.29
Total equipment cost ($)--escalated:	12,224	inflation adjusted
Purchased Equipment Cost ($):	13,201	Equation 2.30
Total Capital Investment ($):	**22,574**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	47
Overhead	50,326
Taxes, insurance, administrative	1,129
Capital recovery	2,175
Total Annual Cost (without credits)	137,554
Recovery credits	0
Total Annual Cost (with credits)	**137,554**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7.

Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999
Current Date:	1/15/2020
Years since Cost Base Date:	21
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.68

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	2	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.41	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	6.14E-02	
VOC inlet concentration (ppmv):	61449.5	
VOC inlet partial pressure (psia):	0.9031	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	6.17	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.545	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.272	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	93	Equation 1.14
Carbon requirement per vessel (lb):	31	
Gas flowrate per adsorbing vessel (acfm):	1	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	0.13	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	82.61	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	33.84	Equation 1.24
Carbon bed depth (ft):	77.535	Equation 1.31
Carbon bed pressure drop (in. w.c.):	263.219	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	16,367	Equation 1.25
Carbon	116	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	87,482	Equation 1.27
Total equipment cost ($)--escalated:	146,934	apply inflation factor
Purchased Equipment Cost ($):	168,974	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**250,081**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	867	Section 1.8.1.3
Steam	216	Equation 1.28
Cooling water	526	Equation 1.29
Carbon replacement	68	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	12,504	
Capital recovery	32,387	
Total Annual Cost (without credits)	180,771	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**180,771**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018	
Current Date:	1/15/2020	
Years since Cost Base Date:	2	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.05	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	2	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.41	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	6.14E-02	
VOC inlet concentration (ppmv):	61449.5	
VOC inlet partial pressure (psia):	0.9031	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	6.17	
Total Adsorption time per canister (hr):	1,750	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.545	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.272	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	9,055	Equation 1.14 (at 1750 adsorption hrs/cycle)
Number of carbon replacements per year:	6	
Minimum carbon requirement (lbs carbon/yr)	54,329	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	132,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	700,584	Equation 1.27
Total equipment cost ($)--escalated:	736,051	apply inflation factor
Purchased Equipment Cost ($):	846,458	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**1,252,758**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	867	Section 1.8.1.3
Carbon replacement	46,326	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	62,638	
Capital recovery	162,238	
Total Annual Cost (without credits)	406,272	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**406,272**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

Dresinate Sources

Table 1. **VOC Control Technology Cost Analysis, Dresinate Operations**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

1a. - Ranking of Technically-Feasible Control Options, by Reduction Efficiency

Ranking	Control Technology	Control Efficiency (%)	Capture Efficiency (%)	Reduction Efficiency (%)	Inlet VOC Emissions (tons/year)	VOC Reduction (tons/year)
1.	Thermal Oxidation	98.0	98.0	96.0	5.4	5.2
2.	Catalytic Oxidation	98.0	98.0	96.0	5.4	5.2
3.	Rotary Concentrator/Oxidizer	98.0	98.0	96.0	5.4	5.2
4.	Regenerative Thermal Oxidizer	98.0	98.0	96.0	5.4	5.2
5.	Refrigerated Condenser	95.0	98.0	93.1	5.4	5.0
6.	Carbon Adsorption (Fixed Bed)	90.0	98.0	88.2	5.4	4.8
7.	Carbon Adsorption (Canister)	90.0	98.0	88.2	5.4	4.8
					*VOC Baseline =	**5.5 tpy**

1b. - Ranking of Annual Control Costs per Ton of VOC Reduced**

Ranking	Control Technology	Capital Cost ($)	Capital Recovery Cost ($/year)	Capital Only Control Cost ($/ton/yr)	Total Annualized Cost ($/year)	**Overall Total Control Cost ($/ton/yr)**
1.	Carbon Adsorption (Fixed Bed)	283,567	36,723	7,725	186,358	**39,200**
2.	Rotary Concentrator/Oxidizer	470,908	45,368	8,764	229,409	**44,317**
3.	Catalytic Oxidation	510,810	48,685	9,405	280,531	**54,193**
4.	Regenerative Thermal Oxidizer	663,970	63,968	12,357	286,203	**55,288**
5.	Thermal Oxidation	560,299	53,980	10,428	345,875	**66,816**
6.	Carbon Adsorption (Canister)	652,707	84,529	17,781	336,181	**70,716**
7.	Refrigerated Condenser	4,349,585	419,049	83,508	1,504,896	**299,894**

* PTE based on sum of Double Drum Dryer, Tank R-1-A, and Tank 782, from IP-12a.
** Note that these costs do not include the purchase and installation cost of ductwork associated with the controls.

Table 2. **Total Annual Cost Spreadsheet - Thermal Incinerator**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	4,000	drum dryer scrubber
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Predominant VOC constituent:	Toluene	
Pollutant heat of combustion (Btu/scf):	4,237	Table 2.16
Pollutant molecular weight (lb/lb-mole)	92.1	based on Toluene
Pollutant concentration (ppmv):	26.8	based on Toluene
Waste gas heat content (BTU/scf):	1.0	Equation 2.16
Waste gas heat content (BTU/lb):	13.5	
Gas heat capacity (BTU/lb-oF):	0.255	air
Combustion temperature (oF):	1,400	
Preheat temperature (oF):	800	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.0408	methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	2.428	Equation 2.21
(scfm):	59.5	
Total Gas Flowrate (scfm):	4,060	
Pressure drop (in. w.c.):	12.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs (EC):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.29
@ 35 % heat recovery:	0	Equation 2.30
@ 50 % heat recovery:	136,369	Equation 2.31
@ 70 % heat recovery:	0	Equation 2.32
Auxiliary equipment :	-	
Total Equipment Cost--base:	136,369	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	300,525	=Base cost x inflation factor
Purchased Equipment Cost (B):	354,620	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**560,299**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	includes benefits
Maintenance labor rate ($/hr):	49.00	includes benefits
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor (CRF):	0.0963	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	125,100	
Electricity	4,577	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	28,015	
Capital recovery	53,980	=CRF x TCI
Total Annual Cost	**345,875**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 3. **Total Annual Cost Spreadsheet - Regenerative Thermal Oxidizer**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2016	
Current Date:	1/15/2020	
Years since Cost Base Date:	4	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.10	

INPUT PARAMETERS

Exhaust Gas flowrate (scfm):	4,000	
Reference temperature (oF):	77	
Waste gas inlet temperature, Tw_i (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.85	
Waste gas heat content, annual avg. (BTU/scf):	1.00	Equation 2.16
Waste gas heat content (BTU/lb):	13.5	
Gas heat capacity (BTU/lb-oF):	0.255	
Combustion temperature (oF):	1,400	
Temperature leaving heat exchanger, Tw_o (oF):	1220	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	methane
Fuel density (lb/ft3):	0.041	methane
Pressure drop (in. w.c.):	19.0	Table 2.13

CALCULATED UTILITY USAGES

Auxiliary Fuel Requirement:	(lb/min):	0.925	Equation 2.21
	(scfm):	22.67	
	(mcf/yr):	11,913.0	
Total Maximum Exhaust Gas Flowrate:	(scfm):	4,023	

CALCULATED CAPITAL COSTS

Oxidizer Equipment Cost (EC):		
@ 85% heat recovery:	322,637	Equation 2.33
@ 95% heat recovery:	0	Equation 2.33
Auxiliary equipment :	0	
Total Equipment Cost--base:	322,637	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	356,131	=Base cost x inflation factor
Purchased Equipment Cost (B):	420,234	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**663,970**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.050	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	47,652	
Electricity	7,181	Section 2.5.2.1
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	33,199	
Capital recovery	63,968	=CRF x TCI
Total Annual Cost	**286,203**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

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Table 4. Total Annual Cost Spreadsheet - Catalytic Incinerator
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1988	
Current Date:	1/15/2020	
Years since Cost Base Date:	32	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	2.20	

INPUT PARAMETERS

Gas flowrate (scfm):	4,000	
Reference temperature (oF):	77	
Inlet gas temperature (oF):	200	
Inlet gas density (lb/scf):	0.0739	air
Primary heat recovery (fraction):	0.50	
Waste gas heat content (BTU/scf):	1.00	Equation 2.16
Waste gas heat content (BTU/lb):	13.53	
Gas heat capacity (BTU/lb-oF):	0.26	air
Combustion temperature (oF):	850	
Preheat temperature (oF):	525	Equation 2.18
Fuel heat of combustion (BTU/lb):	21,502	Methane
Fuel density (lb/ft3):	0.0408	Methane

CALCULATED PARAMETERS

Auxiliary Fuel Needed (lb/min):	1.239	Equation 2.21
(scfm):	30.4	
Total Gas Flowrate (scfm):	4,030	
Catalyst Volume (ft3):	7.8	
Pressure drop (in. w.c.):	14.0	Table 2.13

CALCULATED CAPITAL COSTS

Equipment Costs ($):		
Incinerator:		
@ 0 % heat recovery:	0	Equation 2.34
@ 35 % heat recovery:	0	Equation 2.35
@ 50 % heat recovery:	124,324	Equation 2.36
@ 70 % heat recovery:	0	Equation 2.37
Other equipment :	-	
Total Equipment Cost--base:	124,324	=EC + Auxiliary costs
Total Equipment Cost--escalated (A):	273,981	=Base cost x inflation factor
Purchased Equipment Cost (B):	323,297	=1.18A (Table 2.10)
Total Capital Investment (TCI):	**510,810**	=1.58B (Table 2.10)

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.12
Maintenance labor factor (hr/sh):	0.5	Table 2.12
Electricity price ($/kwh):	0.055	
Catalyst price ($/ft3):	650	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Catalyst life (years):	2	
Capital recovery factor (system):	0.0963	
Capital recovery factor (catalyst):	0.5378	
Taxes, insurance, admin. factor:	0.05	

CALCULATED ANNUAL COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	63,854	
Electricity	5,301	Section 2.5.2.1
Catalyst replacement	2,947	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	25,540	
Capital recovery	48,685	=CRF x TCI
Total Annual Cost	**280,531**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2, reflect this date.
All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 5.

Total Annual Cost Spreadsheet - Rotary Concentrator/Oxidizer
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1996	
Current Date:	1/15/2020	
Years since Cost Base Date:	24	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.81	

PARAMETERS

Flowrate (cfm)	4,000	
Control device input mass (tons/year)	5.4	
Concentration (avg. ppmv)	26.82	based on Toluene
Facility operating schedule (hours/year)	8,760	
Thermal oxidizer temperature (F)	1,400	
Fuel cost, ($/million BTU)	4.00	
Electricity cost, ($/kwhr)	0.055	

ENERGY CALCULATIONS

Heat recovery (%)	50	
Pressure drop (inches WC)	14	Table 2.13 (catalytic)
Electrical power (kW)	10.9	Section 2.5.2.1
Fuel usage (Btu/hr)	600,199	Equation 2.21

CAPITAL COSTS

Equipment cost (EC), (Durr budgetary costs, 3/15/96)	130,695	
Escalated Equipment Cost (A)	236,391	inflation adjustment
Other equipment:	0	
Total Direct Cost (TDC), ($)	382,971	sty-cost.wk3
Total Capital Investment (TCI), ($)	470,908	sty-cost.wk3

ANNUAL COST INPUTS

Operating factor (hr/yr):	8,760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.50	Table 2.12
Maintenance labor factor (hr/sh):	0.50	Table 2.12
Electricity price ($/kwh):	0.055	
Natural gas price ($/mscf):	4.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL OPERATING COSTS

Operating labor	26,280	
Supervisory labor	3,942	Table 2.12
Maintenance labor	26,828	
Maintenance materials	26,828	Table 2.12
Natural gas	21,031	
Electricity	5,261	
Overhead	50,326	Table 2.12
Taxes, insurance, administrative	23,545	
Capital recovery	45,368	=CRF x TCI
Total Annual Cost	**229,409**	

* Date and costs based on *Addendum to Assessment of Styrene Emission Controls for FRP/C and Boat Building Industries* , EPA-600/R-96-136, November 1996, and the associated spreadsheet (sty-cost.wk3) developed by EPA. Some equations in this document refer to EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.2, Chapter 2.

Table 6. **Total Annual Cost Spreadsheet - Packaged Condenser**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2014	
Current Date:	1/15/2020	
Years since Cost Base Date:	6	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.16	

INPUT PARAMETERS:

Inlet stream flowrate (scfm):	4,000	
Inlet stream temperature (oF):	200	
VOC to be condensed:	Toluene	
VOC inlet volume fraction:	0.000027	
Required VOC removal (fraction):	0.90	
Antoine equation constants for VOC:		
A:	6.955	Table B below, for Toluene
B:	1344.800	Table B below, for Toluene
C:	219.480	Table B below, for Toluene
VOC heat of condensation (BTU/lb-mole):	14,290.0	Table A below, for Toluene
VOC heat capacity (BTU/lb-mole-oF):	37.5	Table A below, for Toluene
Coolant specific heat (BTU/lb-oF):	0.650	Default value
VOC boiling point (oF):	231.0	Table A below, for Toluene
VOC critical temperature (oR):	1,065.0	Table A below, for Toluene
VOC molecular weight (lb/lb-mole):	92.1	Table A below, for Toluene
VOC condensate density (lb/gal):	7.20	Table A below, for Toluene
Air heat capacity (BTU/lb-mole-oF):	6.95	Default value

DESIGN PARAMETERS:

Outlet VOC partial pressure (mm Hg):	0.0020	Equation 2.6
Condensation temperature, Tc (oF):	-112.1	Equation 2.8
VOC flowrate in (lb-moles/hr):	0.0164	Equation 2.9
VOC flowrate out (lb-moles/hr):	0.002	Equation 2.10
VOC condensed (lb-moles/hr):	0.015	inlet - outlet
(lb/hr):	1.4	lb-moles x molecular weight
VOC heat of condensation @ Tc (BTU/lb-mole):	18,300	Equation 2.14
Enthalpy change, condensed VOC (BTU/hr):	444	Equation 2.12
Enthalpy change, uncondensed VOC (BTU/hr):	19	Equation 2.16
Enthalpy change, air (BTU/hr):	1,327,975	Equation 2.17
Condenser heat load (BTU/hr):	1,328,438	sum of enthalpy changes
Heat transfer coefficient, U (BTU/hr-ft2-oF):	20.0	Default value
Log-mean temperature difference (oF):	95.6	Equation 2.19
Condenser surface area (ft2):	694.7	Equation 2.18
Coolant flowrate (lb/hr):	81,750	Equation 2.22
Refrigeration capacity (tons):	110.70	Equation 2.23
Electricity requirement (kW/ton of refrigeration)	11.7	Table 2.5 (see below)

CAPITAL COSTS:

Equipment Costs ($):		
-- Refrigeration unit/single-stage (< 10 tons):	0	Equation 2.26
-- Refrigeration unit/single-stage (> 10 tons):	709,801	Equation 2.27
-- Multistage refrigeration unit:	1,624,706	Equation 2.28
Total equipment cost ($)--base:	2,030,882	Equation 2.29
Total equipment cost ($)--escalated:	2,355,201	inflation adjusted
Purchased Equipment Cost ($):	2,543,617	Equation 2.30
Total Capital Investment ($):	**4,349,585**	Table 2.3

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	Table 2.4
Maintenance labor factor (hr/sh):	0.5	Table 2.4
Electricity price ($/kWhr):	0.055	
Recovered VOC value ($/lb):	0.00	
Annual interest rate (fraction):	0.05	
Control system life (years):	15	
Capital recovery factor:	0.0963	
Taxes, insurance, admin. factor:	0.05	

ANNUAL COSTS:

Operating labor	26,280
Supervisory labor	3,942
Maintenance labor	26,828
Maintenance materials	26,828
Electricity	734,165
Overhead	50,326
Taxes, insurance, administrative	217,479
Capital recovery	419,049
Total Annual Cost (without credits)	1,504,896
Recovery credits	0
Total Annual Cost (with credits)	**1,504,896**

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 2, reflect this date. All calculated values in this table are based on equations from Chapter 2 of this manual.

