draft

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY

Comment and Response Document

TITLE V Operating Permit No. 23-00012
(RACT II)

Braskem America, Inc.
Marcus Hook Borough, Delaware County

November 2019

Commenter's Name	Title	Agency
Cynthia Stahl	Acting Associate Director	US EPA Region III

Comment 1

In the VOC RACT economic analysis (within the Facility's RACT II analysis), Braskem did not provide all the data it used to assess the range of control efficiencies. For example, design analysis and vendor quotes were not included to justify the total annual costs, including operating and maintenance costs as well as capital recovery costs. In addition, because this RACT evaluation and determination is to become a state implementation plan (SIP) revision, all documentation must be publicly available and included in the SIP package at the time of the SIP public comment period and upon submittal to EPA for approval. If this information is based on confidential or proprietary information, then please submit the estimates with a claim of Confidential Business Information (CBI) and they will not be released to the public.

Response 1

The RACT II economic analysis is in the Attachment to Braskem's RACT II Analysis and Significant Permit Modification (November 11, 2016 revised). Braskem utilized costing methodologies derived from EPA's Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001 (OAQPS Manual). As part of the facility's 2009 plan approval for thermal oxidizer shutdown, Braskem provided equipment costs for the thermal oxidizer with concentrator and carbon bed options. Those estimates have been adjusted to 2015 dollars using the Chemical Engineering Plant Cost Index (CEPCI). The analysis uses Braskem-specific labor rates, adjusted to 2015 dollars using the CEPCI.

The Attachment to this response includes relevant information assembled by Braskem's technical consultant in support of its original proposal. This information reflects economic information for relevant equipment based on the analyses by the technical consultants.

In addition, Braskem indicated to the Department of Environmental Protection. DEP that it received budgetary estimates from John Zink Company through Ryan Equipment Sales Company. The budgetary cost estimate was prepared for an RTO for 1000 scfm of air with trace 0.16% C3, C6 and C9 maximum vapors at 99% DRE. The specific cost estimate for such system was $200,000 to $250,000.

Comment 2

In PADEP's review memo, the Agency lists RACT for the storage silos as the VOC emission limits of 12.10 tons per year (TPY) for source 101A and 4.63 TPY for Source ID 101B. To clarify, the proposed VOC RACT emission for source 101B (the three storage silos in plant 2) is in a 12-month rolling sum.

Response 2

Section D Condition #002 for each source (101A and 101B) in the Operating Permit states the TPY limit as 12-month rolling sum. A Review Memo Addendum (Attachment B), dated November 18, 2019, specifies the annual basis as a 12-month rolling sum.

Comment 3

Braskem was subject to RACT under the 1-hour ozone standard and still is subject to the requirements of a SIP approved permit. See Permit No. 23-00012 issued on February 15, 1996, as approved into the Pennsylvania SIP on December 15, 2000 (65 FR 78418). It should be noted that there are several remaining RACT I requirements that are still applicable to the Facility, such as the VOC limits of 10 pounds/hour and 240 pounds/day for the plant 1 polypropylene plant source.

Response 3

On December 15, 2000, several requirements of RACT 1 Operating Permit OP-23-0012, issued to then owner Epsilon Products Company, were entered into the State Implementation Plan (SIP). The following conditions were listed in the Federal Register (Vol. 65 No. 242) as part of the SIP:

Condition #004A – a flare system for VOC emissions from 2 polypropylene reaction systems, 2 compressor vents, 1 mixer vent, 2 analyzer and pellet dryer vents

Condition #005 – The flare shall be operated with a flame present at all times

Condition #006 – The presence of a flare pilot flame shall be monitored using a thermocouple or equivalent device

Condition #008 – Any gases to be flared shall have a net heating value of 300 Btu per standard cubic foot

Condition #011 – The company shall record the types, amounts, and physical properties of all volatile organic compounds used on a daily and annual basis in the polypropylene Plant No. production process.

Condition #016 – Recordkeeping shall be conducted for major VOC sources to demonstrate compliance with Pennsylvania's RACT regulation, with records being kept for at least 2 years.

Condition #017 – RACT monitoring and recordkeeping shall be implemented upon issuance of the RACT permit.

In a telephone conference on January 24, 2018, EPA advised the Pennsylvania DEP that emission limits of 10 pounds per hour and 240 pounds per day for the entire Plant 1, included with Condition #004C of OP-23-0012, but not included with the SIPed conditions, were intended by EPA to be entered into the SIP. The DEP should request that the original RACT 1 be removed and replaced with RACT II, since there was an ambiguity as to what was intended with RACT I. The company could propose alternate conditions for the RACT II permit, provided the conditions were more protective of the environment than the original RACT I.

The company proposed the following for RACT II for plant 1's combined emissions from combination of fugitive sources, silo sources and manufacturing sources.:

VOC emissions from P1 sources shall be limited to 10 lb/hr and 240 lb/day, each calculated as a rolling twelve (12) month average. At the conclusion of each month during which P1 sources have operated, the permittee shall calculate VOC emissions using established emission estimation techniques, and determine the hours and days of operation for the month. The permittee shall record the monthly VOC emission calculation and operating record and use this information to calculate average VOC emissions as lb/hr and lb/day for the rolling 12-month period then ending with that month.

The company has added an averaging basis for calculation of the hourly and daily limits.

Attachment C compares the original RACT 1 SIPed conditions with comparable conditions in the proposed RACT I and RACT II permit. Conditions in the proposed permit are at least as protective of the environment as RACT 1.

Comment 4

In PADEP's review memo and in the proposed significant modification permit for Braskem, revised April 3, 2017 for incorporation into Pennsylvania's SIP, PADEP neglected to include 40 CFR 60 Subpart VV requirements among the RACT II determination for the following sources: 102A, 102B, 106, and 107.

