

**AIR EMISSION TEST REPORT
FOR THE
VERIFICATION OF VOC CONTROL EFFICIENCY
FOR
PLASTIC PARTS COATING LINE**

**Prepared for:
SUMMIT POLYMERS, INC.
SRN N6261**

**ICT Project No.: 2100011
May 25, 2021**



Report Certification

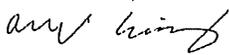
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SUMMIT POLYMERS, INC.
Portage, Michigan**

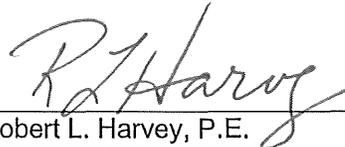
This report has been reviewed by Summit Polymers, Inc. representatives and approved for submittal to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division (AQD).

I certify that the testing was conducted in accordance with the reference test methods and submitted test plan unless otherwise specified in this report. I believe the information provided in this report and its attachments are true, accurate, and complete.

IMPACT COMPLIANCE & TESTING, INC.



Andrew C. Eisenberg,
Environmental Consultant



Robert L. Harvey, P.E.
Services Director

Executive Summary

SUMMIT POLYMERS, INC. VOC CONTROL EFFICIENCY EMISSION TEST RESULTS

Summit Polymers, Inc. (Summit Polymers) contracted Impact Compliance & Testing, Inc. (ICT) to determine the volatile organic compounds (VOC) control efficiency associated with a surface coating line at its plastic interior automotive parts manufacturing facility located in Portage, Kalamazoo County, Michigan.

The conditions of Permit to Install (PTI) No.176-97C require Summit Polymers to determine VOC capture efficiency for its coating line (identified as emission group EU-BASE-CLEAR) and VOC destruction efficiency for the associated regenerative thermal oxidizer (RTO). The destruction efficiency of the RTO was determined based on measurement of the VOC mass flowrate into and out of the unit.

The following table presents the results from the compliance testing.

Emission Unit	Capture Efficiency (%wt)	Avg. RTO Chamber Temp (°F)	Destruction Efficiency (%wt)
EU-BASE-CLEAR	99	1555	96
<i>Requirement</i>	<i>>80</i>	<i>> 1450</i>	<i>> 95</i>

The data and test results presented above indicate that the emission control system satisfies (is in compliance with) the conditions specified in PTI 176-97C. The overall control efficiency will be used with records of solvent use to calculate monthly mass emissions.

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1.0 Introduction

Summit Polymers, Inc. (Summit Polymers) manufactures plastic parts for automobiles. As part of the manufacturing process, the molded parts are directed to a coating line that applies water and solvent based coatings using robotic applicators and an electric convection oven.

The coating line is identified as emission unit EU-BASE-CLEAR in Permit to Install No. 179-97C. The solvent vapor is collected from EU-BASE-CLEAR and directed to a regenerative thermal oxidizer (RTO) for the reduction of volatile organic compound (VOC) emissions.

The conditions of Permit to Install 179-97C issued to Summit Polymers specify:

The permittee shall not operate EU-BASE-CLEAR unless the RTO is installed, maintained and operated in a satisfactory manner. Satisfactory operation of the RTO includes a minimum capture efficiency of 80 percent (by weight), a minimum VOC destruction efficiency of 95 percent (by weight),

Within 180 days from the commencement of trial operation of EU-BASE-CLEAR, the permittee shall verify VOC capture efficiency across EU-BASE-CLEAR by testing at owner's expense, in accordance with Department requirements.

Summit Polymers contracted Impact Compliance & Testing, Inc. (ICT) to perform the VOC capture and destruction efficiency testing required by PTI 176-97C. This test report has been prepared by ICT to present a description of test methods and results for the testing performed March 31, 2021. This test report document generally follows the EGLE guidance document *Format for Submittal of Source Emission Test Plans and Reports*.

The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan dated January 27, 2021 that was reviewed and approved by the Michigan EGLE-AQD.

A copy of the EGLE-AQD test plan approval letter is provided in Attachment 1.

The testing project was managed by Mr. Matthew Rangitsch of Summit Polymers. ICT representatives Andrew Eisenberg, Ryan Prchlik, and Robert Harvey performed the testing. Ms. Monica Brothers and Ms. Lindsey Wells from EGLE-AQD observed portions of the test event.

Questions regarding this test event should be directed to the individuals below.

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2.0 Summary of Test Results and Operating Conditions

2.1 Purpose and Objective of the Tests

Conditions of PTI 176-97C require Summit Polymers to verify the capture efficiency of the emission unit EU-BASE-CLEAR and destruction efficiency of the regenerative thermal oxidizer.