Table 7. **Total Annual Cost Spreadsheet - Fixed Bed Carbon Adsorber with Steam Regeneration**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	1999	
Current Date:	1/15/2020	
Years since Cost Base Date:	21	
Average inflation rate/year, %:	2.5	
Inflation adjustment factor:	1.68	

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	4,000	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.23	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	2.68E-05	
VOC inlet concentration (ppmv):	26.8	
VOC inlet partial pressure (psia):	0.0004	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	5.39	
Adsorption time (hr):	12	Operating hours between carbon replacement
Desorption time (hr):	5	Regenerated off-site
Number of adsorbing vessels:	2	
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6
Material of construction factor:	1.30	stainless steel 316, Table 1.3

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.233	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.116	50% of equilibrium capacity
Number of desorbing vessels:	1	Regenerated off-site
Total number of vessels:	3	
Carbon requirement, total (lb):	190	Equation 1.14
Carbon requirement per vessel (lb):	63	
Gas flowrate per adsorbing vessel (acfm):	2,000	Vertical vessel, flow under 9000 cfm
Adsorber vessel diameter (ft):	5.83	Equation 1.18 or 1.21
Adsorber vessel length or height (ft):	5.08	Equation 1.19 or 1.23
Adsorber vessel surface area (ft2):	146.31	Equation 1.24
Carbon bed depth (ft):	0.079	Equation 1.31
Carbon bed pressure drop (in. w.c.):	1.268	Equation 1.30

CAPITAL COSTS:

Adsorber vessels	51,124	Equation 1.25
Carbon	238	Equation 1.16
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	99,196	Equation 1.27
Total equipment cost ($)--escalated:	166,608	apply inflation factor
Purchased Equipment Cost ($):	191,599	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**283,567**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760	
Operating labor rate ($/hr):	48.00	
Maintenance labor rate ($/hr):	49.00	
Operating labor factor (hr/sh):	0.5	
Maintenance labor factor (hr/sh):	0.5	
Electricity price ($/kWhr):	0.055	
Steam price ($/1000 lb):	5.00	Default values in EPA Cost Manual
Cooling water price ($/1000 gal):	3.55	Default values in EPA Cost Manual
Recovered VOC value ($/lb):	-	
Overhead rate (fraction):	0.6	
Annual interest rate (fraction):	0.05	
Control system life (years):	10.0	
Capital recovery factor (system):	0.1295	
Carbon life (years):	2.0	
Capital recovery factor (carbon):	0.5378	
Taxes, insurance, admin. factor:	0.050	

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	467	Section 1.8.1.3
Steam	189	Equation 1.28
Cooling water	459	Equation 1.29
Carbon replacement	138	Equation 1.38
Overhead	50,326	
Taxes, insurance, administrative	14,178	
Capital recovery	36,723	
Total Annual Cost (without credits)	186,358	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**186,358**	

Table 8. **Total Annual Cost Spreadsheet - Carbon Adsorber Canister (with carbon replacement)**
Eastman Chemical Resins, Inc. - Jefferson Site, West Elizabeth PA

COST REFERENCE DATE*:	2018
Current Date:	1/15/2020
Years since Cost Base Date:	2
Average inflation rate/year, %:	2.5
Inflation adjustment factor:	1.05

INPUT PARAMETERS:

Inlet stream flowrate (acfm):	4,000	
Inlet stream temperature (oF):	200	
Inlet stream pressure (atm):	1	
VOC to be condensed:	Toluene	
Inlet VOC flowrate (avg. lb/hr):	1.23	
VOC molecular weight (lb/lb-mole):	92	
VOC inlet volume fraction:	2.68E-05	
VOC inlet concentration (ppmv):	26.8	
VOC inlet partial pressure (psia):	0.0004	
Required VOC removal (fraction):	0.90	
Annual VOC inlet (tons):	5.39	
Total Adsorption time per canister (hr):	850	Operating hours between carbon replacement
Desorption time (hr):	0	Regenerated off-site
Number of canisters:	2	Only one online at a time
Superficial carbon bed velocity (ft/min):	75.0	default, page 1-35
Carbon price ($/lb):	1.25	reactivated, page 1-6

DESIGN PARAMETERS:

Carbon adsorptivity (lb Toluene/lb carbon):	0.233	Equation 1.1 and Table 1.2
Carbon working capacity (lb VOC/lb carbon):	0.116	50% of equilibrium capacity
Number of desorbing vessels:	0	Regenerated off-site
Total number of vessels:	2	
Total Carbon needed per replacement cycle (lb):	8,993	Equation 1.14 (at 850 adsorption hrs/cycle)
Number of carbon replacements per year:	11	
Minimum carbon requirement (lbs carbon/yr)	98,918	Lbs per replacement times number of replacements

CAPITAL COSTS:

Adsorber vessels (includes cost of carbon)	189,000	Tables 1.5 & 1.6 (based on carbon requirement)
Auxiliary equipment (ductwork, etc.)	0	
Total equipment cost ($)--base:	365,015	Equation 1.27
Total equipment cost ($)--escalated:	383,494	apply inflation factor
Purchased Equipment Cost ($):	441,018	Table 1.4 (less sales taxes)
Total Capital Investment ($):	**652,707**	Table 1.4

ANNUAL COST INPUTS:

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	48.00
Maintenance labor rate ($/hr):	49.00
Operating labor factor (hr/sh):	0.5
Maintenance labor factor (hr/sh):	0.5
Electricity price ($/kWhr):	0.055
Recovered VOC value ($/lb):	-
Overhead rate (fraction):	0.6
Annual interest rate (fraction):	0.05
Control system life (years):	10.0
Capital recovery factor (system):	0.1295
Carbon life (years):	2.0
Capital recovery factor (carbon):	0.5378
Taxes, insurance, admin. factor:	0.050

ANNUAL COSTS:

Operating labor	26,280	
Supervisory labor	3,942	
Maintenance labor	26,828	
Maintenance materials	26,828	
Electricity	467	Section 1.8.1.3
Carbon replacement	84,346	Labor + Material (Eqs. 1.37 & 1.38)
Overhead	50,326	
Taxes, insurance, administrative	32,635	
Capital recovery	84,529	
Total Annual Cost (without credits)	336,181	
Recovery credits		Recovered solvent not re-sold
Total Annual Cost (with credits)	**336,181**	

* Original equipment costs in EPA's OAQPS Control Cost Manual, 7th Edition, Section 3.1, Chapter 1, reflect this date. All calculated values in this table are based on equations from this manual.

ALLEGHENY COUNTY HEALTH DEPARTMENT

IN RE:

Hercules Incorporated State Highway 837 Allegheny County West Elizabeth, PA 15088	**PLAN APPROVAL ORDER AND AGREEMENT NO. 257 UPON CONSENT**

AND NOW, this 14th day of January, ~~1996~~ 1997 0911

WHEREAS, the Allegheny County Health Department, (hereafter referred to as "Department"), has determined that the Hercules Incorporated (hereafter referred to as "HERCULES"), State Highway 837, Allegheny County, West Elizabeth, PA 15088, is the owner and operator of synthetic hydrocarbon resin production facilities at State Highway 837, Allegheny County, West Elizabeth, PA 15088 (hereafter referred to as "the facility"), is a major stationary source of volatile organic compounds (hereafter referred to as "VOCs") emissions as defined in Section 2101.20 of Article XXI, Rules and Regulations of the Allegheny County Health Department, Air Pollution Control (hereafter referred to as "Article XXI"); and

WHEREAS, the Department has determined that Section 2105.06.a. of Article XXI, entitled "Major Sources of NO_x & VOCs" is applicable to HERCULES's operations at this facility; and

WHEREAS, HERCULES promptly submitted to the Department all documents required by Section 2105.06.b of Article XXI (hereafter referred to as "the proposal"); and

WHEREAS, the Department, after a review of the submitted proposal, has determined the proposal to be complete; and

WHEREAS, the Department has further determined, after review of the submitted proposal, that it constitutes Reasonably Available Control Technology (hereafter referred to as "RACT") for control of VOC emissions from HERCULES; and

WHEREAS, the Department and HERCULES desire to memorialize the details of the submitted proposal by entry of a Plan Approval Order and Agreement Upon Consent; and

WHEREAS, pursuant to Section 2109.03 of Article XXI, the Director of the Allegheny County Health Department or his designated representative may issue such orders as are necessary to aid in the enforcement of the provisions of Article XXI;

NOW, THEREFORE, this day first written above, the Department, pursuant to Section 2109.03 of Article XXI, and upon agreement of the parties as hereinafter set forth, hereby issues this Plan Approval Order and Agreement upon Consent:

I. ORDER

1.1. HERCULES shall at no time operate the following process equipment while generating VOC emissions unless all non-fugitive emissions are processed through cooling tower water-cooled condensers. Such condensers shall be properly maintained and operated at all times while treating VOC emissions from the subject equipment, with the exception of activities to mitigate emergency conditions, with a coolant inlet temperature no greater than ten degrees fahrenheit above ambient air temperature, except that at no time will coolant temperature be required to be less than 50°F.

Subject Process Equipment Per Process Unit:

A. V-8 Polymerization Unit Process Equipment:

1. First and second flashers and OVDHS accumulators
2. Mixpot
3. No. twenty-five (25) agitator

B. Water-White Polymerizatyion Unit Process Equipment:

1. Reclaimer

C. MP Polymerization Unit

1. Reactor

D. Suspension Polymerization Unit Process Equipment:

1. North, South and West reactors

E. Pilot Plant Process Equipment:

1. Reactor
2. Neutralizer
3. Funda Filter

F. No. three (3) LTC Finishing Unit Process Equipment:

1. First and second stage reactor vacuum jets

G. C-5 Polymerization Unit Process Equipment:

1. Resin kettles no. eight (8), when containing volatile organic compounds.
2. Solvent flush, irganox, reclaim and precoat tanks

H. No.s one (1) and two (2) LTC Finishing Unit Process Equipment:

1. No.s one (1) and two (2) flasher feed

2. No.s one (1) and two (2) flasher jets

I. C-Polymerization Unit Process Equipment:

1. Reactors no. 1-1, 1-2, 2-1 and 2-2

1.2. HERCULES shall at no time operate the following process equipment while generating VOC emissions unless all such non-fugitive emissions are processed through refrigerated condensers. Such condensers shall be properly maintained and operated at all times while treating VOC emissions, with the exception of activities to mitigate emergency conditions, with coolant inlet temperatures no greater than those listed below.

<u>Subject Process Equipment Per Process Unit:</u>

A. MP Polymerization Unit Process Equipment:

1. Preblend, receiver, solvent filtrate and filtrate receiver tanks

with inlet coolant temperatures no greater than ten (10) degrees centigrade.

B. C-5 Polymerization Unit Process Equipment:

1. Neutralizers and Filtrate Receiver
2. Reactor
3. Toluene column

with inlet coolant temperatures no greater than zero (0) degrees Fahrenheit.

1.3. By no later than May 1, 1997, HERCULES shall complete installation of refrigerated condenser systems, for the purpose of reducing VOC emissions, from the subject process equipment listed below.

<u>Subject Process Equipment Per Process Unit:</u>

A. Hydrogenation Unit Process Equipment:

1. Storage tanks no.s T-101, T-102, T-105 and T-106
2. Autoclave vent tank
3. Product tank, T-501 & Solvent tank, T-502
2. Metering tank
3. Pall and Sweetland filter blowing
4. Autoclaves no.s one (1) and two (2)

B. Water-White Polymerization Unit Process Equipment:

1. Feed dryers
2. Reactors
3. Neutralizer
4. Filtrate receiver

1.4. By no later than August 1, 1997, HERCULES shall commence operation of the refrigerated condenser Systems, for the purpose of reducing VOC emissions,from the subject equipment listed in paragraph 1.3 above. Such condensers shall be properly maintained and operated at all times while treating VOC emissions, with the exception of activities to mitigate emergency conditions, with coolant inlet temperatures no greater than ten (10) degrees centigrade.

1.5. HERCULES shall at all times maintain all appropriate records to demonstrate compliance with the requirements of both Section 2105.06 Article XXI and this Order. Data and information required to determine compliance shall be recorded and maintained by HERCULES and shall include, but not be limited, the following.

A. Production records and condenser coolant temperatures

1.6. HERCULES shall retain all records required by both Section 2105.06 of Article XXI and this Order for the facility for at least two (2) years and shall make the same available to the Department upon request.

1.7. HERCULES shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices.

II. AGREEMENT

The foregoing Order shall be enforced in accordance with and is subject to the following agreement of the parties, to wit:

2.1. The contents of this Order shall be submitted to The U.S. Environmental Protection Agency as a revision to the Commonwealth of Pennsylvania's State Implementation Plan (hereafter referred to as "SIP").

2.2. This Order establishes the extent of HERCULES' obligation with respect to the control of VOCs from this facility. Compliance with the requirements stated in the Order portion of this Order and Agreement shall be deemed compliance with all VOC control requirements for equipment described in HERCULES' RACT Plan. Failure of HERCULES to comply with this Enforcement Order and Agreement by Consent shall subject HERCULES to only the remedies provided for violations of Article XXI.

2.3. If any event occurs which is beyond the control of HERCULES and which causes or may cause delays in the achievement of the deadlines contained in paragraphs 1.3 and 1.4 of this Order.

a. HERCULES shall notify the Department in writing within ten (10) days of the delay or anticipated delay, describing in detail the nature of the delay, the anticipated length of the delay, the precise cause or causes of the delay, the measures taken and to be taken by HERCULES to prevent or minimize the delay, and the timetable by which those measures will be implemented. HERCULES shall adopt all reasonable measures to avoid or minimize any such delay. Failure by HERCULES to comply with the notice requirement of this subparagraph,(2.3.a.) specifically may in sole discretion of the Department render the remaining provisions of this paragraph (2.3.b. - 2.3.c.) void and of no effect as to the particular incident involved.

b. If the Department agrees that the delay or anticipated delay in complying with this Order has been or will be caused by circumstances beyond the control of HERCULES, the time for performance hereunder may be extended for a period no longer than the delay resulting from such circumstances.

c. The burden of proving that any delay is caused by circumstances beyond the control of HERCULES shall rest with HERCULES. Increased costs or expenses associated with the implementation of actions called for by this Order shall not, in any event, be a basis for changes in this Order or extensions of time under this paragraph. Delay in achievement of one interim step shall not necessarily justify or excuse delay in achievement of subsequent steps.

2.4. HERCULES hereby consents to the foregoing Order and hereby knowingly waives all rights to appeal said Order, and the undersigned represents that he is authorized to consent to the Order and to enter into this Agreement on behalf of HERCULES.

2.5. The County shall, upon request by HERCULES, accept and evaluate requests for amendments to Allegheny County's portion of the SIP and if appropriate, submit the amendments to the U.S. EPA for incorporation into the SIP. HERCULES hereby reserves its appeal rights to Article XXI, Rules and Regulations of the ACHD, Hearings and Appeals, for any subject amendments made or failure to make such amendments.

IN WITNESS WHEREOF, and intending to be legally bound, the parties hereby consent to all of the terms and conditions of the foregoing Order and Agreement as of the date of the above written.

HERCULES INC.

By: Joseph P. Ziegler
(signature)

Print or type Name: Joseph P. Ziegler

Title: Plant Manager

Date: 1/3/97

ALLEGHENY COUNTY HEALTH DEPARTMENT

By: Bruce W. Dixon 1/14/97

Bruce W. Dixon, M.D., Director
Allegheny County Health Department

and By: Thomas J. Puzniak

Thomas J. Puzniak, Engineering Manager
Air Quality Program

ALLEGHENY COUNTY HEALTH DEPARTMENT

July 22, 1996

SUBJECT: Review of VOC RACT Submittal
Hercules, Incorporated
State Highway 837
West Elizabeth, PA
Allegheny County

Order and Agreement No. 257

THROUGH: George A Manown, Assistant Manager, Air Quality

FROM: T. J. Novack, P.E.
Air Quality Engineer

SOURCE DESCRIPTION:

The Hercules, Inc., West Elizabeth facility produces synthetic hydrocarbon resins and is a major source of VOCs and NO_x. NO_x RACT was addressed in a separate submittal. The facility produces a variety of resins from resin oils, monomers, solvents and catalysts and is comprised of the following processes.

1. Water white polymerization unit - WW Poly
2. C polymerization unit - C Poly
3. MP polymerization unit - MP Poly
4. C-5 unit
5. LTC 1&2 unit
6. LTC 3 unit
7. V-8 unit
8. HSI unit
9. Hydrogenation unit - Hydro
10. Wastewater treatment plant - WWTP
11. Boilerhouse
12. Pilot Plant

The main polymerization units are the C poly, MP poly, WW poly, HSI & C-5. The LTCs and V-8 units are finishing processes that treat resin produced by the main polymerization units. The Hydro unit hydrogenizes resins produced in the main polymerization units prior to the finishing processes.

PROCESS COMPONENTS, VOC MAXIMUM POTENTIAL TO EMIT AND EXISTING CONTROL EFFICIENCY:

All VOC emitting process components, along with existing VOC controls, existing VOC control efficiency, uncontrolled maximum potential VOC emissions per component and per process and existing controlled maximum potential VOC emissions per component and per process are presented in appendix A, " Process Data."

