CATEGORY Type: **FIBERGLASS OPERATION**

BACT Category: Cured-In-Place Pipe (CIPP) Process <6,

BACT Determination Number: 266	**BACT Determination Date:** 6/16/2020

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: FIBERGLASS MFG PROCESS

Unit Size/Rating/Capacity: <6,480 lbs VOC/year

Equipment Location:

EXPIRED

BACT Determination Information

District Contact: Jeff Quok Phone No.: (916) 874-4863 email: jquok@airquality.org

ROCs	**Standard:**	
	Technology Description:	Open molding using compliant resins and gel coats (See comments), and the use of vapor suppressed Tub/Shower resins; or Closed Molding; or capture and control system with 90% overall efficiency, and Compliance with Rule 465 Cleaning Material Requirements
	Basis:	Achieved in Practice
NOx	**Standard:**	
	Technology Description:	No standard
	Basis:	Achieved in Practice
SOx	**Standard:**	
	Technology Description:	No standard
	Basis:	
PM10	**Standard:**	
	Technology Description:	Application equipment as specified in applicable District Rule
	Basis:	
PM2.5	**Standard:**	
	Technology Description:	Application equipment as specified in applicable District Rule
	Basis:	
CO	**Standard:**	
	Technology Description:	No standard
	Basis:	
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: Maximum monomer content percent by weight: clear marble resin gel coats = 40%; All other clear gel coats = 44%; White and off-white gel coats = 30%; non-white gel coats = 37%; primer pigmented gel coats = 28%; specialty gel coats = 48%; tooling gel coat = 40%; Marble resins = 10% with fillers or 32% without; solid surface resins = 17%; Tub/Shower resins = 24% with fillers or 35% without; lamination resins = 31% with fillers or 35% without; fire retardant resins = 38%; corrosion resistant resins = 48%; high strength resins = 40%; atomized tooling resins = 39%; non-atomized tooling resins = 30%; all other resins = 35%

CATEGORY Type: **FIBERGLASS OPERATION**

BACT Category: CURED-IN-PLACE PIPE (CIPP) PROCE

BACT Determination Number: 267	**BACT Determination Date:** 6/16/2020

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: FIBERGLASS MFG PROCESS

Unit Size/Rating/Capacity: ≥ 6,480 lbs VOC/year

Equipment Location:

EXPIRED

BACT Determination Information

District Contact:

ROCs	**Standard:**	
	Technology Description:	Compliance with Rule 465, and VOC Capture and Control System with ≥ 90% total control efficiency
	Basis:	Cost Effective
NOx	**Standard:**	
	Technology Description:	No Standard
	Basis:	
SOx	**Standard:**	
	Technology Description:	No Standard
	Basis:	
PM10	**Standard:**	
	Technology Description:	Application equipment as specified in applicable District Rule
	Basis:	Achieved in Practice
PM2.5	**Standard:**	
	Technology Description:	Application equipment as specified in applicable District Rule
	Basis:	Achieved in Practice
CO	**Standard:**	
	Technology Description:	No Standard
	Basis:	
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: This is a generic BACT determination based on BACT determinations made, and published, by other air agencies in California and/or other States.

777 12th Street, Third Floor

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

EXPIRED

DETERMINATION NOS.: 266 & 267

DATE: 06/16/2020

ENGINEER: Jeffrey Quok

Category/General Equip Description:	Polyester Resin Operation
Equipment Specific Description:	Cured-In-Place Pipe (CIPP) Process
Equipment Size/Rating:	< 6,480 lbs VOC/year, Minor Source (BACT #266) ≥ 6,480 lbs VOC/year, Minor Source (BACT #267)
Previous BACT Det. No.:	None

This is a new BACT/T-BACT determination for Cured-In-Place Pipe (CIPP) polyester resin operations that are not major sources of hazardous air pollutants (HAP) and are not located at major sources of HAP.

Cured-In-Place Pipe (CIPP) Process: CIPP is one of several trenchless pipe rehabilitation technologies that is being used to repair in ground sewer, water and industrial pipes that developed leaks due to structural defects. It is a lining system that is installed through a manhole or other access points, hence does not require excavation in order to rehabilitate a pipeline. A resin-saturated felt tube is pulled into the damaged pipe. The tube is sealed on one end and then hot water is pumped into the tube to cure the resin and form a tight-fitting, jointless and corrosion-resistant replacement pipe.

BACT/T-BACT ANALYSIS

A. ACHIEVED IN PRACTICE (Rule 202, §205.1a):

The following control technologies are currently employed as BACT/T-BACT for Polyester Resin Operations – Cured-In-Place Pipe (CIPP) Process:

US EPA

BACT
Source: EPA RACT/BACT/LAER Clearinghouse

Fiberglass Lamination	
VOC	No emission limits, BACT is VOC content limits and transfer efficiency requirement. All add-on control technologies were found to be cost-prohibitive. California content limits were used as BACT. The permit includes limits on VOC content in resins, gel coats, and transfer efficiencies to reduce VOC emissions.
NOx	N/A – Not applicable to process
SOx	N/A – Not applicable to process
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	N/A – Not applicable to process

RBLC ID: OR-0045 (08/04/2005)

T-BACT
There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS:
40 CFR Part 63 Subpart WWWW – National Emissions Standards for Hazardous Air Pollutants: Reinforced Plastic Composites Production. This regulation applies to reinforced plastic composites production facilities that are located at a major source of HAP. [40 CFR §63.5785]

This regulation applies only to reinforced plastic composites production operations that are major sources of HAP (10 tons/year single HAP, or 25 tons/year any combination of HAP) or are located at a major source of HAP. Therefore, this regulation is not considered achieved in practice for non-major sources.

Air Resources Board (ARB)
BACT Source: ARB BACT Clearinghouse There are no BACT standards published in the clearinghouse for this category. Note: ARB has determinations for polystyrene foam manufacturing and for fiber impregnation (polymer-impregnated fiber material). The District determined that these determinations are not applicable to this source category. **T-BACT** There are no T-BACT standards published in the clearinghouse for this category. **RULE REQUIREMENTS:** There are no regulations for this source category.

Sacramento Metropolitan AQMD
BACT Source: SMAQMD BACT Clearinghouse There are no BACT standards published in the clearinghouse for this category. **T-BACT** There are no T-BACT standards published in the clearinghouse for this category. However, since the primary VOCs controlled by the applicable District Rule are HAPs (styrene and methyl methacrylate), compliance with the District Rule is considered T-BACT. **RULE REQUIREMENTS:** Rule 465 – Polyester Resin Operations (9/25/08) This rule requires the following: a. Each polyester resin operation shall comply with one of the following process or control requirements: 1. The use of low-VOC polyester resins with the following monomer content: i. Resins, except for specialty resins and gel coats, which contain no more than 35% by weight as applied, as determined by Section 502.3. ii. Pigmented gel coats which contain no more than 45% by weight as applied, as determined by Section 502.3. iii. Specialty resins and clear gel coats which contain no more than 50% by weight as applied, as determined by Section 502.3. 2. A polyester resin material containing a vapor suppressant, such that weight loss from VOC emissions does not exceed 60 grams per square meter of exposed surface area during resin polymerization, as determined by Section 502.1. 3. The use of a closed-mold system. b. In lieu of using the aforementioned controls, the source may install air pollution control equipment capable of overall capture and control efficiency of 90%.