Capture efficiency for the emission unit was verified using the criteria of USEPA Methods 204B (for the captured gas stream to the RTO) and 204E (for uncaptured emissions exiting the drying oven). VOC destruction efficiency was determined based on measurements of the RTO inlet and outlet gas.

2.2 Operating Conditions During the Compliance Tests

The testing was performed during normal operating conditions. The oxidizer fan operated at approximately 45 hertz (Hz) and maintained a vacuum of 0.20 inches of water (in. wc) in the EU-BASE-CLEAR exhaust duct (inlet to RTO) at the velocity measurement location on the exterior wall of the building.

Attachment 2 provides diagrams of the sampling locations.

RTO combustion chamber temperature data were recorded at thirty-second intervals by the Summit Polymers continuous data logger. The RTO combustion chamber temperature ranged from a minimum of 1540°F to a maximum of 1566°F. The three-test average combustion chamber temperature was 1555°F.

Attachment 3 provides operating records provided by Summit Polymers for the test periods.

2.3 Summary of Air Pollutant Sampling Results

Table 2.1 and 2.2 present a summary of VOC capture efficiency and RTO destruction efficiency results (average of the three test periods).

Test results for each one-hour sampling period are presented in Section 6.0 of this report.

The test results verify that the:

- EU-BASE-CLEAR enclosure operates at a VOC capture efficiency of 99% by weight, which satisfies the permit requirement of a minimum capture efficiency of 80% by weight.
- Regenerative thermal oxidizer operates at a VOC destruction efficiency of 96% by weight, which satisfies the permit requirement for a minimum destruction efficiency of 95% by weight.

Table 2.1 Summary of EU-BASE-CLEAR VOC capture efficiency measurements (three-test average)

Captured Gas Flowrate (scfm)	Captured Gas VOC Concentration (ppmv C3)	Oven Fugitive Flowrate (scfm)	Oven Fugitive VOC Concentration (ppmv C3)	Capture Efficiency ¹ (% wt)
11,088	261	1,605	27	98.5%

Table 2.2 Summary of regenerative thermal oxidizer VOC destruction efficiency measurements (three-test average)

VOC Concentration RTO Inlet (ppmv C3)	VOC Concentration RTO Out (ppmv C3)	Min. RTO Chamber Temp ¹ (°F)	Avg. RTO Chamber Temp ¹ (°F)	Destruction Efficiency ² (% wt)
306	11.8	1,540	1,555	96.1%

Table Notes

1. Minimum capture efficiency specified in permit is 80%..
2. Minimum destruction efficiency specified in permit is 95%.

3.0 Source and Sampling Location Description

3.1 General Process Description

EU-BASE-CLEAR is a coating line using water- and solvent-based coatings for plastic injection molded interior trim in automobiles. The booths use HVLP robotic applicators and an electric convection oven. These booths are controlled by a regenerative thermal oxidizer.

3.2 Rated Capacities and Air Emission Controls

Overspray in the coating booths is controlled using water curtains. VOC emissions from EU-BASE-CLEAR are captured using an air collection system and are directed to an RTO for the reduction of VOC emissions. After passing through the RTO, the air is discharged through a vertical exhaust stack.

An economizer unit is installed between the RTO device and the exhaust stack that is used to recover heat from the RTO exhaust and transfer to glycol that is used to heat the coating booths.

3.3 Sampling Locations

The VOC concentration for the RTO inlet (capture gas stream) was sampled from the inlet duct with a diameter of 31.75-inches, which was located exterior to the facility wall, prior to the main RTO fan.

The RTO outlet NMHC concentration and exhaust gas velocity were sampled in the 35.75-inch diameter vertical exhaust stack.

Individual traverse points were determined in accordance with USEPA Method 1.

The uncaptured emissions exiting the EU-BASE-CLEAR oven were sampled at the conveyor silhouette at the oven exit.

Attachment 2 provides diagrams of the emission test sampling locations.

4.0 Sampling and Analytical Procedures

A test protocol for the testing project was reviewed and approved by the EGLE-AQD. This section provides a summary of the sampling and analytical procedures that were used during the testing periods.