VOLATILE ORGANIC STORAGE TANKS:

All existing volatile organic storage tanks at the facility not regulated by Section 2105.12 of Article XXI, "Volatile Organic Compound Storage Tanks", along with the maximum potential VOC emissions per tank are presented in appendix B, "Tank Data."

REGULATORY ANALYSIS:

This facility is a major source NO_x and VOC emissions, therefore, this facility is subject to the requirements of the Reasonably Available Control Technology regulation of section 2105.06 of Article XXI, Allegheny County Health Department, Rules and Regulations, Air Pollution Control.

VOC RACT ANALYSIS:

The VOC RACT analysis was conducted with guidance from EPA-453/R-93-017, "Control of Volatile Organic Compound Emissions from Batch Processes", Draft, November 1993 and EPA's OAQPS Cost Manual. References 1 and 2 respectively.

Processes:

All processes have either water-cooled condensers or refrigerated condensers for VOC control with the exception of the WWTP. Based on the above references 1 and 2, the most inexpensive additional control options were 1) to add water cooled condensers to process units which are presently uncontrolled 2) to upgrade existing cooling tower water condenser systems with refrigerated units, 3) installation of separate thermal oxidation units as secondary treatment on the various plant processes and 4) to install a thermal oxidation unit that would process the existing controlled emissions from the facility. Since all other options are less cost effective than those stated, they were not considered in this RACT analysis.

1. Installation of water cooled condensers on process units that are presently uncontrolled is economically infeasible. See appendix for the cost analysis.

2. Installation of refrigerated condenser systems as secondary VOC controls following existing water cooled condensers were considered the most inexpensive technically feasible options for the following

processes:

1. V-8 Polymerization Unit
2. Hydrogenation Unit
3. Water-white Polymerization Unit
4. HSI Polymerization Unit
5. No. 3 LTC Finishing Unit
6. No.s 1 & 2 LTC Finishing Unit
7. C-Poly Polymerization Unit
8. Pilot Plant

This option was found to be cost prohibitive for all the above processes except the Hydrogenation Unit and the Water-white polymerization unit. The economic analysis for the no. 3 LTC unit demonstrates that this option is also cost prohibitive for the pilot plant. See appendix C for the cost analyses.

2. Installation of separate thermal oxidizers as secondary VOC control systems following the existing refrigerated condenser systems were considered the most inexpensive technically feasible control options for the following processes:

1. C-5 Polymerization Unit
2. MP Polymerization Unit

This option was found to be cost prohibitive for the C-5 polymerization unit which also demonstrates that it is cost prohibitive for the MP polymerization unit.

3. Installation of a thermal oxidation system to treat all processes in the facility was found to be cost prohibitive. In addition, a thermal oxidation unit would pose special problems in construction and operation which include the following:

1. A minimum of at least one mile of main conduit is required to join all the processes at the facility.

2. A main CONRAIL railroad line would have to be crossed with main line conduit.

3. The processes are not continuous VOC emission units which would require extensive instrumentation on the various processes to vent the emissions when they occur without disrupting the processes themselves.

4. The thermal oxidation system would have to be placed at the plant boundary as far away from all storage tanks and processes as possible due to the flammable nature of the components stored and used at the facility. This would require that the system be placed along the Ohio river where flooding would have to be taken into consideration.

See appendix C for the cost analysis.

Waste water treatment plant:

The installation of covers and a refrigerated condenser system was considered the most inexpensive control system for this unit. This system is technically feasible but cost prohibitive. See appendiX C for the cost analysis.

Boiler house:

With a VOC potential to emit of less than 5 TPY operation and maintenance costs alone would make any controls cost prohibitive. See appendix C for the cost analysis.

Storage Tanks:

There are 171 volatile organic storage tanks located at the facility. 37 of these tanks are subject to Section 2105.12 of Article XXI, "Volatile Organic Compound Storage Tanks", and therefor have VOC RACT in place. 134 tanks are not subject to the referenced regulation and are subject to VOC RACT analysis.

The facility is approximately 2,200 feet by 1,200 feet with the storage tanks placed throughout the plant. The storage tanks are grouped in areas in the facility with the largest VOC potential to emit from a group being approximately 62 TPY from 15 tanks.

VOC emission controls were analyzed for 1) the individual storage tank with the largest VOC potential to emit and 2) a group of tanks with a single control system.

1. Tank no. 151 has the largest potential to emit of 49.5 TPY The possible control options consist of thermal oxidation and refrigerated condenser systems. The analysis of thermal oxidation as a secondary control system for the C-5 polymerization process with a VOC potential to emit of 62 TPY, demonstrates that thermal oxidation for this tank is cost prohibitive. The emissions from the C-5 unit are greater than this tank and cost prohibitive making it cost prohibitive for this tank also.

   Based on the analysis of a refrigerated condenser system for the no. 1 & 2 LTC finishing unit with a VOC potential to emit of 54.8 TPY, a condenser system on a single tank would be cost prohibitive.

2. Thermal oxidation or refrigerated condenser systems for a group of tanks with a VOC potential to emit of 62 TPY would be cost prohibitive for the same reasons given in paragraph 1. above. In addition all groups of tanks at the facility individually contain different volatile organics, i.e. styrene, toluene and resin oil, This means that any group of tanks would require numerous individual condensation units or separation units to recover the mixed condensate from a single condensation unit.

CONCLUSIONS AND RECOMMENDATIONS:

Installation of refrigerated condenser systems for the hydrogenation and water-white polymerization units are cost effective and will be considered VOC RACT for these units. The installation of these systems will reduce potential VOC emissions by approximately 300 TPY and raise the overall plant process VOC control efficiency to 89.4%, See appendix D for this summary.

All VOC controls beyond existing controls for all other process units and storage tanks not regulated by Section 2105.12 of Article XXI are cost prohibitive. VOC RACT will be the continued proper operation and maintenance of all VOC emission units, storage tanks and VOC controls, i.e. existing water cooled and refrigerated condensers.

The facility will be subject to following VOC RACT conditions:

1. HERCULES shall at no time operate the following process equipment while generating VOC emissions unless all non-fugitive emissions are processed through cooling tower water-cooled condensers. Such condensers shall be properly maintained and operated at all times while treating VOC emissions fromthe subject equipment, with the exception of activities to mitigate emergency conditions, with a coolant inlet temperature no greater than ten degrees fahrenheit above ambient air temperature,except that at no time will coolant temperature be required to be less than 50°F,

Subject Process Equipment Per Process Unit:

A. V-8 Polymerization Unit Process Equipment:
   1. First and second flashers and OVDHS accumulators
   2. Mixpot
   3. No. twenty-five (25) agitator
B. Water-White Polymerization Unit Process Equipment:
   1. Reclaimer
C. MP Polymerization Unit
   1. Reactor
D. Suspension Polymerization Unit Process Equipment:
   1. North, South and West reactors
E. Pilot Plant Process Equipment:
   1. Reactor
   2. Neutralizer
   3. Funda Filter
F. No. three (3) LTC Finishing Unit Process Equipment:
   1. First and second stage reactor vacuum jets
G. C-5 Polymerization Unit Process Equipment:
   1. Resin kettles no. eight (8), when

containing volatile organic compounds.
2. Solvent flush, irganox, reclaim and precoat tanks

H. No.s one (1) and two (2) LTC Finishing Unit Process Equipment:
1. No.s one (1) and two (2) flasher feed
2. No.s one (1) and two (2) flasher jets

I. C-Polymerization Unit Process Equipment:
1. Reactors no.s 1-1, 1-2, 2-1 and 2-2

J. Solution Polymerization Unit Process Equipment:
1. Reactor

2. HERCULES shall at no time operate the following process equipment while generating VOC emissions unless all such non-fugitive emissions are processed through refrigerated condensers. Such condensers shall be properly maintained and operated at all times while treating VOC emissions, with the exception of activities to mitigate emergency conditions, with coolant inlet temperatures no greater than those listed below.

<u>Subject Process Equipment Per Process Unit:</u>

A. MP Polymerization Unit Process Equipment:
1. Preblend, receiver, solvent filtrate and filtrate receiver tanks

with inlet coolant temperatures no greater than ten (10) degrees centigrade.

B. C-5 Polymerization Unit Process Equipment:
1. Neutralizers and Filtrate Receiver
2. Reactor
3. Toluene column

with inlet coolant temperatures no greater than zero (0) degrees Fahrenheit.

3. By no later than May 1, 1997, HERCULES shall complete installation of refrigerated condenser systems, for the purpose of reducing VOC emissions, from the subject process equipment listed below.

<u>Subject Process Equipment Per Process Unit:</u>

A. Hydrogenation Unit Process Equipment:
1. Storage tanks no.s T-101, T-102, T-105 and T-106
2. Autoclave vent tank
3. Product tank, T-501 & Solvent tank, T-502
2. Metering tank
3. Pall and Sweetland filter blowing

4. Autoclaves no.s one (1) and two (2)

B. Water-White Finishing Unit Process Equipment:

1. Feed dryers
2. Reactors
3. Neutralizer
4. Filtrate receiver

4. By no later than August 1, 1997, HERCULES shall commence operation of the refrigerated condenser Systems, for the purpose of reducing VOC emissions, from the subject equipment listed in paragraph 1.3 above. Such condensers shall be properly maintained and operated at all times while treating VOC emissions, with the exception of activities to mitigate emergency conditions, with coolant inlet temperatures no greater than ten (10) degrees centigrade.

5. HERCULES shall at all times maintain all appropriate records to demonstrate compliance with the requirements of both Section 2105.06 Article XXI and Order no. 257. Data and information required to determine compliance shall be recorded and maintained by HERCULES and shall include, but not be limited, the following.

A. Production records and condenser coolant temperatures

6. HERCULES shall retain all records required by both Section 2105.06 of Article XXI and Order no. 257 for the facility for at least two (2) years and shall make the same available to the Department upon request.

7. HERCULES shall properly maintain and operate all existing process equipment and VOC control equipment at all times while such equipment is emitting VOCs, with the exception of activities to mitigate emergency situations, according to good engineering and air pollution control practices.

APPENDIX A

PROCESS DATA

VOC POTENTIAL TO EMIT AND EXISTING CONTROL EFFICIENCY:

PROCESS - V-8 UNIT

	EMISSION UNIT	EXISTING CONTROL DEVICE	NO CONTROLS PTE TPY	CONTROLLED PTE TPY	VOC PTE REDUCTION TPY	% VOC CONTROL
1	1st STAGE FLASHER/ACCUMULATOR	CONDENSER @ AMBIENT	28.30	7.37	20.93	73.96%
2	2nd STAGE FLASHER/ACCUMULATOR	CONDENSER @ AMBIENT	68.33	7.37	60.96	89.21%
3	RESIN KETTLE RK2	UNCONTROLLED	0.09	0.09	0.0	0.00%
4	RESIN KETTLE RK3	UNCONTROLLED	0.09	0.09	0.0	0.00%
5	RESIN KETTLE RK4	UNCONTROLLED	0.09	0.09	0.0	0.00%
6	# 4 FLAKER	UNCONTROLLED	4.76	4.76	0.0	0.00%
7	SANDVIK FLAKER	UNCONTROLLED	4.76	4.76	0.0	0.00%
8	CB FURNACE	UNCONTROLLED	0.07	0.07	0.0	0.00%
9	H-8 FURNACE	UNCONTROLLED	0.05	0.05	0.0	0.00%
10	DRUMMING AREA	UNCONTROLLED	0.01	0.01	0.0	0.00%
11	RAIL CAR LOADING	UNCONTROLLED	0.06	0.06	0.0	0.00%
12	MIXPOT	CONDENSER @ AMBIENT	2.87	0.66	2.2	77.00%
13	25 AGITATOR	CONDENSER @ AMBIENT	2.87	0.66	2.2	77.00%
		PROCESS TOTAL =	**112.35**	**26.04**	**86.3**	**76.82%**

PROCESS - HYDROGENATION

	EMISSION UNIT	EXISTING CONTROL DEVICE	NO CONTROLS PTE TPY	CONTROLLED PTE TPY	VOC PTE REDUCTION TPY	% VOC CONTROL
1	TANKS T-100 & T- 101	UNCONTROLLED	12.93	12.93	0.00	0.00%
2	TANK T-106	UNCONTROLLED	0.80	0.80	0.00	0.00%
3	METERING TNK	CONDENSER @ AMBIENT	48.86	6.24	42.62	87.23%
4	FILTER BLOW #1	CONDENSER @ AMBIENT	67.66	7.59	60.07	88.78%
5	FILTER BLOW # 2	CONDENSER @ AMBIENT	157.29	17.65	139.64	88.78%
6	AUTOCLAVES 1 & 2 AND TNK - 303	CONDENSER @ AMBIENT	508.54	262.87	245.67	48.31%
7	OB TANK	UNCONTROLLED	1.20	1.20	0.00	0.00%
8	TNK T- 501	CONDENSER @ AMBIENT	110.43	6.81	103.62	93.83%
9	AUTOCLAVE BLOWOUT	CONDENSER @ AMBIENT	324.05	26.44	297.61	91.84%
10	TNKS T-102 & T-105	CONDENSER @ AMBIENT	70.16	6.96	63.20	90.08%
11	SWEETLAND BLOWOUT	CONDENSER @ AMBIENT		4.00	-4.00	ERR
12	CATALYST TANK	UNCRONTROLLED	1.04	1.04	0.00	0.00%
13	PRECOAT TANK	UNCRONTROLLED	0.03	0.03	0.00	0.00%
		PROCESS TOTAL =	**1302.99**	**354.56**	**948.4**	**72.79%**

PROCESS - WATER WHITE POLY

	EMISSION UNIT	EXISTING CONTROL DEVICE	NO CONTROLS PTE TPY	CONTROLLED PTE TPY	VOC PTE REDUCTION TPY	% VOC CONTROL
1	FEED DRYERS	CONDENSER @ 10 C	403.97	13.69	390.3	96.61%
2	NORTH & SOUTH REACTORS	CONDENSER @ AMBIENT	225.42	46.97	178.5	79.16%
3	NORTH & WEST BLEND TNKS	CONDENSER @ AMBIENT	14.26	14.26	0.0	0.00%
4	SLURRY TNK	UNCONTROLLED	0.71	0.71	0.0	0.00%
5	RECLAIMER	CONDENSER @ AMBIENT	2.61	1.37	1.2	47.51%
6	RECLAIMER STORAGE TNK	UNCONTROLLED	2.49	2.49	0.0	0.00%
7	NEUTRALIZER	CONDENSER @ AMBIENT	19.26	7.84	11.4	59.29%
8	NEUTRALIZER EXHAUST	UNCONTROLLED	1.31	1.31	0.0	0.00%
9	FUNDA FILTER	CONDENSER @ AMBIENT	5.25	0.71	4.5	86.48%
10	FILTRATE RECIEVER	CONDENSER @ 20 F	27.67	3.65	24.0	86.81%
11	AUX RECIEVER	UNCONTROLLED	3.86	3.86	0.0	0.00%
		PROCESS TOTAL =	**706.81**	**96.86**	**610.0**	**86.30%**

PROCESS - MP POLY

	EMISSION UNIT	EXISTING CONTROL DEVICE	NO CONTROLS PTE TPY	CONTROLLED PTE TPY	VOC PTE REDUCTION TPY	% VOC CONTROL
1	REACTOR	CONDENSER @ 10 C	105.28	10.79	94.5	89.75%
2	NEUTRALIZER	CONDENSER @ AMBIENT	71.40	11.78	59.6	83.50%
3	SOLVENT TNK, FILTRATE TNK & AUX. RECIEVER	CONDENSER @ AMBIENT	512.00	41.98	470.0	91.80%
		PROCESS TOTAL =	**688.68**	**64.55**	**624.1**	**90.63%**