Response 4

Source IDs 102A and 102B have continuous and intermittent VOC emissions that are controlled by a flare (Source ID C02).

Source IDs 106 and 107 have both fugitive VOC emissions and continuous and intermittent VOC emissions. The continuous and intermittent VOC emissions are controlled by another flare (Source ID C100).

Continuous and Intermittent VOC Emissions

The continuous and intermittent VOC emissions (not equipment leaks) from Source IDs 102A, 102B, 106, and 107 are subject to the provisions of 40 CFR 60 Subpart DDD.

Fugitive Emissions

Fugitive emissions from sources 106 and 107 are subject to 40 CFR Part 60 Subpart VV. Applicable conditions for Subpart VV were included in the April 3, 2017 issuance of the significant Operating Permit modification (e.g. Source ID 106, Conditions #002, #004, #005, #007, etc.)

Source IDs 102A and 102B are not subject to the provisions of 40 CFR 60 Subpart VV, that is, Standards of Performance for Equipment Leaks of VOC in the Synthetic Organic Chemicals Manufacturing Industry, as they do not contain the "group of all equipment (pumps, valves, etc.) that is an affected facility" under 40 CFR Sections 60.480(a)(2) and 60.481. Fugitive emissions from Plant 1 (102A) and Plant 2 (102B) are grouped as Plant 1 and Plant 2 Fugitive Sources (Source IDs 103A and 103B). Subpart VV requirements are therefore under Source IDs 103A and 103B (e.g. Source 103A Conditions #002, #006, #007, #009 etc.) in the Operating Permit.

Attachments:

Cost Effectiveness
Review Memo Addendum
RACT I and II Comparison

Attachment A
Cost Effectiveness

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RACT II - Cost Effectiveness Summary

Cost Effectiveness ($/ton reduced)		Control Option			
		Thermal Oxidation	Thermal Oxidation with Concentrator	Catalytic Thermal Oxidation	Adsorption
101A	Plant 1, Three Storage Silos	$17,161	$16,330	$15,970	$21,040
101B	Plant 2, Three Storage Silos	$46,214	$44,858	$43,871	$35,999

Previous submittal (1-6-17 PADEP Comments)

Cost Effectiveness ($/ton reduced)		Control Option			
		Thermal Oxidation	Thermal Oxidation with Concentrator	Catalytic Thermal Oxidation	Adsorption
101A	Plant 1, Three Storage Silos	$17,838	$21,318	$16,460	$21,667
101B	Plant 2, Three Storage Silos	$47,864	$58,563	$45,217	$37,635

Change

Cost Effectiveness ($/ton reduced)		Control Option			
		Thermal Oxidation	Thermal Oxidation with Concentrator	Catalytic Thermal Oxidation	Adsorption
101A	Plant 1, Three Storage Silos	($677)	($4,989)	($490)	($627)
101B	Plant 2, Three Storage Silos	($1,649)	($13,704)	($1,346)	($1,636)
101A	Plant 1, Three Storage Silos	-4%	-31%	-3%	-3%
101B	Plant 2, Three Storage Silos	-4%	-31%	-3%	-5%

Updates to the Calculations

- Added Sources & Equations column to justify costs.
- Removed annualized cost factor from the annual costs section of each evaluation so that it is not double counted.
- Adjusted purchased equipment costs calculated using OAQPS methodology from 1999 to 2015 dollars ($).

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RACT II - Cost Summary

Assumptions for all equipment:

Number of Years (n)	15
Interest Rate, % (i)	10
Annualized Cost Factor (ACF)	0.131

$$ACF = \frac{i(1+i)^n}{(1+i)^n - 1}$$

EPA Air Pollution Control Cost Manual, Sixth Edition,
EPA/452/B-02-001 - Equation 2.8a

Year	*Chemical Engineering* Cost Index
1982	314
1986	318.4
1988	342.5
1990	357.6
1991	361
1994	368.1
1998	389.5
1999	390.6
2000	394.1
2002	395.6
2009	521.9
2013	567.3
2014	576.1
2015	556.8

Year	EIA Industrial Natural Gas Price ($/mscf)
2015	3.88

July 2017
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Plant 1 Silos - VOC RACT II Cost Effectiveness Summary

		A	B	C	D	E	F	G	H	I	J
Source	Control	Potential Throughput (lb/yr)	Current Emission Rate[1] (lb/hr)	Potential Emissions[2] (TPY)	Control Efficiency[2] (%)	Maximum Post Control Emissions (TPY)	Potential VOC Reduced (TPY)	2015 Total Capital Cost ($)	2015 O&M Cost ($)	2015 Annualized Cost[1] ($)	2015 Cost Effectiveness ($/Ton Reduced)
Plant 1, Three Storage Silos	Thermal Oxidizer	595,680,000.0	0.42	12.1	98%	0.4	11.7	160,433	180,203	201,296	17,161
Plant 1, Three Storage Silos	Thermal Oxidizer and VOC Concentrator	595,680,000.0	0.42	12.1	98%	0.4	11.7	445,083	133,029	191,546	16,330
Plant 1, Three Storage Silos	Catalytic Thermal Oxidizer	595,680,000.0	0.42	12.1	98%	0.4	11.7	106,949	173,270	187,331	15,970
Plant 1, Three Storage Silos	Carbon Bed Absorbtion	595,680,000.0	0.42	12.1	98%	0.2	11.9	56,567	242,050	249,487	21,040
Calculation						= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

[1] Based on 2012 Stack Test Results.
[2] Based on current TVOP emission limit.