Sacramento Metropolitan AQMD

c. The use of HVLP, LVLP, airless, air assisted airless, electrostatic, or an otherwise approved spray method when spray-applying resins.
d. The use of low-VOC cleaning solvents (< 25 g VOC/L)

This rule provides an exemption from the above requirements if the source uses less than 20 gallons of resin per month.

South Coast AQMD

BACT

Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities, page 101 (Revised 2/1/19)

Rating/Size	VOC	NOx	SOx	CO	PM10
Polyester Resin Operations - Molding and Casting					
All	Compliance with AQMD's Rule 1162 and Use of Aqueous Emulsion Cleaner or Acetone for Clean-Up to Maximum Extent Possible (1988/10-20-2000)	N/A	N/A	N/A	N/A

T-BACT

There are no T-BACT standards published in the clearinghouse for this category. However, since the primary VOCs controlled by the applicable District Rule are HAPs (styrene and methyl methacrylate), compliance with the District Rule is considered T-BACT.

RULE REQUIREMENTS:

Reg. XI, Rule 1162 – Polyester Resin Operations (7/8/2005)

This rule requires the following:

a. Application of resins using non-atomizing spray application techniques (as listed in section (c)(1)(A), and application of gel coats using the methods listed in (c)(1)(A), or using air-assisted airless, electrostatic or HVLP methods.
b. The use of the following:
    i. Low-VOC polyester resins and gel coats listed in (c)(2)(A);
    ii. Additionally, for tub/shower open molding, the use of vapor-suppressed resins (≤ 50 g/m^2) [Section (c)(2)(C)];
    iii. the use of a closed-mold system [Section (c)(3)(A)].
    iv. In lieu of using the aforementioned controls, the source may install air pollution control equipment capable of overall capture and control efficiency of 90% [Section (d)].
c. The use of solvents that comply with Rule 1171 – Solvent Cleaning Operations

South Coast AQMD

This rule does not allow the use of vapor suppressed resins in lieu of resins that meet the monomer content limits. SCAQMD staff determined that equivalent reductions could not be verified, since vapor suppressants tend to only reduce emission during curing and not application. (Final Staff Report for Proposed Amended Rule 1162 – Polyester Resin Operations, November 2001, pg. 31-32)

This rule does not provide an exemption for low-use facilities, however, Reg. II, Rule 219 provides a permitting exemption for polyester resin operations that can demonstrate the following:

1. The facility uses less than 1 gallon/day or 22 gallons per month of materials related to the polyester resin operation, and [§ (l)(6)(E)]
2. The facility uses less than 3 gallons/day or 66 gallons per month of coatings, adhesive, and polyester resin and gel coat type materials, and [§ (l)(6)]
3. Total facility emissions do not exceed 4.0 tons per year of VOC. [§ (s)(3)]

Section (c)(2)(A) Table:

Polyester Resin Materials	**Monomer Percentage by Weight as Applied**
Clear Gel Coat	-
For Marble Resins	40%
For Other Resins	44%
Pigmented Gel Coat	-
White and Off White	30%
Non-White	37%
Primer	28%
Specialty Gel Coats	48%
General Purpose Resin	
Marble Resins	10% or (32% as supplied, no fillers)
Solid Surface Resins	17%
Tub/Shower Resins	24% or (35% as supplied, no fillers)
Lamination Resins	31% or (35% as supplied, no fillers)
Others	35%
Fire Retardant Resin	38%
Corrosion Resistant Resins	48%
High Strength Resin	40%

San Joaquin Valley Unified APCD

BACT
Source: SJVUAPCD BACT Clearinghouse
There are no BACT standards published in the clearinghouse for this category.

San Joaquin Valley Unified APCD

T-BACT

There are no T-BACT standards published in the clearinghouse for this category. However, since the primary VOCs controlled by the applicable District Rule are HAPs (styrene and methyl methacrylate), compliance with the District Rule is considered T-BACT.

RULE REQUIREMENTS:

Rule 4684 – POLYESTER RESIN OPERATIONS (8/18/2011)

This rule requires the following:

a. The use of low-VOC polyester resins (as listed in Table 1 of the rule), the use of vapor-suppressed resins (≤ 50 g/m^2), or the use of a closed-mold system. In lieu of using the aforementioned controls, the source may install air pollution control equipment capable of overall capture and control efficiency of 90%.
b. The use of airless, air assisted airless, HVLP spray equipment, or electrostatic spray equipment when spray-applying resins.
c. The use of low-VOC cleaning solvents (< 25 g VOC/L)

This rule provides an exemption from the above requirements if the source uses less than 20 gallons of resin per month. This exemption does not apply to fiberglass boat manufacturers.

Rule 4684 Table 1

Polyester Resin Materials	Monomer Percentage by Weight as Applied
General Purpose Resin	-
Marble Resins	10% or (32% as supplied, no fillers)
Solid Surface Resins	17%
Tub/Shower Resins	24% or (35% as supplied, no fillers)
Lamination Resins	31% or (35% as supplied, no fillers)
Tooling Resin	-
Atomized (spray)	30%
Non-atomized	39%
Specialty Resin	-
Fire Retardant Resin	38%
High Strength Materials	40%
Corrosion Resistant Resin	48%
All Other Resin	35%
Tooling Gel Coat	40%
Pigmented Gel Coat	-
White and Off White	30%
Non-White	37%
Primer	28%
Clear Gel Coat	-
Marble Resin	40%
Other Resin	44%
Specialty Gel Coat	48%

San Diego County APCD

BACT
Source: NSR Requirements for BACT (June 2011)
Fiberglass Manufacturing Line (<10 tons/yr).

	VOC	NOx	SOx	CO	PM10
BACT Emission Rate Limit	Not Determined	N/A	N/A	N/A	Not Determined
BACT Control Option	Compliance with Rule 67.12.1, Polyester Resin Operations.	N/A	N/A	N/A	Airless spray equipment & spray booth with mesh type filters.

T-BACT
There are no T-BACT standards published in the clearinghouse for this category. However, since the primary VOCs controlled by the applicable District Rule are HAPs (styrene and methyl methacrylate), compliance with the District Rule is considered T-BACT.

