



Emissions Compliance Test Report

for the
**Fluid Catalytic Cracking Unit (FCCU)
Regenerator Stack
EU-11-FCCU-S1/SVFCCU**

at the
Marathon Detroit Refinery

in
Detroit, MI

subject to
**Permit No. MI-ROP-A9831-2012c
Title 40 CFR Part 60, Appendix F**

prepared for



**Marathon
Petroleum Company LP**

**Test Date: March 6, 2024
Erthwrks Project No. 9565.1.A2**



A9831-TEST-20240306

1.0 INTRODUCTION

1.1 Identification, location and dates of tests

Erthwrks, Inc. was contracted to conduct emission testing on the Fluid Catalytic Cracking Unit (FCCU) Regenerator Stack in operation at the Marathon Detroit Refinery, located in Detroit Michigan. The testing program was conducted on March 6, 2024.

1.2 Purpose of Testing

This test was conducted to determine the FCCU Regenerator Stack mass emission rates of volatile organic compounds (VOCs) and sulfuric acid (H₂SO₄).

Oxygen (O₂), carbon dioxide (CO₂), moisture content, and stack flow rate were also measured to calculate mass emission rates in pounds per hour (lb/hr), tons per year (tpy), and pounds per million British Thermal Units (lb/mmBTU).

1.3 Contact Information

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Facility Location:

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2.0 SUMMARY OF RESULTS

Table 2.1: FCCU Regenerator Stack Compliance Test Results

Pollutant Measured	EPA Methodology	Measured Result	Applicable Limit	Pass/Fail
VOC	Method 25A	6.2 tpy	21 tpy	Pass
H ₂ SO ₄	CTM-013	0.0041 lb/mmBTU	n/a	n/a

3.0 SOURCE DESCRIPTION

3.1 Description of the process

Marathon Petroleum Company LP produces refined petroleum products from crude oil and is required to demonstrate that select process emission sources are operating in compliance with permitted emissions limits.

Marathon Petroleum Company LP operates the Fluid Catalytic Cracking Unit which uses a catalyst in a process that converts heavier hydrocarbons into lighter products. In the process coke is deposited onto the catalyst. The spent catalyst is then moved to a regenerator where the coke is burned off using air. The hot flue gas from the regenerator is directed to a cooler where the heat is recovered as steam. Before existing the stack, the gas passes through electrostatic precipitators to reduce particulate matter.

3.2 Applicable permit and source designation

The FCCU Regenerator Stack is identified as EU-11-FCCU-S1/SVFCCU and is operated under Permit No. MI-ROP-A9831-2012c.

3.3 Type and quantity of materials processed during tests

During the emission testing on March 6, 2024, at the Marathon Petroleum Company LP refinery, the FCCU Regenerator Stack was tested while operating at the maximum achievable load condition. This operational data was provided by MPC and is located in Attachment G of this report.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Gaseous Sampling – O₂ and CO₂

The following EPA reference methods were utilized to complete this testing program:

- EPA Method 3A for the determination of O₂ and CO₂ concentration

A calibration error (CE) test was conducted as specified in US EPA Method 7E §8.2.3. In accordance with this requirement, a three-point analyzer calibration error test was conducted prior to exhaust sampling. The CE test was conducted by introducing the low, mid, and high-level calibration gasses (as defined by EPA Method 7E §3.3.1-3) sequentially and the response was recorded.

The initial system bias and system calibration error check were conducted in accordance with EPA Method 7E §8.2.5. The upscale calibration gas was introduced at the probe upstream of all sample system components and the response was recorded. The procedure was repeated with the low-level gas concentration and response recorded.

After each test run, the sample system bias check was conducted to validate the run data. The low-level and upscale drift was calculated using equation 7E-4. The arithmetic average of all valid concentration values was adjusted for bias using equation 7E-5B.

A stratification test was conducted in accordance with EPA Method 7E §8.1.2 at the beginning of Run 1. The results were determined to be unstratified and single-point sampling was utilized throughout the remainder of the test. The results of the stratification test is included in Attachment B of this report.