July 2017
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VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Thermal Oxidizer (VOC Control)	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	1,000	scfm
Control Efficiency	98%	

Evaluated at 2015 Cost and Efficiencies
Costs derived from *EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001*

COST COMPONENT:	COST ($)	Sources & Equations
DIRECT COSTS		
Purchased Equipment Costs		
Equipment Cost (EC)	74,654	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Eqn. 2.29 adjusted from 1999 dollars to 2015 using the Chemical Engineering Plant Cost Index (CEPCI)*
Instrumentation (10% of EC)	7,465	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Sales taxes (6% of EC)	4,479	
Freight (5% of EC)	3,733	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Subtotal - Purchased Equipment Costs (PEC)	90,331	
Direct Installation Costs		
Foundations & Supports (8% of PEC)	7,226	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Handling & Erection (14% of PEC)	12,646	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Electrical (4% of PEC)	3,613	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Piping (2% of PEC)	1,807	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Insulation for ductwork (1% of PEC)	903	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Painting (1% of PEC)	903	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Site Preparation / Buildings- Included above	---	
Subtotal - Direct Installation Costs (DIC)	27,099	
TOTAL DIRECT COSTS (TDC)	117,430	
INDIRECT INSTALLATION COSTS		
Engineering Costs (10% of PEC)	9,033	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Construct. & Field Expenses (5% of PEC)	4,517	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Contractor Fees (10% of PEC)	9,033	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Start-up (2% of PEC)	1,807	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Performance Test (1% of PEC)	903	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Compliance Test	15,000	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Contingency (3% of PEC)	2,710	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
TOTAL INDIRECT COSTS, IC	43,003	
TOTAL CAPITAL INVESTMENT (TCI)	160,433	

July 2017
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VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Thermal Oxidizer (VOC Control)	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	1,000	scfm
Control Efficiency	98%	

COST COMPONENT:	COST ($)	Sources & Equations
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Operator/Supervisor (0.5 hr/shift @ $45.72/hr, 500 hours/year)	22,860	*Operator ($) = $45.72/hour × 500 hours/year (Braskem Specific Labor Cost)*
Labor (0.5 hr/shift @ $39.91/hr, 500 hours/year)	19,955	*Labor ($) = $39.91/hour × 500 hours/year (Braskem Specific Labor Cost)*
Material (100% of maintenance labor)	19,955	*Material ($) = 100% × Labor ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
	62,770	
Utilities		
Natural Gas Cost (18.8 MMscf/yr and $3.88/Mscf)	72,944	$Natural\ Gas\ (\$) = 18.8\ \frac{MMscf}{yr} * \$3.88/Mscf \times \frac{1000\ Mscf}{MMscf}$ *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
Electricity Cost ($0.06/kWh) - OAQPS Equation 2.42 and Table 2.11	410.0	$Electricity\ (\$) = \frac{1.17 \times 10^{-4} \times 1{,}000\ scfm \times 4\ inches\ water}{0.6} \times \frac{\$0.06}{kWh} \times 1{,}790\ \frac{hours}{year}$ *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
	73,354	
ANNUAL INDIRECT COSTS		
Overhead (60% of Operation and Maintenance Labor)	37,662	*Overhead ($) = 60% × Operation and Maintenance Labor ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table*
Administrative Charges (2% of TCI)	3,209	*Administrative ($) = 2% × TCI ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
Property Taxes (1% of TCI)	1,604	*Property Tax ($) = 1% × TCI ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
Insurance (1% of TCI)	1,604	*Insurance ($) = 1% × TCI ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
	44,079	
TOTAL ANNUAL COSTS	180,203	

July 2017
Braskem
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VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Thermal Oxidizer (VOC Control)	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	1,000	scfm
Control Efficiency	98%	

COST COMPONENT:	COST ($)	Sources & Equations
TOTAL ANNUAL O&M COSTS	180,203	
Annualized Cost Factor		
Equipment Life (years) = 15		
Interest Rate (%) = 10		
Annualized Cost Factor	0.13	$ACF = \frac{i(1+i)^n}{(1+i)^n - 1}$ *OAQPS Control Cost Manual (6th Edition) Section 4.2, Chapter 2 Equation 2.55*
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT	150,433	
TOTAL ANNUAL CAPITAL REQUIREMENT	21,093	*Total Annual Capital Requirement ($) = TCI ($) * ACF* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 1 Equation 1.28*
TOTAL ANNUALIZED COST *(Total annual O&M cost and annualized capital cost)*	201,296	*Total Annualized Cost ($)* *= Total Annual Capital Requirement + Total O&M Costs ($)*

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Thermal Oxidizer and VOC Concentrator	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

Evaluated at 2015 Cost and Efficiencies
Costs derived from *EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001*

COST COMPONENT:	COST ($)	Sources & Equations
DIRECT COSTS		
Purchased Equipment Costs		
Equipment Cost (EC)	220,770	*Based on 2009 preliminary budgetary estimate from Anguil Environmental Systems, Inc. adjusted from 2009 to 2015 dollars using the CEPCI.*
Instrumentation (10% of EC)	22,077	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Sales taxes (6% of EC)	13,246	
Freight (5% of EC)	11,039	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Subtotal - Purchased Equipment Costs (PEC)	267,132	
Direct Installation Costs		
Foundations & Supports (8% of PEC)	21,371	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Handling & Erection (14% of PEC)	37,398	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Electrical (4% of PEC)	10,685	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Piping (2% of PEC)	5,343	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Insulation for ductwork (1% of PEC)	2,671	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Painting (1% of PEC)	2,671	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Site Preparation / Buildings- Included above	---	
Subtotal - Direct Installation Costs (DIC)	80,140	
TOTAL DIRECT COSTS (TDC)	347,272	
INDIRECT INSTALLATION COSTS		
Engineering Costs (10% of PEC)	26,713	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Construct. & Field Expenses (5% of PEC)	13,357	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Contractor Fees (10% of PEC)	26,713	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Start-up (2% of PEC)	5,343	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Performance Test (1% of PEC)	2,671	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Compliance Test	15,000	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Contingency (3% of PEC)	8,014	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
TOTAL INDIRECT COSTS IC	97,811	
TOTAL CAPITAL INVESTMENT (TCI)	445,083	