PROCESS - SOLUTION POLY EMISSION UNIT		EXISTING CONTROL DEVICE	UNCONTROLLED PTE TPY	CONTROLLED PTE TPY	EXISTING REDUCTION TPY	PERCENT VOC CONTROL
1	PREBLEND TNK	UNCONTROLLED	0.54	0.54	0.0	0.00%
2	CATALYST MIX TNK	UNCONTROLLED	0.10	0.10	0.0	0.00%
3	REACTOR CHARGE	UNCONTROLLED	0.20	0.20	0.0	0.00%
4	REACTOR STRIP #1 AT 1 ATM	CONDENSER @ AMBIENT	2.42	0.53	1.9	78.10%
5	REACTOR STRIP #1 AT VACUUM	CONDENSER @ AMBIENT	21.32	2.98	18.3	86.02%
6	REACTOR STRIP #2 AT VACUUM	CONDENSER @ AMBIENT	2.17	0.30	1.9	86.18%
7	POLY SOLUTION TNK	UNCONTROLLED	0.15	0.15	0.0	0.00%
8	AUX RECEIVERS	UNCONTROLLED	0.03	0.03	0.0	0.00%
9	DOUBLE BELT FLAKER	ENCLOSED FLAKER	0.49	0.49	0.0	0.00%
		PROCESS TOTAL =	27.41	5.31	22.1	80.62%
PROCESS - SUSPENSION POLY						
1	N&S MONOMER MIX TNK	UNCONTROLLED	0.38	0.38	0.0	0.00%
2	W MONOMER MIX TNK	UNCONTROLLED	0.31	0.31	0.0	0.00%
3	NORTH REACTOR	CONDENSER @ AMBIENT	6.15	0.59	5.6	90.41%
4	SOUTH REACTOR	CONDENSER @ AMBIENT	10.54	1.02	9.5	90.32%
5	WEST REACTOR	CONDENSER @ AMBIENT	6.15	0.59	5.6	90.41%
		PROCESS TOTAL =	23.53	2.89	20.6	87.72%
PROCESS - BOILER HOUSE						
1	#5 BOILER	UNCONTROLLED	1.24	1.24	0.0	0.00%
2	#1-2 BOILERS	UNCONTROLLED	1.45	1.45	0.0	0.00%
3	#3-4 BOILERS	UNCONTROLLED	1.95	1.95	0.0	0.00%
		PROCESS TOTAL =	4.64	4.64	0.0	0.00%
PROCESS - WWTP						
1	701 TNKS	UNCONTROLLED	16.7535	16.7535	0.0	0.00%
2	RSW SUMP	UNCONTROLLED	8.3765	8.3765	0.0	0.00%
3	DAF	UNCONTROLLED	7.599	7.599	0.0	0.00%
4	BIO AERATION	UNCONTROLLED	0.143	0.143	0.0	0.00%
5	ACID & FINAL SUMPS	UNCONTROLLED	1.049	1.049	0.0	0.00%
6	BIO CLARIFIER	UNCONTROLLED	0.0165	0.0165	0.0	0.00%
7	PRIMARY CLARIFIER	UNCONTROLLED	0.0025	0.0025	0.0	0.00%
8	702 TNKS	UNCONTROLLED	10.327	10.327	0.0	0.00%
		PROCESS TOTAL =	44.27	44.27	0.0	0.00%
PROCESS - PILOT PLANT						
1	BLDG EXHAUST	UNCONTROLLED	2.91	2.91	0.0	0.00%
2	#1 VACUUM JET	UNCONTROLLED	3.24	3.24	0.0	0.00%
3	#2 VACUUM JET	UNCONTROLLED	3.24	3.24	0.0	0.00%
4	FEED TNKS	UNCONTROLLED	0.43	0.43	0.0	0.00%
5	REACTOR VENTING	CONDENSER @ AMBIENT	6.87	2.57	4.3	62.63%
6	NEUTRALIZER VENTING	CONDENSER @ AMBIENT	5.62	0.76	4.9	86.57%
7	STRIPPING VENTING	CONDENSER @ AMBIENT	22.25	7.37	14.9	66.87%
8	FUNDA	CONDENSER @ AMBIENT	0.55	0.07	0.5	86.48%
9	THERMAL POLY	UNCONTROLLED	0.05	0.05	0.0	0.00%
10	SMALL AUTOCLAVES	UNCONTROLLED	2.17	2.17	0.0	0.00%
		PROCESS TOTAL =	47.34	22.81	24.5	51.81%
PROCESS - #3 LTC						
1	VA-POWER FURNACE	UNCONTROLLED	0.14	0.14	0.0	0.00%
2	1ST STAGE VAC JETS	CONDENSER @ AMBIENT	64.96	7.55	57.4	88.38%
3	2ND STAGE VAC JETS	CONDENSER @ AMBIENT	56.96	16.9	40.1	70.33%
		PROCESS TOTAL =	122.06	24.59	97.5	79.85%

PROCESS - C5 POLY						
	EMISSION UNIT	EXISTING CONTROL DEVICE	UNCONTROLLED PTE TPY	CONTROLLED PTE TPY	EXISTING REDUCTION TPY	PERCENT VOC CONTROL
1	HOT OIL HEATER	UNCONTROLLED	0.16	0.16	0.0	0.00%
2	SOLV FLUSH TNK	CONDENSER @ AMBIENT	45.59	0.94	44.7	97.94%
3	REACTOR, SOAKER, NEUTRALIZERS		0.00	0.00	0.0	NA
4	AND FILTRATE RECEIVER	CONDENSER @ -23 C	298.09	26.20	271.9	91.21%
5	PRECOAT TNK	CONDENSER @ AMBIENT	4.99	0.21	4.8	95.79%
6	TOLUENE COLUMN	CONDENSER @ -23 C	0.12	0.003	0.1	97.50%
7	IRNX SOLN TNK & RECLAIM TNK	CONDENSER @ AMBIENT	29.70	0.84	28.9	97.17%
8	RSN KETTLE #8	CONDENSER @ AMBIENT	10.81	0.08	10.7	99.26%
9	RSN KETTLE #9	UNCONTROLLED	0.09	0.09	0.0	0.00%
10	RSN KETTLE #10	UNCONTROLLED	16.40	16.40	0.0	0.00%
11	FUME SCRUBBER	UNCONTROLLED	49.63	49.63	0.0	0.00%
		PROCESS TOTAL =	455.6	94.6	361.0	79.2%
PROCESS - LTC #1 & #2						
1	#1 LTC CB FURNACE	UNCONTROLLED	0.08	0.08	0.0	0.00%
2	#2 LTC VAPWR FURNACE	UNCONTROLLED	0.11	0.11	0.0	0.00%
3	#1 FLASHER FEED	CONDENSER @ AMBIENT	224.56	19.25	205.3	91.43%
4	#1 LTC FLASHER/ACCUMULATOR	CONDENSER @ AMBIENT	7.73	4.07	3.7	47.35%
5	#2 LTC FLASHER/ACCUMULATOR	CONDENSER @ AMBIENT	7.73	4.07	3.7	47.35%
6	RK-5	CONDENSER @ AMBIENT	5.36	2.82	2.5	47.39%
7	RK-6	UNCONTROLLED	0.77	0.77	0.0	0.00%
8	RK-7	UNCONTROLLED	0.77	0.77	0.0	0.00%
9	#2 FLASHER FEED	CONDENSER @ AMBIENT	224.56	19.25	205.3	91.43%
10	DRUMMING STATION	UNCONTROLLED	0.01	0.01	0.0	0.00%
11	FUME SCRUBBER	CONDENSER @ AMBIENT	4.76	3.57	1.2	25.00%
		PROCESS TOTAL =	476.44	54.77	421.7	88.50%
PROCESS - C POLY						
1	#1 REACTOR	CONDENSER @ AMBIENT	8.16	2.8	5.4	65.69%
2	#2 REACTOR 2-1	CONDENSER @ AMBIENT	45.01	14.97	30.0	66.74%
3	#2 REACTOR 2-2	CONDENSER @ AMBIENT	45.01	14.97	30.0	66.74%
		PROCESS TOTAL =	98.18	32.74	65.4	66.65%
	TOTAL FOR ALL PROCESSES	=	4110.28	828.58	3281.7	79.84%

APPENDIX B

TANK DATA

VOC POTENTIAL TO EMIT FOR ALL VOLATILE ORGANIC STORAGE TANKS NOT REGULATED BY ARTICLE XXI, SECTION 2105.02, " VOLATILE ORGANIC COMPOUND STORAGE TANKS."

	TANK DESIG.	EXISTING VOC CONTROLS	CAPACITY GAL	PTE TPY
1	2		169194	7.57
2	4		88122	11.12
3	5		88122	5.51
4	7		110152	5.59
5	8		169194	8.45
6	9		110152	13.00
7	10		110152	13.23
8	11		169194	4.38
9	12		110152	4.15
10	13		110152	6.80
11	14		110152	9.89
12	15		110152	9.89
13	16		110152	10.28
14	17		110152	5.59
15	18		110152	4.17
16	19		169194	6.52
17	20		169194	6.14
18	21		24936	5.71
19	22		15862	4.44
20	23		15862	4.42
21	24		15862	5.73
22	25		15862	6.59
23	30		22669	4.30
24	31		22669	3.34
25	34		169194	20.09
26	35		169194	20.09
27	40		24880	13.87
28	41		24880	13.87
29	50		268037	23.84
30	51		268037	23.84
31	52		268037	23.84
32	53		528730	28.26
33	57		1909	0.43
34	58		1909	0.43
35	59		1909	0.28
36	60		24880	7.07
37	61		24880	7.07
38	62		3196	0.55

39	63		11885	1.10
40	65		8565	3.30
41	66		75197	8.92
42	67		75197	7.52
43	68		75197	14.13
44	69		75197	14.13
45	71		75197	16.65
46	72		75197	11.41
47	73		75197	7.52
48	74		75197	6.47
49	75		75197	7.52
50	76		75197	7.52
51	77		75197	6.47
52	78		169194	17.97
53	80		11982	0.01
54	81		24880	0.01
55	82		24880	< 0.01
56	83		25379	4.77
57	100		7896	1.88
58	101		7896	2.78
59	103		1500	0.53
60	106		12032	1.47
61	120		19413	0.01
62	121		19413	0.01
63	122		19413	0.01
64	123		19413	0.01
65	125		12795	4.16
66	126		12690	3.76
67	150		1503943	48.88
68	151		1503943	49.47
69	160		158619	5.69
70	161		158619	2.40
71	162		158619	5.96
72	206		25379	5.00
73	207		25379	5.00
74	208		25379	4.34
75	212		6016	2.58
76	250		30455	1.15
77	251		30455	1.34
78	252		30455	1.15
79	253		20726	5.43
80	254		15274	1.36
81	255		14981	0.01
82	256		9987	0.01
83	257		15274	1.36
84	258		10152	0.98
85	259		11280	4.78
86	260		20079	0.60
87	262		20079	6.30
88	263		20726	5.33
89	301		75197	5.96
90	302		75197	5.96
91	303		75197	5.96
92	360		15274	1.23
93	361		20079	1.23
94	362		15274	4.12
95	368		2632	0.91
96	369		25379	0.91
97	500		100000	0.10
98	501		62420	7.27

99	502		62420	7.27
100	503		54330	1.69
101	504		61000	2.40
102	505		9400	1.59
103	506		9400	1.59
104	1000		16919	2.53
105	1001		16919	2.51
106	1002		16919	2.51
107	1003		11750	2.77
108	1004		16919	1.86
109	1005		16919	1.88
110	1201		4018	1.48
111	1202		4018	1.48
112	2-3-B		12043	2.74
113	3-3		9517	3.28
114	3-2-B		24880	3.62
115	4-3-A		24880	0.12
116	4-3-B		24880	< 0.01
117	6-3		11885	3.19
118	8-1-C		3008	2.79
119	8-1-D		3008	2.79
120	8-1-E		3008	2.79
121	FO-2		88122	4.23
122	FO-3		88122	4.23
123	PD-1-1-A		14981	3.41
124	PD-1-1-B		14981	0.51
125	PD-2-1-A		14981	3.91
126	PD-2-1-B		14981	3.91
127	PD9-3		6054	3.69
128	R-100-A		67361	3.83
129	R-100-B		67361	3.83
130	R-100-C		67361	3.83
131	R-100-D		67361	3.83
132	R-100-E		67361	3.83
133	R-1-A		67361	4.72
134	R-1-B		67361	4.38

TOTAL TPY =	**798.17**

APPENDIX C

ECONOMIC ANALYSIS

COST ANALYSIS FOR VOC CONTROLS FOR THE BOILER HOUSE: AND WATER COOLED CONDENSERS FOR UNCONTROLLED PROCESS UNITS:

<u>Assumptions:</u>

1. Capital investment = $0.0
2. Utility costs = $0.0
3. Process costs = $0.0
4. Labor & maint. costs = $24/Hr.
5. Operating hours = 8,760/Yr.

Using cost factors from U.S. EPA's OAQPS cost manual, the following is a cost analysis based on labor and maintenance costs only:

Direct annual costs

Operating labor	$13,140
Supervisor	$1,971
Maintenance labor	$14,454
Material	$14,454
Consumables replacement	$0.0
Utilities	$0.0
Waste disposal	$0.0

Indirect annual costs

Overhead	$26,411
Administration	$0.0
Property taxes/insurance	$0.0
Capital recovery	$0.0
Total annual costs =	$70,430

VOC emissions reduction @ 100% control = 5 TPY
Cost effectiveness = $14,086/ton VOC removed

The potential uncomtrolled VOC emissions from the processes with the exception of the waste water treatment plant rang from 0.25 TPY to 12.5 TPY. At these levels no controls are econamically feasible.

VOC emissions reduction @ 100% control = 12.5
Cost effectiveness = &5,630/ton VOC removed

V-8 UNIT

REFRIGERATED CONDENSERS

PURCHASED EQUIPMENT COST		
EC	CONDENSERS (11) AND AUXILLARY EQUIPMENT	$203,500
	REFRIGERATION UNIT	$65,000
1.08 EC	PURCHASED EQUIPMENT COST TOTAL ,PEC	$219,801

THE TOTAL CAPITAL INVESTMENT IS 3 - 4 TIMES THE EQUIPMENT COSTS
(3 FOR SMALLER PROJECTS WITHOUT MUCH INSTRUMENTATION)

TOTAL CAPITAL INVESTMENT (TCI)	$879,202

ANNUAL COSTS

Annual costs consist of direct and indirect annual costs minus recovery credits.

DIRECT ANNUAL COSTS, DC

	OPERATING LABOR		
	0.5 hr/shift	$15.00	$8,213
	0.15operator		$1,232
	MAINTANENCE		
	0.5 hr/shift	$16.50	$9,034
	100% maint labor		$9,034
	UTILITIES		
	ELECTRICITY	$0.07 kW/hr	$10,424
TOTAL DIRECT ANNUAL COSTS, DC			$37,936

INDIRECT ANNUAL COSTS, IC

	OVERHEAD (60% total labor & maint materials cost)	$16,507
0.01 TCI	PROPERTY TAX	$8,792
0.01 TCI	INSURANCE	$8,792
0.1315 TCI	ADMINISTRATIVE & CAPITAL RECOVERY TAX	$115,615

THIS UNIT WILL BE SHUT DOWN AFTER THIS YEAR.

TOTAL INDIRECT ANNUAL COSTS, IC		$149,706
RECOVERY CREDITS		
	RECOVERED VOC (quantity recovered X op hrs)	$0
TOTAL ANNUAL COST (DC + IC - RC)		$187,643

SUMMARY	WLVD VP	UNCON	@6C CON
MAX POT	23.7	112.3	17.7

FOR A REDUCTION OF 6 TPY MAX POTENTIAL

COST PER TON OF REDUCTION - MAX POTENTIAL $ 31,275

:HYDRO UNIT

REFRIGERATED CONDENSERS

PURCHASED EQUIPMENT COST			
EC	CONDENSERS (8) AND AUXILLARY EQUIPMENT		$148,000
	REFRIGERATION UNIT		$65,000
1.08 EC	PURCHASED EQUIPMENT COST TOTAL ,PEC		$159,861

THE TOTAL CAPITAL INVESTMENT IS 3 - 4 TIMES THE EQUIPMENT COSTS
(3 FOR SMALLER PROJECTS WITHOUT MUCH INSTRUMENTATION)

TOTAL CAPITAL INVESTMENT (TCI)	$639,442

ANNUAL COSTS

Annual costs consist of direct and indirect annual costs minus recovery credits.

DIRECT ANNUAL COSTS, DC			
	OPERATING LABOR		
	0.5 hr/shift	$15.00	$8,213
	0.15operator		$1,232
	MAINTANENCE		
	0.5 hr/shift	$16.50	$9,034
	100% maint labor		$9,034
	UTILITIES		
	ELECTRICITY	$0.07 kW/hr	$10,424
TOTAL DIRECT ANNUAL COSTS, DC			$37,936
INDIRECT ANNUAL COSTS, IC			
	OVERHEAD (60% total labor & maint materials cost)		$16,507
0.01 TCI	PROPERTY TAX		$6,394
0.01 TCI	INSURANCE		$6,394
1.1 TCI	CRF = ADMINISTRATIVE & CAPITAL RECOVERY TAX		$703,386
	CRF = (i (1 + i)^n) / ((1 + i)^n - 1)	i = 10% n = 1 YR	
TOTAL INDIRECT ANNUAL COSTS, IC			$732,682
RECOVERY CREDITS			
	RECOVERED VOC (quantity recovered X op hrs)		$0
TOTAL ANNUAL COST (DC + IC - RC)			$770,619

SUMMARY	CURRENT	UNCON	@6C CON
MAX PTE	355	1,303	108

FOR A REDUCTION OF	247	TPY MAX POTENTIAL
COST PER TON OF REDUCTION - MAX POTENTIAL	$ 3,120	

RACT COST ANALYSIS

WW POLY

REFRIGERATED CONDENSERS

PURCHASED EQUIPMENT COST EC	CONDENSERS (4) AND AUXILLARY EQUIPMENT REFRIGERATION UNIT IS TO BE SHARED WITH WW TANKS	$74,000
1.08 EC	PURCHASED EQUIPMENT COST TOTAL ,PEC	$79,941

THE TOTAL CAPITAL INVESTMENT IS 3 - 4 TIMES THE EQUIPMENT COSTS
(3 FOR SMALLER PROJECTS WITHOUT MUCH INSTRUMENTATION)

TOTAL CAPITAL INVESTMENT (TCI)	$319,762

ANNUAL COSTS

Annual costs consist of direct and indirect annual costs minus recovery credits.