RULE REQUIREMENTS:
Regulation 4, Rule 67.12.1 – Polyester Resin Operations (5/11/16)

This rule requires the following:

a. The use of low-VOC polyester resins (as listed in § (d)(1)(i)) or the use of a closed-mold system. In lieu of using the aforementioned controls, the source may install air pollution control equipment capable of overall capture and control efficiency of 90%.
b. The use of airless, air assisted airless, HVLP spray equipment or electrostatic spray equipment when spray-applying resins.
c. The use of low-VOC cleaning solvents (< 25 g VOC/L)

This rule provides an exemption from the above requirements if the source uses less than 20 gallons of resin per month. This exemption does not apply to fiberglass boat manufacturers.

Vapor suppressed resins are defined and when used, must have VOC emissions that do not exceed 50 grams per square meter of exposed surface area during resin polymerization. However, the rule doesn't require them for certain processes, nor does it allow vapor suppressants to be used in lieu of meeting the monomer limits.

San Diego County APCD

Category	Monomer Weight %
Clear Gel Coat	
Marble Gel Coat	40%
Other Clear Gel Coats	44%
Pigmented Gel Coat	
White and Off-white Gel Coats	30%
Other Non-white Gel Coats	37%
Primer Gel Coat	28%
Specialty Gel Coat	48%
Resins	
Marble Resin	10% or 32% without fillers
Solid Surface Resins	17%
Tub/Shower Resins	24% or 35% without fillers
Lamination Resins	31% or 35% without fillers
Fire Retardant Resins	38%
Corrosion Resistant Resins	48%
High Strength Resins	40%
Other Resins	35%

Bay Area AQMD

BACT
Source: BAAQMD BACT Guideline 129.1.1 (10/25/91)

Polyester Resin Operations - Molding and Casting	
VOC	Compliance w/ BAAQMD Reg. 8, Rule 50 and use of aqueous emulsion cleaner instead of acetone for clean-up to maximum extent possible
NOx	No standard
SOx	No standard
PM10	No standard
PM2.5	No standard
CO	No standard

Bay Area AQMD

Source: BAAQMD BACT Guideline 129.4.1 (12/16/91)

Polyester Resin Operations - Pultrusion	
VOC	Compliance w/ BAAQMD Reg. 8, Rule 50; use of styrene suppressed resin; and use of aqueous emulsion cleaner for clean-up to maximum extent possible
NOx	No standard
SOx	No standard
PM10	No standard
PM2.5	No standard
CO	No standard

T-BACT

There are no T-BACT standards published in the clearinghouse for this category. However, since the primary VOCs controlled by the applicable District Rule are HAPs (styrene and methyl methacrylate), compliance with the District Rule is considered T-BACT.

RULE REQUIREMENTS:

Reg 8, Rule 50 – Polyester Resin Operations (12/2/2009)

This rule requires the following:

a. The use of low-VOC polyester resins (as listed in Table 1 of the rule), the use of vapor-suppressed resins (≤ 50 g/m^2), or the use of a closed-mold system. In lieu of using the aforementioned controls, the source may install air pollution control equipment capable of overall capture and control efficiency of 85% by weight.
b. The use of airless, air assisted airless, HVLP, or electrostatic spray equipment when spray-applying resins.
c. The use of low-VOC cleaning solvents (< 25 g VOC/L).

Table 1

Gel Coats and Resins	Monomer Percentage by Weight
Gel Coats	
Clear Gel Coats	
Marble Resin Gel Coats	42%
Boat Manufacturing Gel Coats	48%
All Other Clear Gel Coats	44%
Pigmented Gel Coats	
White and Off-White Gel Coats	30%
Non-White Boat Manufacturing Gel Coats	33%
Other Non-White Gel Coats	37%
Primer Gel Coats	28%
Specialty Gel Coats	48%
Resins	
Marble Resins	10% with fillers or 32% without fillers*
Solid Surface Resins	17%
Tub/Shower Resins	24% with fillers or 35% without fillers*
Boat Manufacturing (atomized)	28%
Boat Manufacturing (non-atomized)	35%
Lamination Resins	31% with fillers or 35% without fillers*
Fire Retardant Resins	38%
Corrosion Resistant, High Strength and Tooling Resins	
Non-atomizing Mechanical Application	46%**
Filament Application	42%**
Manual Application	40%**
Other Resins	35%

Monomer percent by weight includes the addition of any VOC-containing materials.
* An owner or operator of a polyester resin operation may meet the monomer content limits by adding filler to a resin to reduce the monomer content to the applicable limit or by using resin with a monomer content that complies with the applicable limit without the addition of fillers.
**If the owner or operator manufactures a composite product by using more than one technology to apply corrosion-resistant, high strength or tooling resins, the highest permissible resin monomer content is the applicable limit.
Touch-up and repair resins and gel coats may have a monomer limit up to 10% more than the applicable limit, provided it is applied by hand-held atomized spray technologies with a container that is part of the gun with a maximum capacity of 1 quart.

Comparison of District Rule Limits					
Gel Coats and Resins	Monomer Percentage by Weight (A)				
	SMAQMD	SCAQMD	SJVUAPCD	SDAPCD	BAAQMD
Gel Coats					
Clear Gel Coats					
Marble Resin Gel Coats	50%	**40%**	**40%**	**40%**	42%
All Other Clear Gel Coats	50%	**44%**	**44%**	**44%**	**44%**
Pigmented Gel Coats					
White and Off-White Gel Coats	45%	**30%**	**30%**	**30%**	**30%**
Non-White Gel Coats	45%	**37%**	**37%**	**37%**	**37%**
Primer Gel Coats	45%	**28%**	**28%**	**28%**	**28%**
Specialty Gel Coats	50%	**48%**	**48%**	**48%**	**48%**
Tooling Gel Coat	50%	**-**	**40%**	**-**	**-**
Resins					
Marble Resins	35%	**10% with fillers or 32% without fillers**			
Solid Surface Resins	35%	**17%**	**17%**	**17%**	**17%**
Tub/Shower Resins (B)	35%	**24% with fillers or 35% without fillers**			
Lamination Resins	35%	**31% with fillers or 35% without fillers**			
Fire Retardant Resins	50%	**38%**	**38%**	**38%**	**38%**
Corrosion Resistant (not application method dependent)	50%	**48%**	**48%**	**48%**	-
High Strength (not application method dependent)	50%	**40%**	**40%**	**40%**	-
Tooling Resins					
Atomized (spray)	50%	48%	**39%** (C)	48%	-
Non-atomized	50%	48%	**30%** (C)	48%	-
Corrosion Resistant, High Strength and Tooling Resins					
Non-atomizing Mechanical Application	50%	-	-	-	46% (D)
Filament Application	50%	-	-	-	42% (D)
Manual Application	50%	-	-	-	40%
Other Resins	**35%**	**35%**	**35%**	**35%**	**35%**

(A) **Bolded** limits were considered most stringent.
(B) Vapor Suppressed Tub/Shower Resins may be used that meet the above monomer content limits.
(C) The SJVUAPCD determined that the tooling resin limits listed in 40 CFR 63 Subpart VVVV were technologically feasible even when not used for boat manufacturing. (Final Draft Staff Report, Proposed Rule 4654, June 16, 2011 pg. 12)
(D) The SJVUAPCD determined in their staff report for Rule 4684 that the BAAQMD limits for Corrosion Resistant **were technologically infeasible**. The BAAQMD limits would reduce the styrene levels below what is required to form the necessary cross-links. (Final Draft Staff Report, Proposed Rule 4654, June 16, 2011 pg. 13)

The following control technologies have been identified and are ranked based on stringency:

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
VOC	1. Compliance with applicable District Rule [SCAQMD; SJVUAPCD; SDAPCD; BAAQMD] (A) 2. Compliance with applicable District Rule [SMAQMD] (A) 3. California content limits [EPA]
NOx	Not applicable
SOx	Not applicable
PM10	1. Compliance with application methods required by District Rule [SCAQMD; SJVUAPCD; SDAPCD; BAAQMD]
PM2.5	Not applicable
CO	Not applicable
Styrene/ Methyl Methacrylate (T-BACT)	Same as achieved in practice BACT for VOC.