July 2017
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VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Thermal Oxidizer and VOC Concentrator	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:	COST ($)	Sources & Equations
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Operator/Supervisor (0.5 hr/shift @ $45.72/hr, 500 hours/year)	22,860	*Operator ($) = $45.72/hour × 500 hours/year (Braskem Specific Labor Cost)*
Labor (0.5 hr/shift @ $39.91/hr, 500 hours/year)	19,955	*Labor ($) = $39.91/hour × 500 hours/year (Braskem Specific Labor Cost)*
Material (100% of maintenance labor)	19,955	*Material ($) = 100% × Labor ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
	62,770	
Utilities		
Natural Gas Cost (3.76 MMscf/yr and $3.88/Mscf)	14,589	$Carbon\ (\$) = 11.6\ \frac{ton}{yr} * \frac{\$4{,}600}{ton}$
Electricity Cost ($0.06/kWh) - OAQPS Equation 2.42 and Table 2.11	205.0	$Electricity\ (\$) = \frac{1.17 \times 10^{-4} \times 1{,}000\ scfm \times 4\ inches\ water}{0.6} \times \frac{\$0.06}{kWh} \times 1{,}790\ \frac{hours}{year}$
	14,794	
ANNUAL INDIRECT COSTS		
Overhead (60% of Operation and Maintenance Labor)	37,662	*Overhead ($) = 60% × Operation and Maintenance Labor ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
Administrative Charges (2% of TCI)	8,902	*Administrative ($) = 2% × TCI ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
Property Taxes (1% of TCI)	4,451	*Property Tax ($) = 1% × TCI ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
Insurance (1% of TCI)	4,451	*Insurance ($) = 1% × TCI ($)* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.9*
	55,465	
TOTAL ANNUAL COSTS	133,029	

July 2017
Braskem
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VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Thermal Oxidizer and VOC Concentrator	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:	COST ($)	Sources & Equations
TOTAL ANNUAL O&M COSTS	133,029	
Annualized Cost Factor		
Equipment Life (years) = 15		
Interest Rate (%) = 10		
Annualized Cost Factor	0.13	$ACF = \frac{i(1+i)^n}{(1+i)^n - 1}$ *OAQPS Control Cost Manual (6th Edition) Section 4.2, Chapter 2 Equation 2.55*
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT	445,083	
TOTAL ANNUAL CAPITAL REQUIREMENT	58,517	*Total Annual Capital Requirement ($) = TCI ($) * ACF* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 1 Equation 1.28*
TOTAL ANNUALIZED COST *(Total annual O&M cost and annualized capital cost)*	191,546	*Total Annualized Cost ($) = Total Annual Capital Requirement + Total O&M Costs ($)*

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Catalytic Thermal Oxidizer	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

Evaluated at 2015 Cost and Efficiencies
Costs derived from *EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001*

COST COMPONENT:	COST ($)	Sources & Equations
DIRECT COSTS		
Purchased Equipment Costs		
Equipment Cost (EC)	47,199	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Eqn. 2.34 adjusted from 1999 dollars to 2015 using the CEPCI*
Instrumentation (10% of EC)	4,720	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Sales taxes (6% of EC)	2,832	
Freight (5% of EC)	2,360	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Subtotal - Purchased Equipment Costs (PEC)	57,111	
Direct Installation Costs		
Foundations & Supports (8% of PEC)	4,569	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Handling & Erection (14% of PEC)	7,996	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Electrical (4% of PEC)	2,284	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Piping (2% of PEC)	1,142	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Insulation for ductwork (1% of PEC)	571	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Painting (1% of PEC)	571	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Site Preparation / Buildings- Included above	---	
Subtotal - Direct Installation Costs (DIC)	17,133	
TOTAL DIRECT COSTS (TDC)	74,245	
INDIRECT INSTALLATION COSTS		
Engineering Costs (10% of PEC)	5,711	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Construct. & Field Expenses (5% of PEC)	2,856	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Contractor Fees (10% of PEC)	5,711	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Start-up (2% of PEC)	1,142	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Performance Test (1% of PEC)	571	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Compliance Test	15,000	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
Contingency (3% of PEC)	1,713	*OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.8*
TOTAL INDIRECT COSTS, IC	32,704	
TOTAL CAPITAL INVESTMENT (TCI)	106,949	

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Catalytic Thermal Oxidizer	
Baseline Actual Emissions	1.85	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8750.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:	COST ($)	Sources & Equations
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Operator/Supervisor (0.5 hr/shift @ $45.72/hr, 500 hours/year)	22,860	*Operator ($) = $45.72/hour × 500 hours/year (Braskem Specific Labor Cost)*
Labor (0.5 hr/shift @ $39.91/hr, 500 hours/year)	19,955	*Labor ($) = $39.91/hour × 500 hours/year (Braskem Specific Labor Cost)*
Material (100% of maintenance labor)	19,955	*Material ($) = 100% × Labor ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
	62,770	
Utilities		
Catalyst Replacement	10,000.0	
Natural Gas Cost (15.04 MMscf/yr and $3.88/Mscf)	58,355	$Natural\ Gas\ (\$) = 18.8\ \frac{MMscf}{yr} * \$3.88/Mscf \times \frac{1000\ Mscf}{MMscf}$ *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
Electricity Cost ($0.06/kWh) - OAQPS Equation 2.42 and Table 2.11	205.0	$Electricity\ (\$) = \frac{1.17 \times 10^{-4} \times 1{,}000\ scfm \times 4\ inches\ water}{0.6} \times \frac{\$0.06}{kWh} \times 1{,}790\ \frac{hours}{year}$ *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
	68,560	
ANNUAL INDIRECT COSTS		
Overhead (60% of Operation and Maintenance Labor)	37,662	*Overhead($) = 60% × Operation and Maintenance Labor ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
Administrative Charges (2% of TCI)	2,139	*Administrative($) = 2% × TCI ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
Property Taxes (1% of TCI)	1,069	*Property Tax($) = 1% × TCI ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
Insurance (1% of TCI)	1,069	*Insurance($) = 1% × TCI ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
	41,940	
TOTAL ANNUAL COSTS	173,270	