DIRECT ANNUAL COSTS, DC

	OPERATING LABOR 0.5 hr/shift 0.15operator	$15.00	$8,213 $1,232
	MAINTANENCE 0.5 hr/shift 100% maint labor	$16.50	$9,034 $9,034
	UTILITIES ELECTRICITY	$0.07 kW/hr	$10,424
TOTAL DIRECT ANNUAL COSTS, DC			$37,936

INDIRECT ANNUAL COSTS, IC

	OVERHEAD (60% total labor & maint materials cost)	$16,507
0.01 TCI	PROPERTY TAX	$3,198
0.01 TCI	INSURANCE	$3,198
0.1315 TCI	ADMINISTRATIVE & CAPITAL RECOVERY TAX	$42,049
TOTAL INDIRECT ANNUAL COSTS, IC		$64,951

RECOVERY CREDITS

RECOVERED VOC (quantity recovered X op hrs)	$0
TOTAL ANNUAL COST (DC + IC - RC)	$102,887

SUMMARY	WHVD VP	UNCON	@6C CON
MAX POT	94	706.8	60

FOR A REDUCTION OF 34 TPY MAX POTENTIAL

COST PER TON OF REDUCTION - MAX POTENTIAL	$ 3,030

HSI - SUSPENSION & SOLUTION POLY

REFRIGERATED CONDENSERS

RECEIVED
JAN 09 1996
ALL... ...LTH DEPT
... Quality
Engineering Section

PURCHASED EQUIPMENT COST			
EC	CONDENSERS (11) AND AUXILLARY EQUIPMENT		$203,500
	REFRIGERATION UNIT		$65,000
1.08 EC	PURCHASED EQUIPMENT COST TOTAL ,PEC		$219,801

THE TOTAL CAPITAL INVESTMENT IS 3 - 4 TIMES THE EQUIPMENT COSTS
(3 FOR SMALLER PROJECTS WITHOUT MUCH INSTRUMENTATION)

TOTAL CAPITAL INVESTMENT (TCI)	$879,202

ANNUAL COSTS

Annual costs consist of direct and indirect annual costs minus recovery credits.

DIRECT ANNUAL COSTS, DC

	OPERATING LABOR		
	0.5 hr/shift	$15.00	$8,213
	0.15operator		$1,232
	MAINTANENCE		
	0.5 hr/shift	$16.50	$9,034
	100% maint labor		$9,034
	UTILITIES		
	ELECTRICITY	$0.07 kW/hr	$10,424
TOTAL DIRECT ANNUAL COSTS, DC			$37,936

INDIRECT ANNUAL COSTS, IC

	OVERHEAD (60% total labor & maint materials cost)	$16,507
0.01 TCI	PROPERTY TAX	$8,792
0.01 TCI	INSURANCE	$8,792
0.1315 TCI	ADMINISTRATIVE & CAPITAL RECOVERY TAX	$115,615

THIS UNIT WILL BE SHUT DOWN AFTER THIS YEAR.

TOTAL INDIRECT ANNUAL COSTS, IC		$149,706
RECOVERY CREDITS		
	RECOVERED VOC (quantity recovered X op hrs)	$0
TOTAL ANNUAL COST (DC + IC - RC)		$187,643

SUSPENSION & SOLUTION POLY EMISSIONS SUMMARY 1994 AND MAX

SUSPENSION SUMM	ACTUAL	UNCON	@6C CON
MAX POT	2.9	23.5	0.6

USING XYLENE AS SOLVENT:

SOLUTION SUMM	ACTUAL	UNCON	@6C COND
MAX POT	5.3	27.4	1.8

FOR A REDUCTION OF 5.8 TPY MAX POTENTIAL

COST PER TON OF REDUCTION - MAX POTENTIAL	$32,352

USING TOLUENE AS SOLVENT:

SOLUTION SUMM	ACTUAL	UNCON	@6C COND
MAX POT	9.0	45.6	2.3

FOR A REDUCTION OF 9.0 TPY MAX POTENTIAL

COST PER TON OF REDUCTION - MAX POTENTIAL	$20,849

LTC3 UNIT

REFRIGERATED CONDENSERS

PURCHASED EQUIPMENT COST

EC	CONDENSERS (3) AND AUXILLARY EQUIPMENT		$92,500
	REFRIGERATION UNIT		$65,000
1.08 EC	PURCHASED EQUIPMENT COST TOTAL ,PEC		$99,921

THE TOTAL CAPITAL INVESTMENT IS 3 - 4 TIMES THE EQUIPMENT COSTS
(3 FOR SMALLER PROJECTS WITHOUT MUCH INSTRUMENTATION)

=========

TOTAL CAPITAL INVESTMENT (TCI) $399,682

=========

ANNUAL COSTS

Annual costs consist of direct and indirect annual costs minus recovery credits.

DIRECT ANNUAL COSTS, DC

	OPERATING LABOR		
	0.5 hr/shift	$15.00	$8,213
	0.15operator		$1,232
	MAINTANENCE		
	0.5 hr/shift	$16.50	$9,034
	100% maint labor		$9,034
	UTILITIES		
	ELECTRICITY	$0.07 kW/hr	$10,424
TOTAL DIRECT ANNUAL COSTS, DC			$37,936

INDIRECT ANNUAL COSTS, IC

	OVERHEAD (60% total labor & maint materials cost)	$16,507
0.01 TCI	PROPERTY TAX	$3,997
0.01 TCI	INSURANCE	$3,997
0.1315 TCI	ADMINISTRATIVE & CAPITAL RECOVERY TAX	$52,558

THIS UNIT WILL BE SHUT DOWN AFTER THIS YEAR.

TOTAL INDIRECT ANNUAL COSTS, IC $77,059

RECOVERY CREDITS

RECOVERED VOC (quantity recovered X op hrs) $0

=========

TOTAL ANNUAL COST (DC + IC - RC) $114,995

=========

LTC 3 UNIT EMISSIONS SUMMARY 1994 AND MAX

SUMMARY	WLVD VP	UNCON	@6C CON
MAX POT	24.6	122.1	3.1

FOR A REDUCTION OF 21.5 TPY MAX POTENTIAL

=========

COST PER TON OF REDUCTION - MAX POTENTIAL $5,358

=========

ECONOMIC ANALYSIS FOR THE INSTALLATION OF A REFRIGERATED CONDENSER SYSTEM ON THE PILOT PLANT:

See the economic analysis for the #3 LTC Finishing Unit. This unit would require the same controls but has a lower VOC potential to emit than the LTC Unit making this option cost prohibitive.

LTC 1 & 2

REFRIGERATED CONDENSERS

PURCHASED EQUIPMENT COST			
EC	CONDENSERS (6) AND AUXILLARY EQUIPMENT		$111,000
	REFRIGERATION UNIT		$65,000
1.08 EC	PURCHASED EQUIPMENT COST TOTAL ,PEC		$119,901

THE TOTAL CAPITAL INVESTMENT IS 3 - 4 TIMES THE EQUIPMENT COSTS
(3 FOR SMALLER PROJECTS WITHOUT MUCH INSTRUMENTATION)

TOTAL CAPITAL INVESTMENT (TCI)	$479,602

ANNUAL COSTS

Annual costs consist of direct and indirect annual costs minus recovery credits.

DIRECT ANNUAL COSTS, DC

	OPERATING LABOR		
	0.5 hr/shift	$15.00	$8,213
	0.15operator		$1,232
	MAINTANENCE		
	0.5 hr/shift	$16.50	$9,034
	100% maint labor		$9,034
	UTILITIES		
	ELECTRICITY	$0.07 kW/hr	$10,424
TOTAL DIRECT ANNUAL COSTS, DC			$37,936

INDIRECT ANNUAL COSTS, IC

	OVERHEAD (60% total labor & maint materials cost)	$16,507
0.01 TCI	PROPERTY TAX	$4,796
0.01 TCI	INSURANCE	$4,796
0.1315 TCI	ADMINISTRATIVE & CAPITAL RECOVERY TAX	$63,068
TOTAL INDIRECT ANNUAL COSTS, IC		$89,167
RECOVERY CREDITS		
	RECOVERED VOC (quantity recovered X op hrs)	$0

TOTAL ANNUAL COST (DC + IC - RC)	$127,103

LTC 1 & 2 UNIT EMISSIONS SUMMARY 1994 AND MAX

SUMMARY	WHVD VP	UNCON	@6C CON
MAX POT	54.8	476.5	25.4

FOR A REDUCTION OF 29.4 TPY MAX POTENTIAL

COST PER TON OF REDUCTION - MAX POTENTIAL	$4,330

C-POLY UNIT

REFRIGERATED CONDENSERS

PURCHASED EQUIPMENT COST			
EC	CONDENSERS (3) AND AUXILLARY EQUIPMENT		$55,500
	REFRIGERATION UNIT		$65,000
1.08 EC	PURCHASED EQUIPMENT COST TOTAL ,PEC		$130,140

THE TOTAL CAPITAL INVESTMENT IS 3 - 4 TIMES THE EQUIPMENT COSTS
(3 FOR SMALLER PROJECTS WITHOUT MUCH INSTRUMENTATION)

TOTAL CAPITAL INVESTMENT (TCI)	$520,560

ANNUAL COSTS

Annual costs consist of direct and indirect annual costs minus recovery credits.

DIRECT ANNUAL COSTS, DC			
	OPERATING LABOR		
	0.5 hr/shift	$15.00	$8,213
	0.15operator		$1,232
	MAINTANENCE		
	0.5 hr/shift	$16.50	$9,034
	100% maint labor		$9,034
	UTILITIES		
	ELECTRICITY	$0.07 kW/hr	$10,424
TOTAL DIRECT ANNUAL COSTS, DC			$37,936
INDIRECT ANNUAL COSTS, IC			
	OVERHEAD (60% total labor & maint materials cost)		$16,507
0.01 TCI	PROPERTY TAX		$5,206
0.01 TCI	INSURANCE		$5,206
0.131474 TCI	CRF = ADMINISTRATIVE & CAPITAL RECOVERY TAX		$68,440
	CRF = (i (1 + i)^n) / ((1 + i)^n - 1) i = 10% n = 15 YRS		
TOTAL INDIRECT ANNUAL COSTS, IC			$95,358
RECOVERY CREDITS			
	RECOVERED VOC (quantity recovered X op hrs)		$0
TOTAL ANNUAL COST (DC + IC - RC)			$133,295

C POLY EMISSIONS SUMMARY 1994 AND MAX

SUMMARY	WLVD VP	UNCON	@6C CON
ACTUAL	1.4	3.9	0.2
MAX POT	32.8	98.2	8.0

FOR A REDUCTION OF 1.2 TPY
24.8 TPY MAX POTENTIAL

COST PER TON OF REDUCTION	$111,079
COST PER TON OF REDUCTION - MAX POTENTIAL	$5,375

C-5 UNIT

THERMAL OXIDIZER

DIRECT COSTS			DOLLARS
PURCHASED EQUIPMENT COSTS			
EC	EQUIPMENT COSTS - THERMAL OXIDIZER (3)		$145,000
	AUXILLARY - DUCTWORK		$100,000
A	SUM		$245,000
0.03A	SALES TAX		$7,350
0.05A	FREIGHT		$12,250
B	PURCHASED EQUIPMENT COSTS TOTAL		$264,600

THE TOTAL CAPITAL INVESTMENT IS 3 - 4 TIMES THE EQUIPMENT COSTS
(3 FOR SMALLER PROJECTS WITHOUT MUCH INSTRUMENTATION)

TOTAL CAPITAL INVESTMENT (TCI)	$1,058,400

ANNUAL COSTS

DIRECT ANNUAL COSTS DC		RATE/HR	
OPERATING LABOR			
0.5 hr/shift	OPERATOR	$15.00	$8,213
0.15operator	SUPERVISOR		$1,232
MAINTANENCE			
0.5 hr/shift	LABOR	$16.50	$9,034
100% maint labor	MATERIAL		$9,034
UTILITIES			
	NATURAL GAS	$6.00 MMbtu/hr	$319,160
	ELECTRICITY	$0.07 kW/hr	$10,424
	TOTAL DIRECT COSTS		$357,096
INDIRECT ANNUAL COSTS IC			
60% op,super,maint labor & maint matls	OVERHEAD		$16,507
2% TCI	ADMINISTRATIVE CHARGES		$21,168
1% TCI	PROPERTY TAXES		$10,584
1% TCI	INSURANCE		$10,584
0.1628 TCI	CAPITAL RECOVERY (10 YEAR LIFE & 10% INTEREST)		$172,308
	TOTAL INDIRECT COSTS		$231,151

TOTAL ANNUAL COSTS	$588,247

C-5 UNIT EMISSIONS = 62.1 TPY

100% of the VOC point sources goes to the Thermal oxidizer

TO THERMAL OXIDIZER = 62.1 TPY

AT 99% DESTRUCTION, THE EMISSIONS WOULD BE = 0.66 TPY

FOR A REDUCTION OF 56.1 TPY

COST PER TON OF REDUCTION	$ 10,485

WWTP

COVER THE 2 SUMPS AND THE DAF TANK AND CALCULATE THE EMISSIONS AS A FIXED ROOF TANK USING AP-42 FORTH EDITION 10/92

ADD REFRIGFERATION UNIT, BLOWER,
AND COVERS TO ACID & FINAL SUMP

		CURRENT	AFTER 6C COND
701 A & B		5655	2405
RAW SUMP		3246	1365
ACID & FINAL SUMP		3248	26
DAF TANK		15198	247
BIO AERATION TANK		286	286
PRIMARY CLARIFIER		5	5
SECONDARY CLARIFIER		33	33
702 A & B & C		20654	20654
TOTAL		**48325**	**25021**
	TPY	**24.2**	**12.5**
REDUCTION			**11.7 TPY**

PURCHASED EQUIPMENT COST			
EC	3 TANK ROOFS		$60,000
	REFRIGERATION UNIT		$65,000
1.08 EC		PURCHASED EQUIPMENT COST TOTAL ,PEC	$135,000
TOTAL CAPITAL INVESTMENT (TCI)			$540,000

ANNUAL COSTS

Annual costs consist of direct and indirect annual costs minus recovery credits.

