VOLATILE ORGANIC COMPOUND DESTRUCTION EFFICIENCY TEST

Performed At The
Worthen Coated Fabrics
Regenerative Thermal Oxidizer (RTO)
Grand Rapids, Michigan

Test Date
September 28, 2021

Report No.
TRC Environmental Corporation Report 438134

Report Submittal Date
October 25, 2021

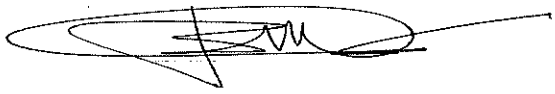
TRC Environmental Corporation
7521 Brush Hill Road
Burr Ridge, Illinois 60527
USA

T (312) 533-2042
F (312) 533-2070

Report Certification

I certify that to the best of my knowledge:

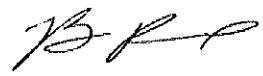
- Testing data and all corresponding information have been checked for accuracy and completeness.
- Sampling and analysis have been conducted in accordance with the approved protocol and applicable reference methods (as applicable).
- All deviations, method modifications, or sampling and analytical anomalies are summarized in the appropriate report narrative(s).



Ben Cacao
Associate Project Manager

October 25, 2021
Date

TRC was operating in conformance with the requirements of ASTM D7036-04 during this test program.



Bruce Randall
TRC Emission Testing Technical Director

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VOLATILE ORGANIC COMPOUND DESTRUCTION EFFICIENCY TEST

1.0 INTRODUCTION

TRC Environmental Corporation (TRC) performed a volatile organic compound (VOC) destruction efficiency (DE) test program on the Regenerative Thermal Oxidizer (RTO) at the Worthen Industries facility in Grand Rapids, Michigan on September 28, 2021. The tests were authorized by and performed for Worthen Industries.

The purpose of this test program was to determine the total hydrocarbon as propane (THC as C_3H_8) destruction efficiency of one RTO during specified operating conditions. The results of the test program will be used to determine compliance with the permit.

1.1 Project Contact Information

Participants		
Test Facility	Worthen Industries 1125 41st Street SE Grand Rapids, Michigan 53901 Permit No. MI-ROP-P0634-2017	Kristi Koetje Environmental Manager 616-325-2203 (phone) 616-890-6452 (cell) KKoetje@worthenind.com
Air Emissions Testing Body (AETB)	TRC Environmental Corporation 7521 Brush Hill Road Burr Ridge, Illinois 60527	Mohammad Khatib Emissions Project Manager 312-533-2026 (phone) 312-533-2070 (fax) mkhatib@trccompanies.com

The tests were conducted by Rome Rothgeb, Greg Rock and Mohammad Khatib of TRC. Documentation of the on-site ASTM D7036-04 Qualified Individual(s) (QI) can be located in the appendix to this report.

April Lazzaro and Trevor Drost from the Michigan Department of Environment, Great Lakes, and Energy (EGLE) Air Quality Division observed the testing.

1.2 Facility and Process Description

Worthen Industries is a chemical and technology manufacturer of high-quality industrial adhesives & coatings, extruded films, coated substrates, and paint.

2.0 SUMMARY OF RESULTS

The results of this test program are summarized in the table below. Detailed individual run results are presented in Section 6.0.

Unit ID / Pollutant Tested	Average Measured Emissions	
	Inlet	Outlet
RTO / THC lb/hr as C_3H_8	106.237	1.737
Destruction Efficiency, %	98.36	

The table below summarizes the test methods used, as well as the number and duration of each at each test location:

Unit ID/ Sample Location	Parameter Measured	Test Method	No. of Runs	Run Duration
RTO Outlet and Inlet	Volumetric Flow Rate	USEPA 1 and 2	3	5 to 9 min
	O_2 and CO_2 Content	USEPA 3	3	grab
	Moisture	ASTM E337-62	3	N/A
	Total Hydrocarbons as C_3H_8	USEPA 25A	3	60 min

3.0 DISCUSSION OF RESULTS

No problems were encountered with the testing equipment during the test program. No changes or problems were encountered that required modification of any procedure presented in the test plan. No adverse test or environmental conditions were encountered during the conduct of this test program.