COST COMPONENT:	COST ($)	Sources & Equations
TOTAL ANNUAL O&M COSTS	173,270	
Annualized Cost Factor		
Equipment Life (years) = 15 Interest Rate (%) = 10		
Annualized Cost Factor	0.13	$ACF = \frac{i(1+i)^n}{(1+i)^n - 1}$ *OAQPS Control Cost Manual (6th Edition)Section 4.2, Chapter 2 Equation 2.55*
CAPITAL RECOVERY COSTS		
TOTAL CAPITAL REQUIREMENT	106,949	
TOTAL ANNUAL CAPITAL REQUIREMENT	14,061	*Total Annual Capital Requirement ($) = TCI ($) * ACF* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 1 Equation 1.28*
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***	187,331	*Total Annualized Cost ($)* *= Total Annual Capital Requirement + Total O&M Costs ($)*

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Carbon Bed Adsorption	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	acfm
Control Efficiency	98%	

Evaluated at 2015 Cost and Efficiencies
Costs derived from *EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001*

COST COMPONENT:	COST ($)	Sources & Equations
DIRECT COSTS		
Purchased Equipment Costs		
Equipment Cost (EC)	21,337	*Based on 2009 preliminary budgetary estimate from Anguil Environmental Systems, Inc. adjusted from 2009 to 2015 dollars using the CEPCI.*
Instrumentation (10%)	2,134	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Sales taxes (6%)	1,280	
Freight (5%)	1,067	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Subtotal - Purchased Equipment Costs (PEC)	25,818	
Direct Installation Costs		
Foundations & Supports (8% of PEC)	2,065	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Handling & Erection (14% of PEC)	3,615	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Electrical (4% of PEC)	1,033	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Piping (2% of PEC)	516	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Insulation for ductwork (1% of PEC)	258	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Painting (1% of PEC)	258	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Site Preparation / Buildings- Included above	---	
Subtotal - Direct Installation Costs (DIC)	7,745	
TOTAL DIRECT COSTS (TDC)	33,564	
INDIRECT INSTALLATION COSTS		
Engineering Costs (10% of PEC)	2,582	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Construct. & Field Expenses (5% of PEC)	1,291	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Contractor Fees (10% of PEC)	2,582	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Start-up (2% of PEC)	516	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Performance Test (1% of PEC)	258	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Compliance Test	15,000	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
Contingency (3% of PEC)	775	*OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 2 Table 2.8*
TOTAL INDIRECT COSTS, IC	23,004	
TOTAL CAPITAL INVESTMENT (TCI)	56,567	

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Carbon Bed Adsorption	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	96%	

COST COMPONENT:	COST ($)	Sources & Equations
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
Operator/Supervisor (0.5 hr/shift @ $45.72/hr, 500 hours/year)	22,860	*Operator ($) = $45.72/hour × 500 hours/year (Braskem Specific Labor Cost)*
Labor (0.5 hr/shift @ $39.91/hr, 500 hours/year)	19,955	*Labor ($) = $39.91/hour × 500 hours/year (Braskem Specific Labor Cost)*
Material (100% of maintenance labor)	19,955	
	62,770	
Utilities		
Carbon Cost (30.25 ton/yr and $4,600/ton)	139,150	$Natural\ Gas\ (\$) = 18.8\ \frac{MMscf}{yr} * \$3.88/Mscf \times \frac{1000\ Mscf}{MMscf}$ *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
Electricity Cost ($0.06/kWh) - OAQPS Equation 2.42 and Table 2.11	205.0	$Electricity\ (\$) = \frac{1.17 \times 10^{-4} \times 1{,}000\ scfm \times 4\ inches\ water}{0.6} \times \frac{\$0.06}{kWh} \times 1{,}790\ \frac{hours}{year}$ *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
	139,355	
ANNUAL INDIRECT COSTS		
Overhead (60% of Operation and Maintenance Labor)	37,662	*Overhead($) = 60% × Operation and Maintenance Labor ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
Administrative Charges (2% of TCI)	1,131	*Administrative($) = 2% × TCI ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
Property Taxes (1% of TCI)	566	*Property Tax($) = 1% × TCI ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
Insurance (1% of TCI)	566	*Insurance($) = 1% × TCI ($)* *OAQPS Control Cost Manual (6th Edition)Section 3.2, Chapter 2 Table 2.9*
	39,925	
TOTAL ANNUAL COSTS	242,050	

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 1 Silos	
Control	Carbon Bed Adsorption	
Baseline Actual Emissions	1.86	tpy
Current Emission Rate	0.42	lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)	Sources & Equations
TOTAL ANNUAL O&M COSTS		242,050	
Annualized Cost Factor			
	Equipment Life (years) = 15		
	Interest Rate (%) = 10		
	Annualized Cost Factor	0.13	$ACF = \frac{i(1+i)^n}{(1+i)^n - 1}$ *OAQPS Control Cost Manual (6th Edition) Section 4.2, Chapter 2 Equation 2.55*
CAPITAL RECOVERY COSTS			
	TOTAL CAPITAL REQUIREMENT	56,567	
	TOTAL ANNUAL CAPITAL REQUIREMENT	7,437	*Total Annual Capital Requirement ($) = TCI ($) * ACF* *OAQPS Control Cost Manual (6th Edition) Section 3.2, Chapter 1 Equation 1.28*
TOTAL ANNUALIZED COST *(Total annual O&M cost and annualized capital cost)*		249,487	*Total Annualized Cost ($)* *= Total Annual Capital Requirement + Total O&M Costs ($)*