(A) In lieu of complying with the applicable monomer content limits of SCAQMD Rule 1162 and SMAQMD Rule 465, a VOC capture and control system may be used. The capture and control system must meet a 90% total control efficiency in both rules.

The following control technologies have been identified as the most stringent, achieved in practice control technologies:

<table>
<tr><th colspan="3">BEST CONTROL TECHNOLOGIES ACHIEVED</th></tr>
<tr><th>Pollutant</th><th>Standard</th><th>Source</th></tr>
<tr><td>VOC</td><td>
1. a. Open Molding using the resins and gel coats meeting the following monomer content limits:
<table>
<tr><th>Gel Coats & Resins</th><th>Monomer Content (wt %)</th></tr>
<tr><td>Gel Coats</td><td></td></tr>
<tr><td>Clear Gel Coats</td><td></td></tr>
<tr><td>Marble Resin Gel Coats</td><td>40%</td></tr>
<tr><td>All Other Clear Gel Coats</td><td>44%</td></tr>
<tr><td>Pigmented Gel Coats</td><td></td></tr>
<tr><td>White and Off-White Gel Coats</td><td>30%</td></tr>
<tr><td>Non-White Gel Coats</td><td>37%</td></tr>
<tr><td>Primer Gel Coats</td><td>28%</td></tr>
<tr><td>Specialty Gel Coats</td><td>48%</td></tr>
<tr><td>Tooling Gel Coat</td><td>40%</td></tr>
<tr><td>Resins</td><td></td></tr>
<tr><td>Marble Resins</td><td>10% with fillers or
32% without fillers</td></tr>
<tr><td>Solid Surface Resins5</td><td>17%</td></tr>
<tr><td>Tub/Shower Resins</td><td>24% with fillers or
35% without fillers</td></tr>
<tr><td>Lamination Resins</td><td>31% with fillers or
35% without fillers</td></tr>
<tr><td>Fire Retardant Resins</td><td>38%</td></tr>
<tr><td>Corrosion Resistant</td><td>48%</td></tr>
<tr><td>High Strength</td><td>40%</td></tr>
<tr><td>Tooling Resins</td><td></td></tr>
<tr><td>Atomized (spray)</td><td>39%</td></tr>
<tr><td>Non-atomized</td><td>30%</td></tr>
<tr><td>Other Resins</td><td>35%</td></tr>
</table>
b. The use of Vapor Suppressed Tub/Shower Resins that meet the above monomer content limits.
or,
2. Closed molding system.
or,
3. Capture and control system that meets a 90% total control efficiency
</td><td>SCAQMD,
SJVUAPCD,
SDAPCD,
BAAQMD</td></tr>
</table>

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
	and, 4. Compliance with Rule 465 Cleaning Material Requirements	
NOx	No standard	
SOx	No standard	
PM10/PM2.5	Application equipment as specified in applicable District Rule	SJVUAPCD
CO	No standard.	
Styrene/ Methyl Methacrylate (T-BACT)	Same as achieved in practice BACT for VOC.	SCAQMD, SJVUAPCD, SDAPCD, BAAQMD

B. TECHNOLOGICALLY FEASIBLE AND COST EFFECTIVE (Rule 202, §205.1.b.):

Technologically Feasible Alternatives:
Any alternative basic equipment, fuel, process, emission control device or technique, singly or in combination, determined to be technologically feasible by the Air Pollution Control Officer.

The table below shows the technologically feasible alternatives identified as capable of reducing emissions beyond the levels determined to be “Achieved in Practice” as per Rule 202, §205.1.a.

Pollutant	**Technology**	**Source**
VOC	1. VOC capture and control (thermal/catalytic incineration or carbon adsorption) 2. Vapor Suppressed Resins in addition to rule limits.	SJVUAPCD, BAAQMD, SCAQMD
NOx	Not applicable	--
SOx	Not applicable	--
PM10	No technologically feasible alternatives identified	--
PM2.5	No technologically feasible alternatives identified	--
CO	Not applicable	--
Styrene/Methyl Methacrylate (T-BACT)	Compliance with NESHAP WWWW	US EPA

Vapor Suppressed Resins (VSR)
The SCAQMD reviewed the feasibility of vapor suppressed resins (VSR) during the rulemaking process to amend Rule 1162 in November 2001. (Final Staff Report for Proposed Amended Rule

1162 – Polyester Resin Operations, November 2001). They discussed the effects of using VSR in addition to the rule limits and decided that requiring VSR is not feasible for all applications. The vapor suppressants used in VSR are typically waxes. During the curing process of a suppressed resin, vapor suppressant forms a layer on the surface of the resin and minimizes the outward diffusion of monomers into the atmosphere. The drawback of vapor suppressants usage is the "secondary bonding", which often requires sanding or grinding the surface of parts if additional laminate layers are to be applied after curing. Such grinding is labor intensive, produces solid waste, may compromise the chemical resistance of the product, and may not be possible for parts with complex shapes (pg. 13). Additionally, industry commented that vapor suppressants may compromise the finished product and cause delamination (pg. 31). SCAQMD staff agreed and limited the requirement of using VSR to tub/shower resins, which is covered in the Achieved in Practice BACT summary. Therefore, no further vapor-suppressants will be considered.

National Emissions Standards for Hazardous Air Pollutants: Reinforced Plastic Composites Production (40 CFR 63 Subpart WWWW)
Although this NESHAP only applies to major sources of HAP or operations located at major sources of HAP, the measure is being reviewed as technologically feasible for T-BACT.

§63.5805. What standards must I meet to comply with this subpart?

Existing centrifugal casting or continuous casting/lamination operation	
HAP ≥ 100 TPY Reduce total organic HAP emissions by 95% by weight; or Meet HAP emissions limits of Table 5 (centrifugal casting); or Organic HAP emission limit of 1.47 lb/ton neat resin plus and neat gel coat plus applied (continuous lamination/casting).	HAP < 100 TPY Meet the appropriate requirements in Table 3 of the subpart.
All other existing operations	
Meet organic HAP emissions limits in Table 3 and work practice standards in Table 4.	
New operations	
HAP ≥ 100 TPY Except as provided in the subpart, reduce total organic HAP emissions by 95% by weight and meet work practice standards in Table 4.	HAP < 100 TPY Meet organic HAP emissions limits in Table 3 and work practice standards in Table 4.