4.0 SAMPLING AND ANALYSIS PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed in accordance with the methods presented in the following sections. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Determination of Sample Point Locations by USEPA Method 1

This method is applicable to gas streams flowing in ducts, stacks, and flues and is designed to provide guidance for the selection of sampling ports and traverse points at which sampling for air pollutants will be performed. Sample ports must be located at least two duct diameters downstream and a half a duct diameter upstream from any flow disturbance.

The cross-section of the measurement site was divided into a number of equal areas, and the traverse points were located in the center of each area. The minimum number of points were determined from Figure 1-2 (non-particulate) of the Method.

4.2 Volumetric Flow Rate Determination by USEPA Method 2

This method is applicable for the determination of the average velocity and the volumetric flow rate of a gas stream.

The gas velocity head (ΔP) and temperature were measured at traverse points defined by USEPA Method 1. The velocity head was measured with a Type S (Stausscheibe or reverse type) pitot tube and oil-filled manometer; and the gas temperature was measured with a Type K thermocouple. The average gas velocity in the flue was calculated based on: the gas density (as determined by USEPA Methods 3 and 4); the flue gas pressure; the average of the square roots of the velocity heads at each traverse point, and the average flue gas temperature.

4.3 CO_2 and O_2 Determination by USEPA Method 3

This method is applicable for the determination of CO_2 and O_2 concentrations and dry molecular weight of a sample from an effluent gas stream of a fossil-fuel combustion process or other process.

A gas sample was extracted from the source using single-point grab sampling. The gas sample was analyzed using a Fyrite analyzer.

4.4 Moisture Determination by ASTM Method E337-62

This method utilizes the flue gas wet bulb/dry bulb temperatures and absolute pressure to approximate the moisture content in the flue gas. Moisture content was calculated as follows:

$$Bws = \left[\frac{e' - AP(t - t')}{P}\right]$$

where:

e' = saturated vapor pressure of water, in.Hg, at the wet bulb temperature, t'

$A = 3.67 \times 10^{-4}[1 + 0.00064(t' - 32)]$

P = absolute pressure, in.Hg, in the duct

t = dry bulb temperature, °F

t' = wet bulb temperature, °F

4.5 Total Organic Concentration Determination by USEPA Method 25A

This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

A gas sample was extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). If necessary, a source-specific response factor was developed for the FIA.

5.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Accreditation from the Louisiana Environmental Laboratory Accreditation Program (LELAP);
- Accreditation from the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA) that our operations conform with the requirements of ASTM D 7036 as an Air Emission Testing Body (AETB).

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this report. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach was used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

ASTM D7036-04 specifies that: *"AETBs shall have and shall apply procedures for estimating the uncertainty of measurement. Conformance with this section may be demonstrated by the use of approved test protocols for all tests. When such protocols are used, reference shall be made to published literature, when available, where estimates of uncertainty for test methods may be found."* TRC conforms with this section by using approved test protocols for all tests.

6.0 TEST RESULTS SUMMARY

Method 25A Test Results Summary

Project Number:	438134	Test Date(s):	09/28/21
Customer:	Worthen Industries	Facility:	Grand Rapids, MI
Unit Identification:	RTO	Recorded by:	Mo Khatib
Load Level/Condition:	High		

Location	Inlet			
Test Run No.	1	2	3	Average
Test Date	9/28/2021	9/28/2021	9/28/2021	
Test Time - Start	9:22	10:40	11:55	
Test Time - End	10:21	11:39	12:54	
THC (ppmvw as Propane)	811.62	715.81	777.29	768.24
Volumetric Flow Rate (scfm)	19742	20090	20596	20143
THC (lb/hr as Propane)	110.028	98.750	109.933	106.237

Location	Outlet			
Test Run No.	1	2	3	Average
Test Date	9/28/2021	9/28/2021	9/28/2021	
Test Time - Start	9:22	10:40	11:55	
Test Time - End	10:21	11:39	12:54	
THC (ppmvw as Propane)	13.33	12.49	12.81	12.88
Volumetric Flow Rate (scfm)	19975	19623	19323	19640
THC (lb/hr as Propane)	1.828	1.683	1.700	1.737

Destruction Efficiency				
Test Run No.	1	2	3	Average
Inlet THC (lb/hr as Propane)	110.028	98.750	109.933	106.237
Outlet THC (lb/hr as Propane)	1.828	1.683	1.700	1.737
Efficiency (%)	98.34	98.30	98.45	98.36

APPENDIX