July 2017
Braskem
Marcus Hook Polymers
Plant 2 Silos - VOC RACT II Cost Effectiveness Summary

		A	B	C	D	E	F	G	H	I	J
Source	Control	Potential Throughput (lb/yr)	Current Emission Rate[1] (lb/hr)	Potential Emissions (TPY)	Control Efficiency[2] (%)	Maximum Post Control Emissions (TPY)	Potential VOC Reduced (TPY)	2015 Total Capital Cost ($)	2015 O&M Cost ($)	2015 Annualized Cost[1] ($)	2015 Cost Effectiveness ($/Ton Reduced)
Plant 2, Three Storage Silos	Thermal Oxidizer	595,680,000.0	0.42	4.6	98%	0.4	4.3	138,529	179,122	197,335	46,214
Plant 2, Three Storage Silos	Thermal Oxidizer and VOC Concentrator	595,680,000.0	0.42	4.6	98%	0.4	4.3	445,083	133,029	191,546	44,858
Plant 2, Three Storage Silos	Catalytic Thermal Oxidizer	595,680,000.0	0.42	4.6	98%	0.4	4.3	106,949	173,270	187,331	43,871
Plant 2, Three Storage Silos	Carbon Bed Absorbtion	595,680,000.0	0.42	4.6	98%	0.1	4.5	56,567	156,260	163,697	35,999
Calculation						= C * (1 - D)	= C - E			= (G * ACF) + H	= I / F

[1] Based on 2012 Stack Test Results.
[2] Based on current TVOP emission limit.

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Thermal Oxidizer (VOC Control)	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

Evaluated at 2015 Cost and Efficiencies
Costs derived from *EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001*

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	63,410
Instrumentation (10% of EC)	6,341
Sales taxes (6% of EC)	3,805
Freight (5% of EC)	3,171
Subtotal - Purchased Equipment Costs (PEC)	**76,726**
Direct Installation Costs	
Foundations & Supports (8% of PEC)	6,138
Handling & Erection (14% of PEC)	10,742
Electrical (4% of PEC)	3,069
Piping (2% of PEC)	1,535
Insulation for ductwork (1% of PEC)	767
Painting (1% of PEC)	767
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs (DIC)	**23,018**
TOTAL DIRECT COSTS (TDC)	**99,744**
INDIRECT INSTALLATION COSTS	
Engineering Costs (10% of PEC)	7,673
Construct. & Field Expenses (5% of PEC)	3,836
Contractor Fees (10% of PEC)	7,673
Start-up (2% of PEC)	1,535
Performance Test (1% of PEC)	767
Compliance Test	15,000
Contingency (3% of PEC)	2,302
TOTAL INDIRECT COSTS, IC	**38,785**
TOTAL CAPITAL INVESTMENT (TCI)	**138,529**

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Thermal Oxidizer (VOC Control)	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
	Operator/Supervisor (0.5 hr/shift @ $45.72/hr, 500 hours/year)	22,860
	Labor (0.5 hr/shift @ $39.91/hr, 500 hours/year)	19,955
	Material (100% of maintenance labor)	19,955
		62,770
Utilities		
	Natural Gas Cost (18.8 MMscf/yr and $3.88/Mscf)	72,944
	Electricity Cost ($0.06/kWh) - OAQPS Equation 2.42 and Table 2.11	205.0
		73,149
ANNUAL INDIRECT COSTS		
	Overhead (60% of Operation and Maintenance Labor)	37,662
	Administrative Charges (2% of TCI)	2,771
	Property Taxes (1% of TCI)	1,385
	Insurance (1% of TCI)	1,385
		43,203
TOTAL ANNUAL COSTS		**179,122**

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Thermal Oxidizer (VOC Control)	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**179,122**
Annualized Cost Factor		
	Equipment Life (years) = 15	
	Interest Rate (%) = 10	
	Annualized Cost Factor	0.13
CAPITAL RECOVERY COSTS		
	TOTAL CAPITAL REQUIREMENT	138,529
	TOTAL ANNUAL CAPITAL REQUIREMENT	**18,213**
TOTAL ANNUALIZED COST ***(Total annual O&M cost and annualized capital cost)***		**197,335**

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Thermal Oxidizer and VOC Concentrator	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

Evaluated at 2015 Cost and Efficiencies
Costs derived from *EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001*

	COST COMPONENT:	COST ($)
DIRECT COSTS		
	Purchased Equipment Costs	
	Equipment Cost (EC)	220,770
	Instrumentation (10% of EC)	22,077
	Sales taxes (6% of EC)	13,246
	Freight (5% of EC)	11,039
	Subtotal - Purchased Equipment Costs (PEC)	**267,132**
	Direct Installation Costs	
	Foundations & Supports (8% of PEC)	21,371
	Handling & Erection (14% of PEC)	37,398
	Electrical (4% of PEC)	10,685
	Piping (2% of PEC)	5,343
	Insulation for ductwork (1% of PEC)	2,671
	Painting (1% of PEC)	2,671
	Site Preparation / Buildings- Included above	- - -
	Subtotal - Direct Installation Costs (DIC)	**80,140**
TOTAL DIRECT COSTS (TDC)		**347,272**
INDIRECT INSTALLATION COSTS		
	Engineering Costs (10% of PEC)	26,713
	Construct. & Field Expenses (5% of PEC)	13,357
	Contractor Fees (10% of PEC)	26,713
	Start-up (2% of PEC)	5,343
	Performance Test (1% of PEC)	2,671
	Compliance Test	15,000
	Contingency (3% of PEC)	8,014
TOTAL INDIRECT COSTS, IC		**97,811**
TOTAL CAPITAL INVESTMENT (TCI)		**445,083**