DIRECT ANNUAL COSTS, DC

	OPERATING LABOR		
	0.5 hr/shift	$15.00	$8,213
	0.15operator		$1,232
	MAINTANENCE		
	0.5 hr/shift	$16.50	$9,034
	100% maint labor		$9,034
	UTILITIES		
	ELECTRICITY	$0.07 kW/hr	$10,424
TOTAL DIRECT ANNUAL COSTS, DC			$37,936

INDIRECT ANNUAL COSTS, IC

	OVERHEAD (60% total labor & maint materials cost)	$16,507
0.01 TCI	PROPERTY TAX	$5,400
0.01 TCI	INSURANCE	$5,400
0.1315 TCI	ADMINISTRATIVE & CAPITAL RECOVERY TAX	$71,010
TOTAL INDIRECT ANNUAL COSTS, IC		$98,317
RECOVERY CREDITS		
	RECOVERED VOC (quantity recovered X op hrs)	$0
TOTAL ANNUAL COST (DC + IC - RC)		$136,253
COST PER TON OF REDUCTION		$10,891

WHOLE FACILITY - THERMAL INCINERATOR

(Total flowrate > 50,000 scfm)

COST BASE DATE: April 1988 [1]

VAPCCI (Third Quarter 1995): [2] 107

INPUT PARAMETERS

-- Total gas flowrate (scfm):	100000
-- Flowrate per unit (scfm):	50000
-- Flowrate/unit, 2nd iter. (scfm):	50000
-- Number of units:	2
-- Reference temperature (oF):	77
-- Inlet gas temperature (oF):	77
-- Inlet gas density (lb/scf):	0.0739
-- Primary heat recovery (fraction):	0.35
-- Waste gas heat content (BTU/scf):	4
-- Waste gas heat content (BTU/lb):	56.56
-- Gas heat capacity (BTU/lb-oF):	0.255
-- Combustion temperature (oF):	1600
-- Preheat temperature (oF):	610
-- Fuel heat of combustion (BTU/lb):	21502
-- Fuel density (lb/ft3):	0.0408

DESIGN PARAMETERS

-- Auxiliary Fuel Reqrmnt (lb/min):		82.466
	(scfm):	2021.2
-- Total Gas Flowrate (scfm):		102021

CAPITAL COSTS

Equipment Costs ($):		
-- Incinerator:		
	@ 0 % heat recovery:	0
	@ 35 % heat recovery:	442,470
	@ 50 % heat recovery:	0
	@ 70 % heat recovery:	0
-- Other (auxiliary equipment, etc.):		1000000
Total Equipment Cost--base:		1,442,470
' ' ' --escalated:		1,923,306
Purchased Equipment Cost ($):		2,269,501
Total Capital Investment ($):		3,653,897

ANNUAL COST INPUTS

Operating factor (hr/yr):	8760
Operating labor rate ($/hr):	13
Maintenance labor rate ($/hr):	14.26
Operating labor factor (hr/sh):	1
Maintenance labor factor (hr/sh):	1
Electricity price ($/kwh):	0
Natural gas price ($/mscf):	3
Annual interest rate (fraction):	0
Control system life (years):	10
Capital recovery factor:	0.1424
Taxes, insurance, admin. factor:	0
Pressure drop (in. w.c.):	8.0

ANNUAL COSTS

Item	Cost ($/yr)	
Operating labor	7,096	
Supervisory labor	1,064	
Maintenance labor	7,805	
Maintenance materials	7,805	
Natural gas	3,505,762	
Electricity	82,261	
Overhead	14,262	
Taxes, insurance, administrative	146,156	
Capital recovery	520,233	
Total Annual Cost	4,292,444	= $7,150/TON VOC REMOVED @ AN ASSUMED MAXIMUM POTENTIAL TREATMENT OF 75% OF ALL PROCESS EMISSIONS = 600 TPY

NOTES:
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[1] Original equipment costs reflect this date.

[2] VAPCCI = Vatavuk Air Pollution Control Cost Index (for thermal incinerators) corresponding to year and quarter shown. Original equipment cost, purchased equipment cost, and total capital investment have been escalated to this date via the VAPCCI and control equipment vendor data.

COST ANALYSIS FOR VOC CONTROLS FOR THE BOILER HOUSE:

Assumptions:

1. Capital investment = $0.0
2. Utility costs = $0.0
3. Process costs = $0.0
4. Labor & maint. costs = $24/Hr.
5. Operating hours = 8,760/Yr.

Using cost factors from U.S. EPA's OAQPS cost manual, the following is a cost analysis based on labor and maintenance costs only:

Direct annual costs	
Operating labor	$13,140
Supervisor	$1,971
Maintenance labor	$14,454
Material	$14,454
Consumables replacement	$0.0
Utilities	$0.0
Waste disposal	$0.0
Indirect annual costs	
Overhead	$26,411
Administration	$0.0
Property taxes/insurance	$0.0
Capital recovery	$0.0
Total annual costs =	$70,430

VOC emissions reduction @ 100% control = 5 TPY
Cost effectiveness = $14,086/ton VOC removed

APPENDIX D

PRE AND POST CONTROL INSTALLATION SUMMARY

VOC PROPOSED POTENTIAL TO EMIT AND CONTROL EFFICIENCY:

PROCESS - HYDROGENATION

EMISSION UNIT	EXISTING CONTROL DEVICE	UNCONTROLLED PTE TPY	CONTROLLED PTE TPY	PROPOSED REDUCTION TPY	PERCENT VOC CONTROL
1 TANKS T-100 & T- 101	CONDENSER @ 6 C	12.93	2.3	10.6	82.21%
2 TANK T-106	CONDENSER @ 6 C	0.80	0.2	0.6	75.00%
3 METERING TNK	CONDENSER @ 6 C	48.86	1.59	47.3	96.75%
4 FILTER BLOW #1	CONDENSER @ 6 C	67.66	1.770	65.9	97.38%
5 FILTER BLOW #2	CONDENSER @ 6 C	157.29	4.12	153.2	97.38%
6 AUTOCLAVES 1 & 2 AND TNK - 303	CONDENSER @ 6 C	508.91	61.47	447.4	87.92%
7 OB TANK	UNCRONTROLLED	1.20	1.2	0.0	0.00%
8 TNK T- 501	CONDENSER @ 6 C	110.43	1.63	108.8	98.52%
9 AUTOCLAVE BLOWOUT	UNCRONTROLLED	324.05	6.17	317.9	98.10%
11 TNKS T-102 & T-105	CONDENSER @ 6 C	70.16	1.83	68.3	97.39%
12 SWEETLAND BLOWOUT	CONDENSER @ 6 C	4.00	1.43	2.6	64.25%
13 CATALYST TANK	UNCRONTROLLED	1.04	1.04	0.0	0.00%
14 PRECOAT TANK	UNCRONTROLLED	0.03	0.03	0.0	0.00%
	PROCESS TOTAL =	1307.36	84.78	1222.6	93.52%

PROCESS - WATER WHITE POLY

EMISSION UNIT	EXISTING CONTROL DEVICE	UNCONTROLLED PTE TPY	CONTROLLED PTE TPY	PROPOSED REDUCTION TPY	PERCENT VOC CONTROL
1 FEED DRYERS	CONDENSER @ 6 C	403.97	13.69	390.3	96.61%
2 REACTORS	CONDENSER @ 6 C	225.42	15.38	210.0	93.18%
3 BLEND TANKS	UNCONTROLLED	14.26	14.26	0.0	0.00%
4 SLURRY TNK	UNCONTROLLED	0.71	0.71	0.0	0.00%
5 RECLAIMER	CONDENSER @ AMBIENT	2.61	1.37	1.2	47.51%
6 RECLAIMER STORAGE TNK	UNCONTROLLED	2.49	2.49	0.0	0.00%
7 NEUTRALIZER	CONDENSER @ 6 C	19.26	3.00	16.3	84.40%
8 NEUTRALIZER EXHAUST	UNCONTROLLED	1.31	1.31	0.0	0.00%
9 FILTRATE RECIEVER	CONDENSER @ 6 C	27.67	3.33	24.3	87.95%
10 FUNDA FILTER	UNCONTROLLED	5.25	5.25	0.0	0.00%
11 AUX RECIEVER	UNCONTROLLED	3.86	3.86	0.0	0.00%
	PROCESS TOTAL =	706.81	64.66	642.2	90.85%

TOTAL AFTER PROPOSED CONTROLS FOR HDROGENATION AND WATER WHITE POLY	=	2014.17	149.44	1864.74	92.58%
TOTAL WITH EXISTING CONTROLS FOR HDROGENATION AND WATER WHITE POLY	=	2009.80	451.42	1558.38	77.54%
TOTAL WITH EXISTING CONTROL FOR ALL PROCESSES	=	4408.37	793.74	3614.63	81.99%
TOTAL AFTER PROPOSED CONTROLS FOR ALL PROCESSES	=	4412.74	491.76	3920.98	88.86%

AIR QUALITY PROGRAM
301 39th Street, Bldg. #7
Pittsburgh, PA 15201-1811

Major Source
INSTALLATION PERMIT

Issued To:	**Eastman Chemical Resins, Inc.** **Jefferson Site** 2200 State Highway 837 West Elizabeth, PA 15088-0545	**ACHD Permit#:**	**0058-I026**
		Date of Issuance:	April 21, 2020
		Expiration Date:	(See Section III.12)

Issued By: Digitally signed by JoAnn Truchan, PE Date: 2020.04.22 09:09:00 -04'00'
JoAnn Truchan, P.E.
Section Chief, Engineering

Prepared By: Digitally signed by Helen Gurvich Date: 2020.04.22 08:54:50 -04'00'
Helen O. Gurvich
Air Quality Engineer

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TABLE OF CONTENTS

AMENDMENTS:

DATE	***SECTION(S)***

I. CONTACT INFORMATION

Facility Location:	**Eastman Chemical Resins, Inc.** **Jefferson Site** 2200 State Highway 837 West Elizabeth, PA 15088-0545
Permittee/Owner:	**Eastman Chemical Resins, Inc.** **Jefferson Site** 2200 State Highway 837 West Elizabeth, PA 15088-0545
Responsible Official:	**Eugene M. Ingram**
Title:	Jefferson Site Manager
Company:	**Eastman Chemical Resins, Inc.** **Jefferson Site**
Address:	2200 State Highway 837 P.O. Box 545 West Elizabeth, PA 15088-0545
Telephone Number:	412-384-2520
Fax Number:	412-384-7311
Facility Contact:	**Janice Kane**
Title:	Senior Environmental Coordinator
Telephone Number:	412-384-2520, ext. 2243
Fax Number:	412-384-7311
E-mail Address:	**jsnyderkane@eastman.com**

AGENCY ADDRESSES:

ACHD Contact:	**Chief Engineer** **Allegheny County Health Department** Air Quality Program 301 39th Street, Building #7 Pittsburgh, PA 15201-1811 aqpermits@alleghenycounty.us
EPA Contact:	**Enforcement Programs Section (3AP12)** **USEPA Region III** 1650 Arch Street Philadelphia, PA 19103-2029

II. FACILITY DESCRIPTION

FACILITY DESCRIPTION

The Eastman Chemical Resins, Inc., Jefferson Site facility (Eastman) produces synthetic hydrocarbon resins from C5 feedstock, monomers, solvents and catalysts by way of cationic polymerization. Resins produced include aliphatic, aliphatic/aromatic, aromatic and liquid resins for use in adhesives, plastics, rubber, graphic arts and numerous other products. The plant is comprised of three polymerization processes (C5, MP-Poly, and WW-Poly), a resin hydrogenation process, four finishing processes (LTC1, LTC2, and C-5), and an emulsion process, five boilers ranging from 18.6 MM Btu/hr to 38.2 MM Btu/hr, a wastewater treatment plant, a pilot plant for testing formulations and processes and approximately 200 storage tanks of various sizes.

The facility is a major source of volatile organic compounds (VOCs) and Hazardous Air Pollutants (HAPs); and a minor source of particulate matter (PM), particulate matter <10 µm in diameter (PM_{10}), particulate matter <2.5 µm in diameter ($PM_{2.5}$), nitrogen oxides (NO_X), sulfur oxides (SO_X), as defined in §2102.20 of Article XXI. The facility is also a minor source of greenhouse gas emissions (CO_2e) as defined in the U.S. EPA Greenhouse Gas Tailoring Rule.

INSTALLATION DESCRIPTION

This permit is an installation addressing the requirements for case-by-case Reasonably Achievable Control Technology (2008 Ozone RACT, or RACT II) for incorporation into the Pennsylvania State Implementation Plan.

DECLARATION OF POLICY

Pollution prevention is recognized as the preferred strategy (over pollution control) for reducing risk to air resources. Accordingly, pollution prevention measures should be integrated into air pollution control programs wherever possible, and the adoption by sources of cost-effective compliance strategies, incorporating pollution prevention, is encouraged. The Department will give expedited consideration to any permit modification request based on pollution prevention principles.

The permittee is subject to the terms and conditions set forth below. These terms and conditions constitute provisions of *Allegheny County Health Department Rules and Regulations, Article XXI Air Pollution Control*. The subject equipment has been conditionally approved for operation. The equipment shall be operated in conformity with the plans, specifications, conditions, and instructions which are part of your application, and may be periodically inspected for compliance by the Department. In the event that the terms and conditions of this permit or the applicable provisions of Article XXI conflict with the application for this permit, these terms and conditions and the applicable provisions of Article XXI shall prevail. Additionally, nothing in this permit relieves the permittee from the obligation to comply with all applicable Federal, State and Local laws and regulations.

III. GENERAL CONDITIONS

1. Prohibition of Air Pollution (§2101.11)

It shall be a violation of this permit to fail to comply with, or to cause or assist in the violation of, any requirement of this permit, or any order or permit issued pursuant to authority granted by Article XXI. The permittee shall not willfully, negligently, or through the failure to provide and operate necessary control equipment or to take necessary precautions, operate any source of air contaminants in such manner that emissions from such source:

a. Exceed the amounts permitted by this permit or by any order or permit issued pursuant to Article XXI;
b. Cause an exceedance of the ambient air quality standards established by Article XXI §2101.10; or
c. May reasonably be anticipated to endanger the public health, safety, or welfare.

2. Nuisances (§2101.13)

Any violation of any requirement of this Permit shall constitute a nuisance.

3. Definitions (§2101.20)

a. Except as specifically provided in this permit, terms used retain the meaning accorded them under the applicable provisions and requirements of Article XXI or the applicable federal or state regulation. Whenever used in this permit, or in any action taken pursuant to this permit, the words and phrases shall have the meanings stated, unless the context clearly indicates otherwise.

b. Unless specified otherwise in this permit or in the applicable regulation, the term "*year*" shall mean any twelve (12) consecutive months.

4. Certification (§2102.01)

Any report or compliance certification submitted under this permit shall contain written certification by a responsible official as to truth, accuracy, and completeness. This certification and any other certification required under this permit shall be signed by a responsible official of the source, and shall state that, based on information and belief formed after reasonable inquiry, the statements and information in the document are true, accurate, and complete.

5. Operation and Maintenance (§2105.03)

All air pollution control equipment required by this permit or Article XXI, and all equivalent compliance techniques that have been approved by the Department, shall be properly installed, maintained, and operated consistent with good air pollution control practice.

6. Conditions (§2102.03.c)

It shall be a violation of this permit giving rise to the remedies provided by Article XXI §2109.02, for any person to fail to comply with any terms or conditions set forth in this permit.

7. Transfers (§2102.03.e)

This permit shall not be transferable from one person to another, except in accordance with Article XXI §2102.03.e and in cases of change-in-ownership which are documented to the satisfaction of the Department, and shall be valid only for the specific sources and equipment for which this permit was issued. The transfer of permits in the case of change-in-ownership may be made consistent with the administrative permit amendment procedure of Article XXI §2103.14.b.

8. Effect (§2102.03.g)

Issuance of this permit shall not in any manner relieve any person of the duty to fully comply with the requirements of Article XXI or any other provision of law, nor shall it in any manner preclude or affect the right of the Department to initiate any enforcement action whatsoever for violations of Article XXI or this Permit, whether occurring before or after the issuance of such permit. Further, the issuance of this permit shall not be a defense to any nuisance action, nor shall such permit be construed as a certificate of compliance with the requirements of Article XXI or this Permit.

9. General Requirements (§2102.04.a)

It shall be a violation of this Permit giving rise to the remedies set forth in Article XXI §2109 for any person to install, modify, replace, reconstruct, or reactivate any source or air pollution control equipment to which this Permit applies unless either:

a. The Department has first issued an Installation Permit for such source or equipment; or

b. Such action is solely a reactivation of a source with a current Operating Permit, which is approved under §2103.13 of Article XXI.

10. Conditions (§2102.04.e)

Further, the initiation of installation, modification, replacement, reconstruction, or reactivation under this

Installation Permit and any reactivation plan shall be deemed acceptance by the source of all terms and conditions specified by the Department in this permit and plan.

11. Revocation (§2102.04.f)

a. The Department may, at any time, revoke this Installation Permit if it finds that:
1) Any statement made in the permit application is not true, or that material information has not been disclosed in the application;
2) The source is not being installed, modified, replaced, reconstructed, or reactivated in the manner indicated by this permit or applicable reactivation plan;
3) Air contaminants will not be controlled to the degree indicated by this permit;
4) Any term or condition of this permit has not been complied with;
5) The Department has been denied lawful access to the premises or records, charts, instruments and the like as authorized by this Permit; or

b. Prior to the date on which construction of the proposed source has commenced the Department may, revoke this Installation Permit if a significantly better air pollution control technology has become available for such source, a more stringent regulation applicable to such source has been adopted, or any other change has occurred which requires a more stringent degree of control of air contaminants.

12. Term (§2102.04.g)

This Installation Permit shall expire in 18 months if construction has not commenced within such period or shall expire 18 months after such construction has been suspended, if construction is not resumed within such period. In any event, this Installation Permit shall expire upon completion of construction, except that this Installation Permit shall authorize temporary operation to facilitate shakedown of sources and air cleaning devices, to permit operations pending issuance of a related subsequent Operating Permit, or to permit the evaluation of the air contamination aspects of the source. Such temporary operation period shall be valid for a limited time, not to exceed 180 days, but may be extended for additional limited periods, each not to exceed 120 days, except that no temporary operation shall be authorized or extended which may circumvent the requirements of this Permit.