Subpart WWWW allows facilities to average process streams, monomer content of resins, control equipment, and application methods to demonstrate compliance with this regulation. Facilities emitting less than 100 tons/year of HAP must meet the mass emission rates listed in Table 3. Subpart WWWW also allows a source to demonstrate compliance using Table 7, which uses the weight percent of HAP present in the resin. The following table is a comparison based on Tables 3 and 7 and the achieved in practices BACT.

	Achieved in Practice BACT	NESHAP WWWW	
Gel Coats & Resins	**Monomer Content (wt %)**	**Maximum HAP Content**	**Source**
Gel Coats			
Clear Gel Coats			
Marble Resin Gel Coats	40%	44%	Table 3
All Other Clear Gel Coats	44%	44%	Table 3
Pigmented Gel Coats			
White and Off-White Gel Coats	30%	30%	Table 3
Non-White Gel Coats	37%	37%	Table 3
Primer Gel Coats	28%	37%	Table 3
Specialty Gel Coats	48%	48%	Table 3
Tooling Gel Coat	40%	40%	Table 3
Resins			
Marble Resins	10% with fillers or 32% without fillers	38.5%	Table 7
Solid Surface Resins	17%	38.5%	Table 7
Tub/Shower Resins	24% with fillers or 35% without fillers	38.5%	Table 7
Lamination Resins	31% with fillers or 35% without fillers	38.5%	Table 7
Fire Retardant Resins	38%	60%	Table 3
Corrosion Resistant	48%	46.4%	Table 7
High Strength	40%	46.4%	Table 7
Tooling Resins			
Atomized (spray)	39%	43.0%	Table 7
Non-atomized	30%	45.9%	Table 7
Other Resins	35%	38.5%	Table 7

Except for corrosion resistant resins, the monomer contents of the Achieved in Practice BACT standard are more stringent. As noted earlier, the SJVUAPCD determined that the corrosion resistant resin limit approved by the BAAQMD was technologically infeasible. This limit appears to be based on the NESHAP limits. Additionally, because facilities have the option to average their resins to meet the NESHAP standards, facilities may actually use resins that exceed the content limits listed above, as long as they average them out using some other allowable method. Thus, in general, the Achieved in Practice BACT standards are more stringent than NESHAP WWWW for T-BACT.

<u>Cost Effective Determination:</u>
After identifying the technologically feasible control options, a cost analysis is performed to take into consideration economic impacts for all technologically feasible controls identified.

<u>Maximum Cost per Ton of Air Pollutants Controlled</u>

1. A control technology is considered to be cost-effective if the cost of controlling one ton of that air pollutant is less than the limits specified below (except coating operations):

Pollutant	Maximum Cost ($/ton)
ROG	17,500
NOx	24,500
PM10	11,400
SOx	18,300
CO	TBD if BACT is triggered

<u>Cost Effectiveness Analysis Summary</u>
The cost analysis was processed in accordance with the EPA OAQPS Air Pollution Control Cost Manual (Sixth Edition). The sales tax rate was based on the District's standard rate of 8.5% as approved on 10/17/16. The electricity (13.8 cents/kWh) and natural gas (7.12 dollars/1,000 cubic feet) rates were based on an industrial application as approved by the District on 10/17/16. The life of the equipment was based on the EPA cost manual recommendation. The interest rate was based on the previous 6-month average interest rate on United States Treasury Securities (based on the life of the equipment) and addition of two percentage points and rounding up the next higher integer rate. The labor (Occupation Code 51-8099: Plant and System Operators) rate was based on data from the Bureau of Labor Statistics.

<u>Carbon Adsorption System:</u>

Waste Gas Flow Rate = 8,000 acfm (10 air changes per hour)

Equipment Life = 10 years

Total Capital Investment = $274,980

Direct Annual Cost = $13,443 per year

Indirect Annual Cost = $44,524 per year

Total Annual Cost = $55,860 per year

VOC Removed = 3.19 tons per year

Cost of VOC Removal = $17,505 per ton reduced

A detailed calculation of the cost effectiveness for VOC removal with a carbon absorber is shown in Attachment B. Uncontrolled VOC emissions of 6,480 lb/year or greater is the cost-effective threshold for control equipment using carbon absorption control technology.

<u>Thermal Oxidizer:</u>

Waste Gas Flow Rate = 20,000 acfm (EPA Recommended Value)

Equipment Life = 20 years

Total Capital Investment = $1,120,944

Direct Annual Cost = $74,737 per year

Indirect Annual Cost = $141,446 per year

Total Annual Cost = $216,184 per year

VOC Removed = 12.26 tons per year

Cost of VOC Removal = $17,638 per ton reduced

A detailed calculation of the cost effectiveness for VOC removal with a thermal oxidizer is shown in Attachment C. Uncontrolled VOC emissions of 24,886 lb/year or greater is the cost-effective threshold for control equipment using thermal oxidation control technology.

Conclusion: In this analysis, different emission operating levels are presented with the corresponding total cost per ton of VOC controlled using either a carbon adsorption control or a thermal oxidizer. Uncontrolled VOC emission level of 6,480 lb per year or greater must be reached in order for the carbon absorption control option to be cost effective. Uncontrolled VOC emission level of 24,886 lb per year or greater must be reached in order for a thermal oxidizer to be cost effective. The emissions level for the cost effectiveness of controls is based on the District cost effective limit for VOC of $17,500 per ton controlled.

C. SELECTION OF BACT:

Based on the above analysis, BACT for VOC, NOx, SOx, PM10, PM2.5, and CO is as follows:

<table>
<tr><th colspan="3">BACT FOR POLYESTER RESIN OPERATION – CURED-IN-PLACE PIPE (CIPP) PROCESS
< 6,480 lb VOC/year, Minor Source (BACT #266)</th></tr>
<tr><th>Pollutant</th><th>Standard</th><th>Source</th></tr>
<tr><td>VOC</td><td>
1. a. Open Molding using the resins and gel coats meeting the following monomer content limits:
<table>
<tr><th>Gel Coats & Resins</th><th>Monomer Content (wt %)</th></tr>
<tr><td>Gel Coats</td><td></td></tr>
<tr><td>Clear Gel Coats</td><td></td></tr>
<tr><td>Marble Resin Gel Coats</td><td>40%</td></tr>
<tr><td>All Other Clear Gel Coats</td><td>44%</td></tr>
<tr><td>Pigmented Gel Coats</td><td></td></tr>
<tr><td>White and Off-White Gel Coats</td><td>30%</td></tr>
<tr><td>Non-White Gel Coats</td><td>37%</td></tr>
<tr><td>Primer Gel Coats</td><td>28%</td></tr>
<tr><td>Specialty Gel Coats</td><td>48%</td></tr>
<tr><td>Tooling Gel Coat</td><td>40%</td></tr>
<tr><td>Resins</td><td></td></tr>
<tr><td>Marble Resins</td><td>10% with fillers or
32% without fillers</td></tr>
<tr><td>Solid Surface Resins</td><td>17%</td></tr>
<tr><td>Tub/Shower Resins</td><td>24% with fillers or
35% without fillers</td></tr>
<tr><td>Lamination Resins</td><td>31% with fillers or
35% without fillers</td></tr>
<tr><td>Fire Retardant Resins</td><td>38%</td></tr>
<tr><td>Corrosion Resistant</td><td>48%</td></tr>
<tr><td>High Strength</td><td>40%</td></tr>
<tr><td>Tooling Resins</td><td></td></tr>
<tr><td>Atomized (spray)</td><td>39%</td></tr>
<tr><td>Non-atomized</td><td>30%</td></tr>
<tr><td>Other Resins</td><td>35%</td></tr>
</table>
b. The use of Vapor Suppressed Tub/Shower Resins that meet the above monomer content limits.
or,
2. Closed molding system.
or,
3. Capture and control system with 90% overall control efficiency
and,
4. Compliance with Rule 465 Cleaning Material Requirements
</td><td>SCAQMD,
SJVUAPCD,
SDAPCD,
BAAQMD</td></tr>
</table>

BACT FOR POLYESTER RESIN OPERATION – CURED-IN-PLACE PIPE (CIPP) PROCESS < 6,480 lb VOC/year, Minor Source (BACT #266)		
Pollutant	**Standard**	**Source**
NOx	No standard	
SOx	No standard	
PM10	Application equipment as specified in applicable District Rule	SJVUAPCD
PM2.5	Application equipment as specified in applicable District Rule	SJVUAPCD
CO	No standard	
T-BACT	Same as achieved in practice BACT for VOC	SCAQMD, SJVUAPCD

BACT FOR POLYESTER RESIN OPERATION – CURED-IN-PLACE PIPE (CIPP) PROCESS ≥ 6,480 lb VOC/year, Minor Source (BACT #267)		
Pollutant	**Standard**	**Source**
VOC	Compliance with Rule 465, **and** VOC capture and control system with 90% total control efficiency	Cost Effective
NOx	No standard	
SOx	No standard	
PM10	Application equipment as specified in applicable District Rule	SJVUAPCD
PM2.5	Application equipment as specified in applicable District Rule	SJVUAPCD
CO	No standard	
T-BACT`	Same as achieved in practice BACT for VOC	SCAQMD, SJVUAPCD

APPROVED BY: Brian F Krebs **DATE:** **06/18/20**

Attachment A

Review of BACT Determinations published by EPA

List of BACT determinations published in EPA's RACT/BACT/LAER Clearinghouse (RBLC) for Fiberglass Manufacturing (except boats):

RBLC#	Permit Date	Process Code (B), (C)	Equipment	Pollutant	Standard	Case-By-Case Basis
IN-0162	08/19/2010	49.005	FIBERGLASS PRODUCTION LINE ONE	VOC	COMPLIANCE WITH 40 CFR 63 WWWW AND COMPLIANCE WITH OPERATOR TRAINING REQUIREMENTS IN 326 IAC 20-56-2	BACT-PSD
IN-0162	08/19/2010	49.005	FIBERGLASS PRODUCTION LINE TWO	VOC		BACT-PSD
WA-0338	07/11/2007	49.005	WOOL FIBERGLASS INSULATION – FORMING AND COLLECTION	CO	24.95 LB/HR	BACT-PSD
				NOx	1.07 LB/HR	
				PM	14.90 LB/HR	
				VOC	11.34 LB/HR	
OR-0045	08/04/2005	49.005	FIBERGLASS LAMINATION	VOC	NO EMISSION LIMITS, BACT IS VOC CONTENT LIMITS AND TRANSFER EFFICIENCY REQUIREMENTS. ALL ADD-ON CONTROL TECHNOLOGIES WERE FOUND TO BE COST-PROHIBITIVE. CALIFORNIA CONTENT LIMITS WERE USED AS BACT. THE PERMIT INCLUDES LIMITS ON VOC CONTENT IN RESINS, GEL COATS AND TRANSFER EFFICIENCIES TO REDUCE VOC EMISSIONS	BACT-PSD;

= Not applicable to this determination. Equipment is for production of fiberglass wool insulation.

= Selected as the most stringent BACT determination achieved in practice.

Attachment B

Cost Effectiveness Analysis Carbon Absorption

Data Inputs

Select the type of carbon adsorber system:	Fixed-Bed Carbon Adsorber with Steam Regeneration		RESET
For fixed-bed carbon adsorbers, provide the following information:			
Select the type of operation:	Intermittent Operation		
Select the type of material used to fabricate the carbon adsorber vessels:	Stainless Steel, 304		
Select the orientation for the adsorber vessels:	Horizontal		

Enter the design data for the proposed Fixed-Bed Carbon Adsorber with Steam Regeneration

Number of operating hours per year (θ_s)	2,080	hours/year	
Waste Gas Flow Rate (Q)	8,000	acfm (at atmospheric pressure and 77°F)	
VOC Emission Rate (m_{voc})	3.115	lbs/hour	
Required VOC removal efficiency (E)	98.5	percent	
Superficial Bed Velocity (v_b)	75.00	ft/min	
Estimated equipment life of adsorber vessels and auxiliary Equipment (n)	15	Years*	* 15 years is a default equipment life. User should enter actual value, if known.
Estimated Carbon life (n)	5	Years	
Total Number of carbon beds (N_{total})	3	Beds*	* 3 beds is the default. User should enter actual number of beds, if known.
Number of carbon beds adsorbing VOC when system is operating (N_A)	2	Beds*	* 2 beds is the default. User should enter actual number of beds, if known.
Total time for adsorption (θ_A)	12	hours*	* 12 hours is a default value. User should enter actual value, if known.
Total time for desorption (θ_D)	5	hours*	* 5 hours is a default value. User should enter actual value, if known.
Estimated Carbon Replacement Rate (CRR)	379	lbs/hour*	* 379 lbs./hour is a default value. User should enter actual value, if known.

Enter the Characteristics of the VOC/HAP:

Name of VOC/HAP	Styrene	
Partial Pressure of Styrene in waste gas stream	0.0104	psia
Parameter "k" for Styrene	0.551	**Note:** Typical values of "k" and "m" for some common VOCs are shown in Table A.
Parameter "m" for Styrene	0.110	

Enter the cost data for the carbon adsorber:

Desired dollar-year	2020			
CEPCI* for 2020	567.5	CEPCI value for 2020	390.6	1999
Annual Interest Rate (i)	5	percent*	* 5 percent is a default value. User should enter current prime bank rate.	