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Thermal Oxidizer and VOC Concentrator	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
	Operator/Supervisor (0.5 hr/shift @ $45.72/hr, 500 hours/year)	22,860
	Labor (0.5 hr/shift @ $39.91/hr, 500 hours/year)	19,955
	Material (100% of maintenance labor)	19,955
		62,770
Utilities		
	Natural Gas Cost (3.76 MMscf/yr and $3.88/Mscf)	14,589
	Electricity Cost ($0.06/kWh) - OAQPS Equation 2.42 and Table 2.11	205.0
		14,794
ANNUAL INDIRECT COSTS		
	Overhead (60% of Operation and Maintenance Labor)	37,662
	Administrative Charges (2% of TCI)	8,902
	Property Taxes (1% of TCI)	4,451
	Insurance (1% of TCI)	4,451
		55,465
TOTAL ANNUAL COSTS		133,029

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Thermal Oxidizer and VOC Concentrator	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		133,029
Annualized Cost Factor		
	Equipment Life (years) = 15	
	Interest Rate (%) = 10	
	Annualized Cost Factor	0.13
CAPITAL RECOVERY COSTS		
	TOTAL CAPITAL REQUIREMENT	445,083
	TOTAL ANNUAL CAPITAL REQUIREMENT	58,517
TOTAL ANNUALIZED COST (Total annual O&M cost and annualized capital cost)		191,546

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Catalytic Thermal Oxidizer	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

Evaluated at 2015 Cost and Efficiencies
Costs derived from *EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001*

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	47,199
Instrumentation (10% of EC)	4,720
Sales taxes (6% of EC)	2,832
Freight (5% of EC)	2,360
Subtotal - Purchased Equipment Costs (PEC)	**57,111**
Direct Installation Costs	
Foundations & Supports (8% of PEC)	4,569
Handling & Erection (14% of PEC)	7,996
Electrical (4% of PEC)	2,284
Piping (2% of PEC)	1,142
Insulation for ductwork (1% of PEC)	571
Painting (1% of PEC)	571
Site Preparation / Buildings- Included above	- - -
Subtotal - Direct Installation Costs (DIC)	**17,133**
TOTAL DIRECT COSTS (TDC)	**74,245**
INDIRECT INSTALLATION COSTS	
Engineering Costs (10% of PEC)	5,711
Construct. & Field Expenses (5% of PEC)	2,856
Contractor Fees (10% of PEC)	5,711
Start-up (2% of PEC)	1,142
Performance Test (1% of PEC)	571
Compliance Test	15,000
Contingency (3% of PEC)	1,713
TOTAL INDIRECT COSTS, IC	**32,704**
TOTAL CAPITAL INVESTMENT (TCI)	**106,949**

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Catalytic Thermal Oxidizer	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
	Operator/Supervisor (0.5 hr/shift @ $45.72/hr, 500 hours/year)	22,860
	Labor (0.5 hr/shift @ $39.91/hr, 500 hours/year)	19,955
	Material (100% of maintenance labor)	19,955
		62,770
Utilities		
	Catalyst Replacement	10,000.0
	Natural Gas Cost (15.04 MMscf/yr and $3.88/Mscf)	58,355
	Electricity Cost ($0.06/kWh) - OAQPS Equation 2.42 and Table 2.11	205.0
		68,560
ANNUAL INDIRECT COSTS		
	Overhead (60% of Operation and Maintenance Labor)	37,662
	Administrative Charges (2% of TCI)	2,139
	Property Taxes (1% of TCI)	1,069
	Insurance (1% of TCI)	1,069
		41,940
TOTAL ANNUAL COSTS		173,270

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Catalytic Thermal Oxidizer	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		**173,270**
Annualized Cost Factor		
	Equipment Life (years) = 15	
	Interest Rate (%) = 10	
	Annualized Cost Factor	0.13
CAPITAL RECOVERY COSTS		
	TOTAL CAPITAL REQUIREMENT	106,949
	TOTAL ANNUAL CAPITAL REQUIREMENT	**14,061**
TOTAL ANNUALIZED COST *(Total annual O&M cost and annualized capital cost)*		**187,331**

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Carbon Bed Adsorption	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

Evaluated at 2015 Cost and Efficiencies
Costs derived from *EPA Air Pollution Control Cost Manual, Sixth Edition, EPA/452/B-02-001*

COST COMPONENT:	COST ($)
DIRECT COSTS	
Purchased Equipment Costs	
Equipment Cost (EC)	21,337
Instrumentation (10% of EC)	2,134
Sales taxes (6% of EC)	1,280
Freight (5% of EC)	1,067
Subtotal - Purchased Equipment Costs (PEC)	**25,818**
Direct Installation Costs	
Foundations & Supports (8% of PEC)	2,065
Handling & Erection (14% of PEC)	3,615
Electrical (4% of PEC)	1,033
Piping (2% of PEC)	516
Insulation for ductwork (1% of PEC)	258
Painting (1% of PEC)	258
Site Preparation / Buildings- Included above	---
Subtotal - Direct Installation Costs (DIC)	**7,745**
TOTAL DIRECT COSTS (TDC)	**33,564**
INDIRECT INSTALLATION COSTS	
Engineering Costs (10% of PEC)	2,582
Construct. & Field Expenses (5% of PEC)	1,291
Contractor Fees (10% of PEC)	2,582
Start-up (2% of PEC)	516
Performance Test (1% of PEC)	258
Compliance Test	15,000
Contingency (3% of PEC)	775
TOTAL INDIRECT COSTS, IC	**23,004**
TOTAL CAPITAL INVESTMENT (TCI)	**56,567**