13. Annual Installation Permit Administrative Fee (§2102.10.c & e)

No later than 30 days after the date of issuance of this Installation Permit and on or before the last day of the month in which this permit was issued in each year thereafter, during the term of this permit until a subsequent corresponding Operating Permit or amended Operating Permit is properly applied for, the owner or operator of such source shall pay to the Department, in addition to all other applicable emission and administration fees, an Annual Installation Permit Administration Fee in an amount of $750.

14. Severability Requirement (§2103.12.l)

The provisions of this permit are severable, and if any provision of this permit is determined to by a court of competent jurisdiction to be invalid or unenforceable, such a determination will not affect the remaining provisions of this permit.

15. Reporting Requirements (§2103.12.k)

a. The permittee shall submit reports of any required monitoring at least every six (6) months. All instances of deviations from permit requirements must be clearly identified in such reports. All required reports must be certified by the Responsible Official.

b. Prompt reporting of deviations from permit requirements is required, including those attributable to upset conditions as defined in this permit and Article XXI §2108.01.c, the probable cause of such deviations, and any corrective actions or preventive measures taken.

c. All reports submitted to the Department shall comply with the certification requirements of General Condition III.4 above.

d. Semiannual reports required by this permit shall be submitted to the Department as follows:
   1) One semiannual report is due by July 31 of each year for the time period beginning January 1 and ending June 30.
   2) One semiannual report is due by February 1 of each year for the time period beginning July 1 and ending December 31.
   3) The first semiannual report shall be due July 31, 2020 for the time period beginning on the issuance date of this permit through June 30, 2020.

e. Reports may be emailed to the Department at aqreports@alleghenycounty.us in lieu of mailing a hard copy.

16. Minor Installation Permit Modifications (§2102.10.d)

Modifications to this Installation Permit may be applied for but only upon submission of an application with a fee in the amount of $300 and where:

a. No reassessment of any control technology determination is required; and
b. No reassessment of any ambient air quality impact is required.

17. Violations (§2104.06)

The violation of any emission standard established by this Permit shall be a violation of this Permit giving rise to the remedies provided by Article §2109.02.

18. Other Requirements Not Affected (§2105.02)

Compliance with the requirements of this permit shall not in any manner relieve any person from the duty to fully comply with any other applicable federal, state, or county statute, rule, regulation, or the like, including, but not limited to, any applicable NSPSs, NESHAPs, MACTs, or Generally Achievable Control Technology standards now or hereafter established by the EPA, and any applicable requirement of BACT or LAER as provided by Article XXI, any condition contained in this Installation Permit and/or any additional or more stringent requirements contained in an order issued to such person pursuant to Part I of Article XXI.

19. Other Rights and Remedies Preserved (§2109.02.b)

Nothing in this permit shall be construed as impairing any right or remedy now existing or hereafter created in equity, common law or statutory law with respect to air pollution, nor shall any court be deprived of such jurisdiction for the reason that such air pollution constitutes a violation of this permit

20. Penalties, Fines, and Interest (§2109.07.a)

A source that fails to pay any fee required under this Permit or article XXI when due shall pay a civil penalty of 50% of the fee amount, plus interest on the fee amount computed in accordance with of Article XXI §2109.06.a.4 from the date the fee was required to be paid. In addition, the source may have its permit revoked.

21. Appeals (§2109.10)

In accordance with State Law and County regulations and ordinances, any person aggrieved by an order or other final action of the Department issued pursuant to Article XXI shall have the right to appeal the action to the Director in accordance with the applicable County regulations and ordinances.

IV. SITE LEVEL TERMS AND CONDITIONS

1. Reporting of Upset Conditions (§2103.12.k.2)

The permittee shall promptly report all deviations from permit requirements, including those attributable to upset conditions as defined in Article XXI §2108.01.c, the probable cause of such deviations, and any corrective actions or preventive measures taken.

2. Visible Emissions (§2104.01.a)

Except as provided for by Article XXI §2108.01.d pertaining to a cold start, no person shall operate, or allow to be operated, any source in such manner that the opacity of visible emissions from a flue or process fugitive emissions from such source, excluding uncombined water:

a. Equal or exceed an opacity of 20% for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or,
b. Equal or exceed an opacity of 60% at any time.

3. Odor Emissions (§2104.04) (County-only enforceable)

No person shall operate, or allow to be operated, any source in such manner that emissions of malodorous matter from such source are perceptible beyond the property line.

4. Materials Handling (§2104.05)

The permittee shall not conduct, or allow to be conducted, any materials handling operation in such manner that emissions from such operation are visible at or beyond the property line.

5. Operation and Maintenance (§2105.03)

All air pollution control equipment required by this permit or any order under Article XXI, and all equivalent compliance techniques approved by the Department, shall be properly installed, maintained, and operated consistently with good air pollution control practice.

6. Open Burning (§2105.50)

No person shall conduct, or allow to be conducted, the open burning of any material, except where the Department has issued an Open Burning Permit to such person in accordance with Article XXI §2105.50 or where the open burning is conducted solely for the purpose of non-commercial preparation of food for human consumption, recreation, light, ornament, or provision of warmth for outside workers, and in a manner which contributes a negligible amount of air contaminants.

7. Shutdown of Control Equipment (§2108.01.b)

a. In the event any air pollution control equipment is shut down for reasons other than a breakdown, the person responsible for such equipment shall report, in writing, to the Department the intent to shut down such equipment at least 24 hours prior to the planned shutdown. Notwithstanding the submission of such report, the equipment shall not be shut down until the approval of the Department is obtained; provided, however, that no such report shall be required if the source(s)

served by such air pollution control equipment is also shut down at all times that such equipment is shut down.

b. The Department shall act on all requested shutdowns as promptly as possible. If the Department does not take action on such requests within ten (10) calendar days of receipt of the notice, the request shall be deemed denied, and upon request, the owner or operator of the affected source shall have a right to appeal in accordance with the provisions of Article XI.

c. The prior report required by Site Level Condition IV.7.a above shall include:

1) Identification of the specific equipment to be shut down, its location and permit number (if permitted), together with an identification of the source(s) affected;
2) The reasons for the shutdown;
3) The expected length of time that the equipment will be out of service;
4) Identification of the nature and quantity of emissions likely to occur during the shutdown;
5) Measures, including extra labor and equipment, which will be taken to minimize the length of the shutdown, the amount of air contaminants emitted, or the ambient effects of the emissions;
6) Measures which will be taken to shut down or curtail the affected source(s) or the reasons why it is impossible or impracticable to shut down or curtail the affected source(s) during the shutdown; and
7) Such other information as may be required by the Department.

d. Shutdown reports may be emailed to the Department at aqreports@alleghenycounty.us in lieu of mailing a hard copy.

8. Breakdowns (§2108.01.c)

a. In the event that any air pollution control equipment, process equipment, or other source of air contaminants breaks down in such manner as to have a substantial likelihood of causing the emission of air contaminants in violation of this permit, or of causing the emission into the open air of potentially toxic or hazardous materials, the person responsible for such equipment or source shall immediately, but in no event later than sixty (60) minutes after the commencement of the breakdown, notify the Department of such breakdown and shall, as expeditiously as possible but in no event later than seven (7) days after the original notification, provide written notice to the Department.

b. To the maximum extent possible, all oral and written notices required shall include all pertinent facts, including:

1) Identification of the specific equipment which has broken down, its location and permit number (if permitted), together with an identification of all related devices, equipment, and other sources which will be affected.
2) The nature and probable cause of the breakdown.
3) The expected length of time that the equipment will be inoperable or that the emissions will continue.
4) Identification of the specific material(s) which are being, or are likely to be emitted, together with a statement concerning its toxic qualities, including its qualities as an irritant, and its potential for causing illness, disability, or mortality.
5) The estimated quantity of each material being or likely to be emitted.

6) Measures, including extra labor and equipment, taken or to be taken to minimize the length of the breakdown, the amount of air contaminants emitted, or the ambient effects of the emissions, together with an implementation schedule.
7) Measures being taken to shut down or curtail the affected source(s) or the reasons why it is impossible or impractical to shut down the source(s), or any part thereof, during the breakdown.

c. Notices required shall be updated, in writing, as needed to advise the Department of changes in the information contained therein. In addition, any changes concerning potentially toxic or hazardous emissions shall be reported immediately. All additional information requested by the Department shall be submitted as expeditiously as practicable.

d. Unless otherwise directed by the Department, the Department shall be notified whenever the condition causing the breakdown is corrected or the equipment or other source is placed back in operation by no later than 9:00 AM on the next County business day. Within seven (7) days thereafter, written notice shall be submitted pursuant to Paragraphs a and b above.

e. Breakdown reporting shall not apply to breakdowns of air pollution control equipment which occur during the initial startup of said equipment, provided that emissions resulting from the breakdown are of the same nature and quantity as the emissions occurring prior to startup of the air pollution control equipment.

f. In no case shall the reporting of a breakdown prevent prosecution for any violation of this permit or Article XXI.

g. Breakdown reports may be emailed to the Department at aqreports@alleghenycounty.us in lieu of mailing a hard copy.

9. Cold Start (§2108.01.d)

In the event of a cold start on any fuel-burning or combustion equipment, except stationary internal combustion engines and combustion turbines used by utilities to meet peak load demands, the person responsible for such equipment shall report in writing to the Department the intent to perform such cold start at least 24 hours prior to the planned cold start. Such report shall identify the equipment and fuel(s) involved and shall include the expected time and duration of the startup. Upon written application from the person responsible for fuel-burning or combustion equipment which is routinely used to meet peak load demands and which is shown by experience not to be excessively emissive during a cold start, the Department may waive these requirements and may instead require periodic reports listing all cold starts which occurred during the report period. The Department shall make such waiver in writing, specifying such terms and conditions as are appropriate to achieve the purposes of Article XXI. Such waiver may be terminated by the Department at any time by written notice to the applicant. Cold start notifications may be emailed to the Department at aqreports@alleghenycounty.us.

10. Monitoring of Malodorous Matter Beyond Facility Boundaries (§2104.04)

The permittee shall take all reasonable action as may be necessary to prevent malodorous matter from becoming perceptible beyond facility boundaries. Further, the permittee shall perform such observations as may be deemed necessary along facility boundaries to insure that malodorous matter beyond the facility boundary in accordance with Article XXI §2107.13 is not perceptible and record all findings and corrective action measures taken.

11. Emissions Inventory Statements (§2108.01.e & g)

a. Emissions inventory statements in accordance with §2108.01.e shall be submitted to the Department by March 15 of each year for the preceding calendar year. The Department may require more frequent submittals if the Department determines that more frequent submissions are required by the EPA or that analysis of the data on a more frequent basis is necessary to implement the requirements of Article XXI or the Clean Air Act.

b. The failure to submit any report or update within the time specified, the knowing submission of false information, or the willful failure to submit a complete report shall be a violation of this permit giving rise to the remedies provided by Article XXI §2109.02.

12. Orders (§2108.01.f)

In addition to meeting the requirements Site Level Conditions IV.7 through IV.11, inclusive, the person responsible for any source shall, upon order by the Department, report to the Department such information as the Department may require in order to assess the actual and potential contribution of the source to air quality. The order shall specify a reasonable time in which to make such a report.

13. Violations (§2108.01.g)

The failure to submit any report or update thereof required by Site Level Conditions IV.7 through IV.12 above, inclusive, within the time specified, the knowing submission of false information, or the willful failure to submit a complete report shall be a violation of this permit giving rise to the remedies provided by Article XXI §2109.02.

14. Emissions Testing (§2108.02)

a. **Orders:** No later than 60 days after achieving full production or 120 days after startup, whichever is earlier, the permittee shall conduct, or cause to be conducted, such emissions tests as are specified by the Department to demonstrate compliance with the applicable requirements of this permit and shall submit the results of such tests to the Department in writing. Upon written application setting forth all information necessary to evaluate the application, the Department may, for good cause shown, extend the time for conducting such tests beyond 120 days after startup but shall not extend the time beyond 60 days after achieving full production. Emissions testing shall comply with all applicable requirements of Article XXI, §2108.02.e.

b. **Tests by the Department:** Notwithstanding any tests conducted pursuant to this permit, the Department or another entity designated by the Department may conduct emissions testing on any source or air pollution control equipment. At the request of the Department, the permittee shall provide adequate sampling ports, safe sampling platforms and adequate utilities for the performance of such tests.

c. **Testing Requirements:** No later than 45 days prior to conducting any tests required by this permit, the person responsible for the affected source shall submit for the Department's approval a written test protocol explaining the intended testing plan, including any deviations from standard testing procedures, the proposed operating conditions of the source during the test, calibration data for specific test equipment and a demonstration that the tests will be conducted under the direct supervision of persons qualified by training and experience satisfactory to the Department to conduct such tests. In addition, at least 30 days prior to conducting such tests, the person responsible shall notify the Department in writing of the time(s) and date(s) on which the tests will be conducted and shall allow Department personnel to observe such tests, record data, provide pre-weighed filters, analyze samples in a County laboratory and to take samples for independent analysis. Test results shall be comprehensively and accurately reported in the units of measurement specified by the applicable emission limitations of this permit.

d. Test methods and procedures shall conform to the applicable reference method set forth in this permit or Article XXI Part G, or where those methods are not applicable, to an alternative sampling and testing procedure approved by the Department consistent with Article XXI §2108.02.e.2.

e. **Violations:** The failure to perform tests as required by this permit or an order of the Department, the failure to submit test results within the time specified, the knowing submission of false information, the willful failure to submit complete results, or the refusal to allow the Department, upon presentation of a search warrant, to conduct tests, shall be a violation of this permit giving rise to the remedies provided by Article XXI §2109.02.

15. Abrasive Blasting (§2105.51)

a. Except where such blasting is a part of a process requiring an operating permit , no person shall conduct or allow to be conducted, abrasive blasting or power tool cleaning of any surface, structure, or part thereof, which has a total area greater than 1,000 square feet unless such abrasive blasting complies with all applicable requirements of Article XXI §2105.51.

b. In addition to complying with all applicable provisions of §2105.51, no person shall conduct, or allow to be conducted, abrasive blasting of any surface unless such abrasive blasting also complies with all other applicable requirements of Article XXI unless such requirements are specifically addressed by §2105.51.

16. Asbestos Abatement (§2105.62, §2105.63)

In the event of removal, encasement, or encapsulation of Asbestos-Containing Material (ACM) at a facility or in the event of the demolition of any facility, the permittee shall comply with all applicable provisions of Article XXI §2105.62 and §2105.63.

17. Volatile Organic Compound Storage Tanks (§2105.12.a)

No person shall place or store, or allow to be placed or stored, a volatile organic compound having a vapor pressure of 1.5 psia or greater under actual storage conditions in any aboveground stationary storage tank having a capacity equal to or greater than 2,000 gallons but less than or equal to 40,000 gallons, unless there is in operation on such tank pressure relief valves which are set to release at the higher of 0.7 psig of pressure or 0.3 psig of vacuum or at the highest possible pressure and vacuum in accordance with State or local fire codes, National Fire Prevention Association guidelines, or other national consensus standard approved in writing by the Department. Petroleum liquid storage vessels that are used to store produced crude oil and condensate prior to lease custody transfer are exempt from these requirements.

18. Permit Source Premises (§2105.40)

a. **General.** No person shall operate, or allow to be operated, any source for which a permit is required by Article XXI Part C in such manner that emissions from any open land, roadway, haul road, yard, or other premises located upon the source or from any material being transported within such source or from any source-owned access road, haul road, or parking lot over five (5) parking spaces:

1) Are visible at or beyond the property line of such source;

2) Have an opacity of 20% or more for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or

3) Have an opacity of 60% or more at any time.

b. **Deposition on Other Premises:** Visible emissions from any solid or liquid material that has been deposited by any means from a source onto any other premises shall be considered emissions from such source within the meaning of Site Level Condition IV.18.a above.

19. Parking Lots and Roadways (§2105.42)

a. The permittee shall not maintain for use, or allow to be used, any parking lot over 50 parking spaces or used by more than 50 vehicles in any day or any other roadway carrying more than 100 vehicles in any day or 15 vehicles in any hour in such manner that emissions from such parking lot or roadway:

1) Are visible at or beyond the property line;

2) Have an opacity of 20% or more for a period or periods aggregating more than three (3) minutes in any 60 minute period; or

3) Have an opacity of 60% or more at any time.

b. Visible emissions from any solid or liquid material that has been deposited by any means from a parking lot or roadway onto any other premises shall be considered emissions from such parking lot or roadway.

c. Site Level Condition IV.19.a above shall apply during any repairs or maintenance done to such parking lot or roadway.

d. Notwithstanding any other provision of this permit, the prohibitions of Site Level Condition IV.19 may be enforced by any municipal or local government unit having jurisdiction over the place where such parking lots or roadways are located. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by Article XXI §2109.02 for any violations of Site Level Condition IV.19.