* CEPCI is the Chemical Engineering Plant Cost Index. The use of CEPCI in this spreadsheet is not an endorsement of the index for purpose of cost escalation or de-escalation, but is there merely to allow for availability of a well-known cost index to spreadsheet users. Use of other well-known cost indexes (e.g., M&S) is acceptable.

Electricity (P_{elec})	$0.1380	per kWh	
Steam (P_s)	$5.00	per 1,000 lbs*	* $5.00/1,000 lbs is a default value. User should enter actual value, if known.
Cooling Water (P_{cw})	$3.55	per 1,000 gallons of water*	* $3.55/1,000 gallons is a default value. User should enter actual value, if known.
Operator Labor Rate	$27.48	per hour*	* $27.48/hour is a default value. User should enter actual value, if known.
Maintenance Labor Rate	$30.23	per hour*	* $30.23/hour is a default value. User should enter actual value, if known. If the rate is not known, use 1.10 x operator labor rate.
Carbon Cost (CC)	$4.20	per lb	* $4.20/lb is a default value based on 2018 market price. User should enter actual value, if known.
Re-Sale Value of Recovered VOC (P_{voc})	$0.33	per lb*	* $0.33/lb is a default value for recovered toluene based on 2018 data. User should enter actual value of
Disposal/Treatment Cost for Recovered VOC (D_{voc})	$0.00	per lb*	* $0/lb is a default value for disposal and/or treatment of recovered VOC/HAP. User should enter actual

If known, enter any additional costs for site preparation and building construction/modification:

Site Preparation (SP) =	$0	* Default value. User should enter actual value, if known.	
Buildings (Bldg) =	$0	* Default value. User should enter actual value, if known.	
Equipment Costs for auxiliary equipment (e.g., ductwork, dampers, and stack) (EC_{aux}) =	$32,000	* Default value. User should enter actual value, if known.	
Contingency Factor (CF)	10.0	percent*	* 10 percent is a default value. The contingency factor should be between 5 and 15 percent.

Cost Estimate

Capital Costs

Estimated capital costs for a Fixed-Bed Carbon Adsorber with Steam Regeneration with the following characteristics:

VOC Controlled/Recovered =	Styrene
Adsorber Vessel Orientation =	Horizontal
Operating Schedule =	Intermittent Operation

Total Capital Investment (TCI) (in 2020 dollars)

Parameter	Equation	Cost
Costs for Each Carbon Adsorber Vessel (C_v) =	$271 \times F_m \times S^{0.778}$ =	$21,199
Total Cost for All Carbon Adsorber Vessels and Carbon(EC_{Adsorb}) =	$5.82 \times Q^{-0.133} \times [C_c + (N_A + N_D) \times C_v]$ =	$114,497
Auxiliary Equipment (EC_{aux}) =	(Based on design costs or estimated using methods provided in Section 2)	$32,000
Total Purchased Equipment Costs for Carbon Adsorber (A) =	$= EC_{Adsorb} + EC_{aux}$ =	$146,497
Instrumentation =	0.10 × A =	Included in A
Sales taxes =	0.03 × A =	$4,395
Freight =	0.05 × A =	$7,325
	Total Purchased Equipment Costs (B) =	$158,217

Direct Installation Costs (in 2020 dollars)

Parameter	Equation	Cost
Foundations and Supports =	0.08 × B =	$12,657
Handling and Erection =	0.14 × B =	$22,150
Electrical =	0.04 × B =	$6,329
Piping =	0.02 × B =	$3,164
Insulation =	0.01 × B =	$1,582
Painting =	0.01 × B =	$1,582
Site Preparation (SP) =		$0
Buildings (Bldg) =		$0
	Total Direct Costs (DC) = B + (0.3 × B) + SP + Bldg =	$205,682

Total Indirect Installation Costs (in 2020 dollars)

Parameter	Equation	Cost
Engineering =	0.10 × B =	$15,822
Construction and field expenses =	0.05 × B =	$7,911
Contractor fees =	0.10 × B =	$15,822
Start-up =	0.02 × B =	$3,164
Performance test =	0.01 × B =	$1,582
	Total Indirect Costs (IC) =	$44,301
Contingency Cost (C) =	CF(IC+DC)=	$24,998

Total Capital Investment (TCI) =	**DC + IC + C = (1.28 × B) + SP + Bldg. + C =**	**$274,980**	**in 2020 dollars**

Annual Costs

Direct Annual Costs			
Parameter	**Equation**	**Cost**	
Annual Electricity Cost =	$Q_{Elec} \times P_{elec}$ =	$729	
Annual Steam Cost (C_s) =	3.50 x m_{voc} x Θ_s x P_s =	$113	
Annual Cooling Water Cost (C_{cs}) =	3.43 x C_s/P_s x P_{wc} =	$276	
Operating Labor Costs:	Operator = 0.5 hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$3,572	
	Supervisor = 15% of Operator	$536	
Maintenance Costs:	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$3,930	
	Materials = 100% of maintenance labor	$3,930	
Carbon Replacement Costs:	Labor = CRF_{carbon} x (Labor Rate × M_c)/CRR =	$4	
	Carbon = CRF_{carbon} x CC x M_c x 1.08 =	$352	
Direct Annual Costs (DAC) =		**$13,443**	**in 2020 dollars**

Indirect Annual Costs			
Parameter	**Equation**	**Cost**	
Overhead	= 60% of sum of operator, supervisor, maintenance labor Plus maintenance materials	$7,181	
Administrative Charges	= 2% of TCI	$5,500	
Property Taxes	= 1% of TCI	$2,750	
Insurance	= 1% of TCI	$2,750	
Capital Recovery	= $CRF_{Adsorber}$ × (TCI - [(1.08 x CC x M_c) + (LR x M_c/CRR)] =	$26,344	
Indirect Annual Costs (IAC) =		**$44,524**	**in 2020 dollars**

Recovered Solvent Credit/Disposal Costs

Disposal Cost		
Parameter	**Equation**	**Cost**
VOC Disposal/Treatment Costs (*Disposal $_{cost}$*)	$= m_{voc} \times \Theta_s \times D_{voc} \times E =$	$0

VOC Recovery Credit			
Parameter	**Equation**	**Cost**	
Annual Recovery Credit for Condensate (RC)	$= m_{voc} \times \Theta_s \times P_{voc} \times E =$	$2,106	
Total Annual Cost (TAC) =	**DAC + IAC + C + $Disposal_{cost}$ - RC =**	**$55,860**	**in 2020 dollars**

Cost Effectiveness

Cost Effectiveness			
Parameter	**Equation**	**Cost**	
Total Annual Cost =	TAC =	$55,860	per year in 2020 dollars
Annual Quantity of VOC Removed/Recovered =	$W_{voc} = m_{voc} \times \Theta_s \times E =$	3.19	tons/year
Cost Effectiveness =	Total Annual Cost (TAC) / Annual Quantity of VOC Removed/Recovered =	$17,505.51	per ton of pollutants removed/recovered in 2020 dollars