4.1 Summary of Sampling Methods

USEPA Method 1	Exhaust gas velocity measurement locations were determined based on the physical stack / duct arrangements and the requirements in USEPA Method 1
USEPA Method 2	Gas velocity pressure was determined using a Type-S Pitot tube connected to a red oil incline manometer; temperature was measured using a K-type thermocouple connected to the Pitot tube.
USEPA Method 3A	Exhaust gas O ₂ and CO ₂ content for the thermal oxidizer exhaust was determined using instrumental analyzers.
USEPA Method 4	Exhaust gas moisture for the regenerative thermal oxidizer exhaust was determined based on the chilled impinger procedure.
USEPA Method 25A	Regenerative thermal oxidizer inlet THC concentration was determined using a flame ionization analyzer (FIA). Exhaust gas VOC (as NMHC) concentration was determined using an FIA equipped with a methane separation column
USEPA Method 204B	Determination of the VOC content of the captured gas stream using an FIA.
USEPA Method 204E	Determination of the uncaptured VOC from the coating line using an FIA.

4.2 Regenerative Thermal Oxidizer Inlet Measurements

Gas velocity measurements for the RTO inlet gas were performed once per one-hour test period by USEPA Method 2 using a type-S Pitot tube and red oil manometer. Temperature measurements were recorded at each traverse point using a K-type thermocouple and a calibrated digital thermometer.

The captured gas stream (RTO inlet) consists of building air containing evaporated solvents. There is no combustion or other chemical reaction that would significantly alter the composition of the ambient air. Therefore, a dry molecular weight of 29.0 was used as specified in Section 8.6 of Method 2.

Moisture measurements for the RTO inlet gas stream were determined using the USEPA Method 4 wet-bulb/dry-bulb approximation technique. Wet bulb and dry bulb temperature measurements were obtained using a type-K thermocouple and calibrated digital pyrometer; the corresponding moisture content was determined using these measurements and a psychometric chart calculation.

THC concentration was determined using a flame ionization analyzer (FIA) in accordance with USEPA Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer*. The sample gas was delivered to the instrument using a heated Teflon sampling line to prevent condensation or contamination of the sample and was introduced directly to the FIA instrument without conditioning (was not dried in a condenser). The FIA instrument was calibrated using certified concentrations of propane in air. The calibration gases were diluted with hydrocarbon free air to obtain intermediate propane concentrations and to demonstrate linearity of the instrument.

4.3 Regenerative Thermal Oxidizer Exhaust Measurements

Gas velocity measurements for the RTO exhaust were performed once per one-hour test period by USEPA Method 2 using a type-S Pitot tube and red oil manometer. Temperature measurements were recorded at each traverse point using a K-type thermocouple and a calibrated digital thermometer.

CO₂ and O₂ content of the exhaust gas stream was measured using instrumental analyzers in accordance with Method 3A. A non-dispersive infrared gas (NDIR) analyzer was used to measure exhaust gas CO₂ content; paramagnetic sensor was used to measure the exhaust gas O₂ content.

Moisture content of the exhaust gas stream was determined using the USEPA Method 4 chilled impinger method.

VOC as non-methane hydrocarbon (NMHC) concentrations in the exhaust were determined using a TEI, Model 55i Methane-NMHC analyzer. The TEI 55i is an automated batch analyzer that repeatedly collects and analyzes samples of the exhaust gas stream that are drawn into the instrument by the internal sampling pump. The sampled gas is separated by an internal gas chromatography (GC) column into methane and non-methane fractions and each fraction is analyzed separately using an FIA in accordance with USEPA Method 25A.

A continuous sample of the exhaust gas was delivered to the instrument analyzers using an extractive gas sampling system. The sample gas stream was split between the CO₂/O₂ instruments and the NMHC instrument. The gas stream to the CO₂/O₂ instruments was conditioned (dried using a condenser) prior to analysis. The exhaust gas sample was delivered directly to the NMHC FIA instrument (measured on a wet gas basis). The NMHC instrument was calibrated by the procedures of Method 25A using certified propane concentrations in hydrocarbon-free air.

Attachment 4 provides air flowrate field data and calculations.

Attachment 5 provides recorded instrumental analyzer concentration data.

4.4 RTO VOC Destruction Efficiency Calculation

The inlet THC and outlet NMHC concentrations for the RTO are measured relative to a propane calibration standard (parts per million as propane, C₃). The molecular weight of propane was used to calculate VOC mass flowrate for the inlet and outlet.

$$M_{VOC} = C_{VOC} \times Q \times MW_{C_3} \times (60 \text{ min/hr}) / V_M / 1E+06$$

Destruction efficiency for each test period was calculated using the following equation:

$$DE_{VOC} = 1 - [(M_{VOC,out}) / (M_{VOC,in})] \times 100\%$$

Where:

- M_{VOC} = Calculated VOC mass flowrate (lb/hr)
- DE_{VOC} = Calculated VOC destruction efficiency (% wt)
- C_{VOC} = Measured VOC concentration, THC or NMHC (ppmv propane)
- Q = Measured volumetric flowrate (scfm)
- MW_{C₃} = Molecular weight propane (44.1 lb/lb-mol)
- V_M = Molar volume of ideal gas (385 scf/lb-mol)

Attachment 6 provides VOC destruction efficiency calculations.