20. Permit Source Transport (§2105.43)

a. No person shall transport, or allow to be transported, any solid or liquid material outside the boundary line of any source for which a permit is required by Article XXI Part C in such manner that there is any visible emission, leak, spill, or other escape of such material during transport.

b. Notwithstanding any other provision of this permit, the prohibitions of Site Level Condition IV.20 may be enforced by any municipal or local government unit having jurisdiction over the place where such visible emission, leak, spill, or other escape of material during transport occurs. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by Article XXI §2109.02 for any violation of Site Level Condition IV.20.

21. Construction and Land Clearing (§2105.45)

a. No person shall conduct, or allow to be conducted, any construction or land clearing activities in such manner that the opacity of emissions from such activities:

1) Equal or exceed 20% for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or
2) Equal or exceed 60% at any time.

b. Notwithstanding any other provision of this permit, the prohibitions of Site Level Condition IV.21 may be enforced by any municipal or local government unit having jurisdiction over the place where such construction or land clearing activities occur. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by Article XXI §2109.02 for any violations of Site Level Condition IV.21.

22. Mining (§2105.46)

No person shall conduct, or allow to be conducted, any mining activities in such manner that emissions from such activities:

a. Are visible at or beyond the property line;
b. Have an opacity of 20% or more for a period or periods aggregating more than three (3) minutes in any sixty (60) minute period; or,
c. Have an opacity of 60% or more at any time.

23. Demolition (§2105.47)

a. No person shall conduct, or allow to be conducted, any demolition activities in such manner that the opacity of the emissions from such activities equal or exceed 20% for a period or periods aggregating more than three (3) minutes in any 60 minute period.

b. Notwithstanding any other provisions of this permit, the prohibitions of Site Level Condition IV.23 may be enforced by any municipal or local government unit having jurisdiction over the place where such demolition activities occur. Such enforcement shall be in accordance with the laws governing such municipal or local government unit. In addition, the Department may pursue the remedies provided by Article XXI §2109.02 for any violations of Site Level Condition IV.23.

24. Fugitive Emissions (§2105.49)

The person responsible for a source of fugitive emissions, in addition to complying with all other applicable provisions of this permit shall take all reasonable actions to prevent fugitive air contaminants from becoming airborne. Such actions may include, but are not limited to:

a. The use of asphalt, oil, water, or suitable chemicals for dust control;
b. The paving and maintenance of roadways, parking lots and the like;
c. The prompt removal of earth or other material which has been deposited by leaks from transport,

erosion or other means;

d. The adoption of work or other practices to minimize emissions;

e. Enclosure of the source; and

f. The proper hooding, venting, and collection of fugitive emissions.

25. Episode Plans (§2106.02)

The permittee shall upon written request of the Department, submit a source curtailment plan, consistent with good industrial practice and safe operating procedures, designed to reduce emissions of air contaminants during air pollution episodes. Such plans shall meet the requirements of Article XXI §2106.02.

26. New Source Performance Standards (§2105.05)

a. It shall be a violation of this permit giving rise to the remedies provided by §2109.02 of Article XXI for any person to operate, or allow to be operated, any source in a manner that does not comply with all requirements of any applicable NSPS now or hereafter established by the EPA, except if such person has obtained from EPA a waiver pursuant to Section 111 or Section 129 of the Clean Air Act or is otherwise lawfully temporarily relieved of the duty to comply with such requirements.

b. Any person who operates, or allows to be operated, any source subject to any NSPS shall conduct, or cause to be conducted, such tests, measurements, monitoring and the like as is required by such standard. All notices, reports, test results and the like as are required by such standard shall be submitted to the Department in the manner and time specified by such standard. All information, data and the like which is required to be maintained by such standard shall be made available to the Department upon request for inspection and copying.

27. Miscellaneous Organic Chemical Manufacturing NESHAP (40 CFR Part 63, Subpart FFFF)

The permittee shall comply with all applicable requirements of the National Emission Standards for Hazardous Air Pollutants, 40 CFR Part 63, Subpart FFFF – the “Miscellaneous Organic Chemical Manufacturing NESHAP” or “MON”. [25 PA Code §129.99; 25 PA Code §129.100]

V. EMISSION UNIT LEVEL TERMS AND CONDITIONS

A. <u>C-5 – Storage Tanks</u>

1. Restrictions:

The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit(s) associated with the C5 VOC storage tanks. [§2102.04.b.5]

2. Work Practice Standard:

a. The permittee shall do the following for all VOC storage tanks and associated equipment: [§2105.03, 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in according with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The VOC storage tanks shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

B. C-5 Operations – Pastillating Belts #1 and #2 (S055)

1. Restrictions:

The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit(s) associated with Pastillating Belts #1 and #2. [2102.04.b.5]

2. Work Practice Standard:

a. The permittee shall do the following for Pastillating Belts #1 and #2 and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer’s or the operator’s maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer’s or the operator’s maintenance procedures.

b. The Pastillating Belts #1 and #2 shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

C. MP Poly Unit (S034)

1. Restrictions:

a. The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit(s) associated with the MP Poly Unit. [2102.04.b.5]

b. The permittee shall properly maintain and operate the condensers E-500-5, E-701-5, and E-701-4 at all times when emissions are routed to them. [§2105.03; RACT Order #257, condition 1.7; 25 PA Code §129.99]

c. The inlet coolant temperature to the condenser E-701-4 (S034) shall not exceed 10°C (50°F) over any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions. [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.2.A; 25 PA Code §129.99]

d. If measured one-hour block average exit vapor temperatures for the condenser E-701-4 (S034) exceed 35°C from the condenser, the permittee shall take the following actions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.1.C ;25 PA Code §129.99]

   a) Confirm that the glycol cooler is operating properly by reviewing current operating conditions (e.g. that the chiller system is operating and circulating coolant, and that glycol coolant is being supplied at less than 10°C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°C. Exit vapor temperature exceeding 35°C due to solely to high ambient temperatures shall be documented per paragraph b.
   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 35°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 50°F (10°C), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.
   c) Periods of exit vapor temperatures in excess of 35°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

2. Monitoring Requirements:

a. The permittee shall install, operate, and maintain an inlet coolant temperature instrument on E-701-4 condenser that continuously monitors the coolant inlet temperature at all times when emissions are routed to it. The temperature probes used shall be certified by the manufacturer to be accurate to within 2% of the temperature measured in Celsius or to within 2.5°C, whichever is greater. The permittee shall record the coolant inlet temperature at least once every 15 minutes while the equipment associated with the temperature probe and transmitter is in operation. [§2102.04.b.6; §2103.12.i; RACT Order #257, condition 1.1 and 1.2; 25 PA Code §129.99]

3. Record Keeping Requirements:

a. The permittee shall keep and maintain records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

4. Work Practice Standard:

a. The permittee shall do the following for MP Poly Unit (filtrate system: filtrate receiver, neutralizer, solvent wash tank, heel tank, Funda filter) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer’s or the operator’s maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer’s or the operator’s maintenance procedures.

b. The MP Poly Unit (filtrate system: filtrate receiver, neutralizer, solvent wash tank, heel tank, Funda filter) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

D. WW Poly Unit (S013, S020, S023, S027)

1. Restrictions:

a. The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit(s) associated with the WW Poly Unit. [2102.04.b.5]

b. Refrigerated vent condensers [E-200-7 (S013), E-900-7 (S020), E-903-3 (S023), and E-901-7 (S027)]: The condensers shall be properly maintained and operated according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, conditions 1.3 and 1.4; 25 PA Code §129.99]

1) The inlet coolant temperature to each condenser shall not exceed 10°C in any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions;
2) The exit vapor temperature of each condenser shall not exceed 35°C over any one-hour block average when emissions are being routed through them, except as specified in condition V.A.1.e.3) below;
3) If measured one-hour block average exit vapor temperatures exceed 35°C from a condenser, the permittee shall take the following actions:
   a) Confirm that the glycol cooler is operating properly by reviewing current operating conditions (e.g. that the chiller system is operating and circulating coolant, and that glycol coolant is being supplied at less than 10°C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°C. Exit vapor temperature exceeding 35°C due to solely to high ambient temperatures shall be documented per paragraph b.
   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 35°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 50°F (10°C), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.

   c) Periods of exit vapor temperatures in excess of 35°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

2. Monitoring Requirements:

a. The permittee shall install, operate, and maintain an inlet coolant temperature instrument on E-200-7, E-900-7, E-901-7, and E-903-3 condensers that continuously monitor the coolant inlet temperature. The temperature probes used shall be certified by the manufacturer to be accurate to within 2% of the temperature measured in Celsius or to within 2.5°C, whichever is greater. The permittee shall record the coolant inlet temperature at least once every 15 minutes while the equipment associated with the temperature probe and transmitter is in operation. [§2102.04.b.6; §2103.12.i; RACT Order #257, conditions 1.1 -1.3; 25 PA Code §129.99]

3. Record Keeping Requirements:

a. The permittee shall keep and maintain records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

b. The permittee shall keep records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment. [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]

4. Work Practice Standard:

a. The permittee shall do the following for WW Poly Unit (feed dryers and regeneration, west filtrate receiver, solvent wash receiver, and east filtrate receiver) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The WW Poly Unit (feed dryers and regeneration, west filtrate receiver, solvent wash receiver, and east filtrate receiver) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

E. WW Poly Storage Tanks (S025)

1. Restrictions:

a. The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with the WW Poly Storage Tanks. [2102.04.b.5]

b. The inlet coolant temperature to the condenser E-202-1 shall not exceed 10°C (50°F) over any one-hour block average when emissions are routed through the condensers with the exception of activities to mitigate emergency conditions. [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.4; 25 PA Code §129.99]

2. Record Keeping Requirements:

a. The permittee shall keep and maintain records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

b. The permittee shall keep records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment. [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]

3. Work Practice Standard:

a. The permittee shall do the following for WW Poly storage tanks (73, 75, 76, 77) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The WW Poly storage tanks (73, 75, 76, 77) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

F. LTC Process Operations (S108, S109, S110, S111, S112, S113, S114)

1. Restrictions:

a. The permittee shall continue to comply with all applicable regulatory requirements and the VOC requirements in the applicable Installation Permit associated with the LTC Process Operations. [2102.04.b.5]

b. Cooling tower water chilled vent condensers [E-301B-E3 (S109); E-301-4 (S108); E-607-2 (S110); E-RK5-4 (S111); E-RK6-3 (S112); E-RK7-4 (S113)]: The condensers shall be properly operated and maintained according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, condition 1.1.H; 25 PA Code §129.99]

1) The inlet coolant temperature to each condenser shall not exceed 10°F (5.6°C) above ambient air temperature over any one-hour block average when emissions are routed through the condenser with the exception of activities to mitigate emergency conditions and except that at no time will coolant temperature be required to be less than 50°F (10°C).
2) The exit vapor temperature of each condenser shall not exceed 40°C over any one-hour block average when emissions are being routed through them, except as specified in paragraph 3).
3) If measured one-hour block average exit vapor temperatures exceed 40°C from a condenser, the permittee shall take the following actions:
   a) Confirm that the cooling tower is operating properly by reviewing current operating conditions (e.g. that the cooling system is operating and circulating cooling water, and that cooling water is being supplied at less than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to less than 50°F (10 °C). Corrective actions are required to be taken to correct loss of coolant supply or to return the coolant supply temperature to less than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to less than 50°F (10 °C)). Exit vapor temperature exceeding 40°C due to solely to high ambient temperatures shall be documented per paragraph b.

   b) The following documentation will be maintained for the period when the condenser exit vapor temperature exceeds 40°C for any one-hour average during current operating conditions and when the coolant supply temperature is more than 10°F (5.6°C) above ambient (except that at no time will coolant temperature be required to be less than 50°F (10°C)), or when the coolant supply is interrupted:
      i) Identification of the tank and condenser.
      ii) The nature and probable cause of the event.
      iii) The temperature of the outlet gas and coolant supply.
      iv) The ambient air temperature at the time of the exceedance.
      v) The estimated quantity of VOC and total hap emitted, if any.
      vi) Appropriate corrective actions taken.

   c) Periods of exit vapor temperatures in excess of 40°C not due solely to high ambient temperature shall be considered a breakdown in accordance with §2108.01.

c. The vacuum leak rate from the #1 shall not exceed 10 lb/hr. The vacuum leak rate from #2 LTC Vacuum System shall not exceed 15 lb/hr. Compliance with this condition shall be demonstrated during regular compliance testing performed at least once every five years after the most recent stack test. [§2102.04.b.6; §2102.04.e; 25 PA Code §129.99 & §129.100]

2. **Record Keeping Requirements:**

a. The permittee shall keep and maintain the following data on-site for these operations [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]:

1) All records of monitoring required by V.A.3 above.
2) Records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment.
3) Maximum resin (lb/min) and polymerizate (gal/min) feed rates (daily).
4) Amount (lbs.) and type of resin and polymerizate (monthly, 12-month rolling total)
5) Changes in #4 LTC Vacuum System vacuum pump status (upon occurrence).

3. **Work Practice Standard:**

a. The permittee shall do the following for LTC Process (#1 and #2 Vacuum systems and #1/#2 Pastillator Belt) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
2) Keep records of any maintenance; and
3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The LTC Process (#1 and #2 Vacuum systems and #1/#2 Pastillator Belt) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

G. Dresinate Production Line (S085)

1. Restrictions:

The permittee shall continue to comply with all regulatory and Permit requirements. [2102.04.b.5]

2. Work Practice Standard:

a. The permittee shall do the following for Dresinate Production Line (Double Drum Dryer) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]

1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
2) Keep records of any maintenance; and
3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The Dresinate Production Line (Double Drum Dryer) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

H. Hydrogenation Unit (S004, S007, S012)

1. Restrictions:

a. The maximum production rate for Hydrogenation Unit process shall not exceed 22 million pounds per 12-month rolling period. [§2102.04.e; 25 PA Code §129.99]

b. Refrigerated vent condensers E-104-2 (S012), E-201-2 (S004), E-403-2 (S007): The condensers shall be properly maintained and operated according to good engineering practices, manufacturer's recommendations and the following conditions at all times while treating process emissions: [§2105.06.b.3; §2102.04.e; §2103.12.a.2.B; RACT Order #257, conditions 1.3 and 1.4; 25 PA Code §129.99]
1) The outlet coolant temperature shall not exceed at any time 40°F.
2) Instrumentation shall be provided to continuously monitor the coolant outlet temperature of each condenser to within one (1) degree Fahrenheit at all times.

2. Record Keeping Requirements:

a. The permittee shall keep and maintain production records and records of condenser coolant temperature. [§2103.12.j, RACT Order #257, condition 1.5; 25 PA Code §129.100]

b. The permittee shall keep records of operation, inspection, calibration, maintenance and/or replacement of process or control equipment. [§2103.12.j & k; RACT Order #257, condition 1.5; 25 PA Code §129.100]

3. Monitoring Requirements:

a. The permittee shall monitor and record the exit vapor temperature of each refrigerated vent condensers at least once every 15 minutes when the process is in operation. [§2102.04.b.6, §2102.04.e., §2103.12.i]

4. Work Practice Standard:

a. The permittee shall do the following for Hydrogenation Unit (tanks 103 and 104, catalyst catch tank, Mott filter, Heel tank, Vent tanks, Autoclaves #1 and #2, Storage tanks 102, 105, 106) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
2) Keep records of any maintenance; and
3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The Hydrogenation Unit (tanks 103 and 104, catalyst catch tank, Mott filter, Heel tank, Vent tanks, Autoclaves #1 and #2, Storage tanks 102, 105, 106) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

I. Wastewater Treatment Plant (F027, F033, F034, F035)

1. Work Practice Standard:

a. The permittee shall do the following for Wastewater Treatment Plant (Bioaeration tank, tanks 702A, 702B, and 702C) and associated equipment: [§2105.03; 25 PA Code §129.99; 25 PA Code §129.100]
   1) Perform regular maintenance in accordance with the manufacturer's or the operator's maintenance procedures;
   2) Keep records of any maintenance; and
   3) Keep a copy of either the manufacturer's or the operator's maintenance procedures.

b. The Wastewater Treatment Plant (Bioaeration tank, tanks 702A, 702B, and 702C) shall be properly operated and maintained at all times according to good engineering practices, with the exception of activities to mitigate emergency conditions. [RACT Order #257, condition 1.7; §2105.03; 25 PA Code §129.99]

VI. ALTERNATIVE OPERATING SCENARIOS

There are no alternative operating scenarios for this permit