Attachment C

Cost Effectiveness Analysis Thermal Oxidizer

Data Inputs

Select the type of oxidizer: Regenerative Thermal Oxidizer

RESET

Enter the following information for your emission source:

Composition of Inlet Gas Stream				
Pollutant Name	Concentration (ppmv)	Lower Explosive Limit (LEL) (ppmv)*	Heat of Combustion (Btu/scf)	Molecular Weight
Styrene	37	9,000	4,629	104.15

Note: The lower explosion limit (LEL), heat of combustion and molecular weight for some commonly used VOC/HAP are provided in the table below.

s

Enter the design data for the proposed oxidizer:

Percent Energy Recovery (HR) = 70 percent

Number of operating hours/year	2,080	hours/year	
Inlet volumetric flow rate(Q_{wi}) at 77°F and 1 atm.	20,000	scfm*	* 20,000 scfm is a default volumetric flow rate. User should enter actual value, if known.
Inlet volumetric flow rate(Q_{wi}) (actual conditions)	20,900	acfm*	* 20,900 acfm is a default volumetric flow rate. User should enter actual value, if known.
Pressure drop (ΔP)	23	inches of water*	* 23 inches of water is the default pressure drop for thermal oxidizers; 19 inches of water is the default pressure drop for catalytic oxidizers. Enter actual value, if known.
Motor/Fan Efficiency (ε)	60	percent*	* 60% is a default fan efficiency. User should enter actual value, if known.
Inlet Waste Gas Temperature (T_{wi})	77	°F	
Operating Temperature (T_{fi})	2,000	°F*	* Note: Default value for Tfi is 2000°F for thermal regenerative oxidizers. Use actual value if known. Tfi for regenerative oxidizers typically between 1800 and 2000°F.
Destruction and Removal Efficiency (DRE)	98.5	percent	
Estimated Equipment Life	20	Years*	* 20 years is the typical equipment life. User should enter actual value, if known.
Heat Loss (η)	1	percent*	* 1 percent is a default value for the heat loss. User should enter actual value, if known. Heat loss is typically between 0.2 and 1.5%.

Enter the cost data:

Desired dollar-year	2020			
CEPCI* for 2020	541.7	Enter the CEPCI value for 2020	541.7	2016 CEPCI
Annual Interest Rate (i)	5	Percent		
Electricity ($Cost_{elect}$)	0.138	$/kWh		
Natural Gas Fuel Cost ($Cost_{fuel}$)	0.00712	$/scf		
Operator Labor Rate	$26.61	per hour		* $26.61 per hour is a default labor rate. User should enter actual value, if known.
Maintenance Labor rate	$27.40	per hour		* $27.40 per hour is a default labor rate. User should enter actual value, if known.
Contingency Factor (CF)	10.0	Percent		* 10 percent is a default value for construction contingencies. User may enter values between 5 and 15 percent.

* CEPCI is the Chemical Engineering Plant Cost Escalation/De-escalation Index. The use of CEPCI in this spreadsheet is not an endorsement of the index for purposes of cost escalation or de-escalation, but is there merely to allow for availability of a well-known cost index to spreadsheet users. Use of other well-known cost indexes (e.g., M&S) is acceptable.

Cost Estimate

Direct Costs			
Total Purchased equipment costs (in 2020 dollars)			
Incinerator + auxiliary equipment[a] (A) =			
Equipment Costs (EC) for Regenerative Oxidizer	=[2.664 x 100,000 + (13.98 x Qtot)] x (2020 CEPI/2016 CEPCI) =	$546,578	in 2020 dollars
Instrumentation[b] =	0.10 × A =	$54,658	
Sales taxes =	0.03 × A =	$16,397	
Freight =	0.05 × A =	$27,329	
	Total Purchased equipment costs (B) =	$644,962	in 2020 dollars
Direct Installation Costs (in 2020 dollars)			
Foundations and Supports =	0.08 × B =	$51,597	
Handlong and Errection =	0.14 × B =	$90,295	
Electrical =	0.04 × B =	$25,798	
Piping =	0.02 × B =	$12,899	
Insulation for Ductwork =	0.01 × B =	$6,450	
Painting =	0.01 × B =	$6,450	
Site Preparation (SP) =		$0	
Buildings (Bldg) =		$0	
	Total Direct Installaton Costs =	$193,489	
Total Direct Costs (DC) =	Total Purchase Equipment Costs (B) + Total Direct Installation Costs =	$838,450	in 2020 dollars
Total Indirect Installation Costs (in 2020 dollars)			
Engineering =	0.10 × B =	$64,496	
Construction and field expenses =	0.05 × B =	$32,248	
Contractor fees =	0.10 × B =	$64,496	
Start-up =	0.02 × B =	$12,899	
Performance test =	0.01 × B =	$6,450	
	Total Indirect Costs (IC) =	$180,589	
Continency Cost (C) =	CF(IC+DC)=	$101,904	
Total Capital Investment =	**DC + IC +C =**	**$1,120,944**	**in 2020 dollars**

Footnotes

a - Auxiliary equipment includes equipment (e.g., duct work) normally not included with unit furnished by incinerator vendor.

b - Includes the instrumentation and controls furnished by the incinerator vendor.

Direct Annual Costs		
Annual Electricity Cost	= Fan Power Consumption × Operating Hours/year × Electricity Price =	$26,906
Annual Fuel Costs for Natural Gas	= $Cost_{fuel}$ × Fuel Usage Rate × 60 min/hr × Operating hours/year	$36,729
Operating Labor	Operator = 0.5hours/shift × Labor Rate × (Operating hours/8 hours/shift)	$3,459
	Supervisor = 15% of Operator	$519
Maintenance Costs	Labor = 0.5 hours/shift × Labor Rate × (Operating Hours/8 hours/shift)	$3,562
	Materials = 100% of maintenance labor	$3,562
Direct Annual Costs (DC) =		**$74,737 in 2020 dollars**
Indirect Annual Costs		
Overhead	= 60% of sum of operating, supervisor, maintenance labor and maintenance materials	$6,661
Administrative Charges	= 2% of TCI	$22,419
Property Taxes	= 1% of TCI	$11,209
Insurance	= 1% of TCI	$11,209
Capital Recovery	= CRF[TCI-1.08(cat. Cost)]	$89,947
Indirect Annual Costs (IC) =		**$141,446 in 2020 dollars**
Total Annual Cost =	**DC + IC =**	**$216,183 in 2020 dollars**

Cost Effectiveness

Cost Effectiveness = (Total Annual Cost)/(Annual Quantity of VOC/HAP Pollutants Destroyed)

Total Annual Cost (TAC) =	$216,183 per year in 2020 dollars
VOC/HAP Pollutants Destroyed =	12.26 tons/year
Cost Effectiveness =	$17,638 per ton of pollutants removed in 2020 dollars