4.5 Coating Oven Fugitive VOC Measurements

The EU-BASE-CLEAR coating line generally consists of two coating booths, a flash off tunnel, and drying oven. Air is drawn into the enclosure via the entrance to the first coating booth and air is collected from various sections of the coating line enclosure and directed to the RTO for VOC emission reduction. The oven operates at a slight positive pressure and a small amount of air leaves the enclosure through the conveyor opening at the oven exit (oven exit conveyor silhouette).

The coating booths are a clean room-type environment and are not readily accessible during operation. Streamers (colored Teflon tape) were affixed to the conveyor opening into the spray coating booth and the direction of airflow into the booth was verified visually through a glass window throughout each capture efficiency test. Since the direction of airflow at the booth entrance is inward, no uncontrolled VOC are released through the entrance to the enclosure.

For the oven exit, the uncaptured volumetric flowrate was measured using a calibrated hot-wire anemometer (low velocity measurement instrument) according to Section 4.2.2 of Method 204E. The conveyor silhouette at the oven exit was divided into twelve (12) nearly equal areas and the exit velocity was measured near the center of each designated area once per hour during the capture efficiency test periods. The exit volumetric flowrate was calculated based on the average of the twelve velocity measurements and the calculated silhouette area.

The VOC concentration in the uncaptured oven exhaust was monitored continuously throughout each capture test period using a THC FIA according to the sampling procedures

of USEPA Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer* and the procedures of USEPA Method 204E.

A heated sampling probe was inserted approximately 12 inches into the oven (through the exit conveyor window) and the sample gas was delivered to the instrument using a heated Teflon sampling line. The FIA instrument was calibrated using certified concentrations of propane in air. The calibration gases were diluted with hydrocarbon free air to obtain intermediate propane concentrations and to demonstrate linearity of the instrument.

The gas exiting the oven is heated building air containing a small amount of evaporated solvents. A dry molecular weight of 29.0 was used as specified in Section 8.6 of Method 2 and moisture was estimated using wet bulb and dry bulb temperature measurements.

4.6 Coating Line Enclosure VOC Capture Efficiency Calculation

The THC mass flowrate (in pounds per hour calculated as propane) for each monitored gas stream was calculated and VOC capture efficiency was determined using the following equation:

$$CE_{VOC} = \frac{M^{C}_{VOC}}{M^{C}_{VOC} + M^{U}_{VOC}} \times (100\%)$$

Where: CE_{VOC} = VOC capture efficiency (% weight)
 M^{C}_{VOC} = THC mass flowrate for captured stream (lb/hr)
 M^{U}_{VOC} = THC mass flowrate in uncaptured gas stream (lb/hr)

Attachment 6 provides VOC capture efficiency calculations.

5.0 QA/QC Activities

5.1 Flow Measurement Equipment

Prior to arriving onsite, the instruments used during the source test to measure exhaust gas properties and velocity (barometer and Pitot tube) were calibrated to specifications in the sampling methods.

The absence of cyclonic flow for each sampling location was verified using an S-type Pitot tube and oil manometer. The Pitot tube was positioned at each of the velocity traverse points with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero).

The TSI VelociCalc hot wire anemometer was calibrated by Advanced Labs, Inc. approximately one month prior to the test event.

5.2 Gas Divider Certification (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider was used to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step STEC gas divider delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.3 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the CO₂ and O₂ analyzers by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the upscale calibration gas and zero gas into the sampling system (at the base of the stainless-steel sampling probe prior to the particulate filter and Teflon® heated sample line) and determining the instrument response against the initial instrument calibration readings.

At the beginning of each test day, appropriate high-range, mid-range, and low-range span gases followed by a zero gas were introduced to the THC and NMHC analyzers, in series at a tee connection, which is installed between the sample probe and the particulate filter, through a poppet check valve. After each one-hour test period, mid-range and zero gases were re-introduced in series at the tee connection in the sampling system to check against the method's performance specifications for calibration drift and zero drift error.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO₂ and O₂ in nitrogen and zeroed using hydrocarbon free nitrogen. The THC and NMHC instruments

were calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.4 Dry Gas Meter Calibration

The dry gas metering console, which was used to extract a measured amount of exhaust gas from the stack for moisture content determinations, was calibrated prior to and after the testing program. This calibration uses the critical orifice calibration technique presented in USEPA Method 5.