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Carbon Bed Adsorption	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)
ANNUAL DIRECT COSTS		
Operation and Maintenance Labor		
	Operator/Supervisor (0.5 hr/shift @ $45.72/hr, 500 hours/year)	22,860
	Labor (0.5 hr/shift @ $39.91/hr, 500 hours/year)	19,955
	Material (100% of maintenance labor)	19,955
		62,770
Utilities		
	Carbon Cost (30.25 ton/yr and $4,600/ton)	53,360
	Electricity Cost ($0.06/kWh) - OAQPS Equation 2.42 and Table 2.11	205.0
		53,565
ANNUAL INDIRECT COSTS		
	Overhead (60% of Operation and Maintenance Labor)	37,662
	Administrative Charges (2% of TCI)	1,131
	Property Taxes (1% of TCI)	566
	Insurance (1% of TCI)	566
		39,925
TOTAL ANNUAL COSTS		**156,260**

July 2017
Braskem
Marcus Hook Polymers
VOC RACT II Control Cost Effectiveness

Source	Plant 2 Silos	
Control	Carbon Bed Adsorption	
Maximum Throughput		lb/yr
Baseline Actual Emissions	1.86	tpy
Current Emission Rate		lb/hr
Hours per year	8760.0	Hours
Exhaust Flow Rate	500	scfm
Control Efficiency	98%	

COST COMPONENT:		COST ($)
TOTAL ANNUAL O&M COSTS		156,260
Annualized Cost Factor		
	Equipment Life (years) = 15	
	Interest Rate (%) = 10	
	Annualized Cost Factor	0.13
CAPITAL RECOVERY COSTS		
	TOTAL CAPITAL REQUIREMENT	56,567
	TOTAL ANNUAL CAPITAL REQUIREMENT	7,437
TOTAL ANNUALIZED COST *(Total annual O&M cost and annualized capital cost)*		163,697

Attachment B
Review Memo Addendum

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
SOUTHEAST REGIONAL OFFICE

MEMO

Addendum

TO James Rebarchak
Regional Manager
Air Quality

FROM Tina Vogler, P.E.
Air Quality Engineer
New Source Review Section
Air Quality

THROUGH James A. Beach, PE
Environmental Engineer Manager
New Source Review Section
Air Quality

DATE October 17, 2017

RE RACT II
Braskem America, Inc.
Marcus Hook Borough, Delaware County
Application No. 23-00012
APS ID: 687816; AUTH ID: 1160332

On April 3, 2017, the Department of Environmental Protection (DEP) issued a Significant Operating Permit Modification to Braskem America, Inc. (Braskem), incorporating its Alternate RACT II proposal for its polypropylene manufacturing plant. This memo amends the associated Review Memo (dated March 28, 2017) for comments made by EPA, received in DEP on June 20, 2017. Comments and DEP response are in the document: "Commonwealth of Pennsylvania, Comment and Response Document, Title V Operating Permit No. 23-00012 (RACT II), Braskem America, Inc., Marcus Hook Borough, Delaware County, October 2017.

The paragraph commented on is repeated from the March 28, 2017 Review Memo with corrections shown in bold.

Source ID 101A/101B – Storage Silos

RACT for the storage silos are the VOC emission limits of 12.10 tons per year, **on a 12-month rolling basis**, for Source ID 101A and 4.63 tons per year, **on a 12-month rolling basis**, for Source ID 101B, plus monitoring and recordkeeping requirements.

Attachment C
RACT I and RACT II Comparison

Condition numbers from OP-23-0012	Condition numbers from TVOP 23-00012	Auth No. 1256335 11-19-2019
RACT I SIPed condition	RACT II Proposed Equivalent Conditions	RACT II More Stringent or Additional Requirement
	All Plant 1 Polypropylene Manufacturing Sources, Source ID 102A	
Condition #004A – This Operating Permit is issued for Operation of a polypropylene Plant No. 1 with the following source: a flare system for VOC emissions from 2 polypropylene reaction systems, 2 compressor vents, 1 mixer vent, 2 analyzer and pellet dryer vents	Condition #004(a) the continuous and intermittent emission streams from the process shall be vented and combusted in the flare…	Condition #004(a)(6) The flare shall be operated at all times when emissions may be vented to it. Condition #004(c) -This condition contain valve car-seal requirements that favor venting to the flare
Condition #005 – The flare shall be operated with a flame present at all times		Condition #004(a)(2) – The flare shall be operated and maintained with a stable flame present at all times Condition #007(b)(i) - The permittee shall operate the flare as follows: A flame monitoring device shall be operated to indicate the presence of a flare flame.
Condition #006 – The presence of a flare pilot flame shall be monitored using a thermocouple or equivalent device	Condition #007(b)(ii)…The permittee shall operate the flare as follows :A thermocouple or equivalent monitoring device to indicate the presence of a flame at each pilot light…	
Condition #008 – Any gases to be flared shall have a net heating value of 300 Btu per standard cubic foot	Condition #004(a)(3) The flare shall be used only with the net heating value of the gas being combusted being 11.2 MJ/scm (300 Btu/scf) or greater, … .	Condition #004(a)(3)… Compliance with this condition shall be determined on a three (3) hour rolling average, using a gas chromatography analyzer or DEP approved device
Condition #011 – The company shall record the types, amounts, and physical properties of all volatile organic compounds used on a daily and annual basis in the polypropylene Plant No. 1 production process.	Condition #009 (c)– The permittee shall record the following: …data including mass flows, maintenance purge activities, or other engineering material balances necessary for emissions calculations.	
Condition #016 – Recordkeeping shall be conducted for major VOC sources to demonstrate compliance	Condition #009 – The permittee shall record the following: hours of operation of the plant on a	

with Pennsylvania's RACT regulation, with records being kept for at least 2 years.	monthly basis, polypropylene production on a monthly basis and as a 12-month rolling sum Condition #008(b)- The permittee shall keep records of VOC … on a monthly basis and as a 12-month rolling sum.	