Attachment 7 provides QA/QC records for the equipment and instruments used for the compliance test.

6.0 Results

6.1 Test Results and Allowable Emission Limits

The coating line VOC capture efficiency and RTO destruction efficiency test results are presented in Tables 6.1 and 6.2.

The results of the testing verify that the EU-BASE-CLEAR:

- Enclosure operates at a VOC capture efficiency greater than 98%.
- RTO operates at a VOC destruction efficiency of 96% by weight.

The test results satisfy the requirements of PTI 176-97C, which specifies that ... *Satisfactory operation of the RTO includes a minimum capture efficiency of 80 percent (by weight), a minimum VOC destruction efficiency of 95 percent (by weight), maintaining a minimum temperature of 1450°F, and a minimum retention time of 0.5 seconds.*

6.2 Variations from Normal Sampling Procedures or Operating Conditions

The testing was performed in accordance with specified USEPA methods and the approved test protocol.

The initial RTO test periods yielded destruction efficiency results that were less than 95% by weight. The test crew noted that the outlet NMHC concentration was spiking higher than expected during the RTO valve switch, which was reducing the calculated destruction efficiency. After investigation by Summit Polymers, it was determined that one of the controllers for the bed switch valve was not operating properly resulting in a slower closing time for one direction. The controller was repaired and the bed switch temperature setpoint was also increased from 165°F to 175°F.

Destruction efficiency tests 1 through 3 were discarded, and test 4 was aborted due to a power loss on the RTO outlet sampling line. Three tests (DE-5 through DE-7) were performed at the corrected RTO conditions and resulted in calculated destruction efficiencies that satisfied permit requirements.

Data and measurements for all discarded test periods are included with the compliance test data in Attachments 3, 4, 5 and 6.

Table 6.1 Measured gas conditions and VOC capture efficiency for EU-BASE-CLEAR enclosure; Summit Polymers

Test No.	CE-1	CE-2	CE-3	Three Test Average
Test date	3/30/21	3/31/21	3/31/21	
Test period (24-hr clock) ¹	1120-1605	0935-1235	1308-1728	
<u>Captured Gas Stream (to RTO)</u>				
THC concentration (ppmv C ₃)	252	225	306	261
RTO inlet gas flowrate (scfm)	10,918	11,079	11,268	11,088
Captured VOC (lb/hr)	18.9	17.1	23.7	19.9
<u>Uncaptured Oven Exhaust</u>				
THC concentration (ppmv C ₃)	32.5	18.9	29.8	27.1
Gas flowrate (scfm)	1,580	1,508	1,727	1,605
Uncaptured VOC (lb/hr)	0.35	0.20	0.35	0.30
VOC Capture Efficiency (%)	98.2%	98.9%	98.5%	98.5%
<i>Permit requirement</i>				> 80%

1. The capture efficiency tests were three hours in duration. Test Nos. CE-1 and CE-3 consisted of three (3) one-hour sampling periods within a 5 hour period.

Table 6.2 Measured gas conditions and VOC destruction efficiency for regenerative thermal oxidizer; Summit Polymers

Test No.	DE-5	DE-6	DE-7	Three Test
Test date	3/31/21	3/31/21	3/31/21	Average
Test period (24-hr clock)	1308-1408	1445-1545	1628-1728	
Min. RTO chamber temp (°F)	1,544	1,540	1,546	
Avg. RTO chamber temp (°F)	1,553	1,554	1,557	1,555
Fan speed (Hz)	45.3	45.3	45.3	45.3
<u>RTO Inlet Conditions</u>				
Inlet gas flowrate (scfm)	11,226	11,354	11,224	11,268
THC concentration (ppmv C ₃)	312	294	313	306
Inlet VOC (lb/hr)	24.1	23.0	24.1	23.7
<u>RTO Outlet Conditions</u>				
Outlet gas flowrate (scfm)	11,061	11,480	11,416	11,319
NMHC concentration (ppmv C ₃)	10.8	12.5	12.3	11.8
Outlet VOC (lb/hr)	0.82	0.98	0.96	0.92
VOC Destruction Efficiency (%)	96.6%	95.7%	96.0%	96.1%
<i>Permit requirement</i>				> 95%