See Figure 1 below for a sample system diagram.

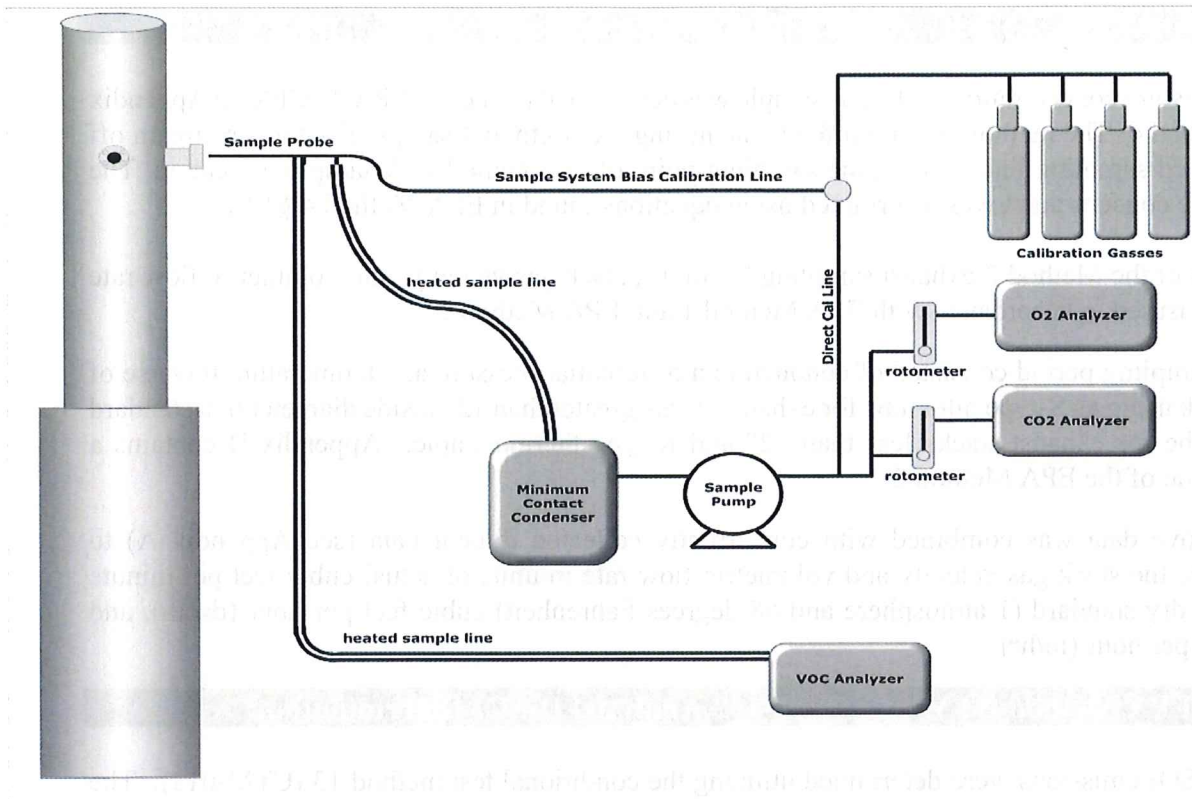


Figure 1: Example Erthwrks Gaseous Sampling System Diagram

4.2 Gaseous Sampling – VOC as THC (Method 25A)

The determination of the VOC concentration was determined by measuring total hydrocarbon compound (THC) and followed all QAQC procedures as specified in the US EPA 40 CFR 60 Appendix A, Method 25A with the exception of the EGLE requirement to adjust the final results for drift using Equation 7E-5B. The calibration error (CE) test was conducted following the procedures specified in EPA Method 25A §8.4. In accordance with this requirement, a four-point analyzer calibration error test was conducted prior to exhaust sampling. This CE test was conducted by introducing the zero, low, mid, and high-level calibration gases (as defined by EPA Method 25A §7.1.2-5) and the response recorded. The results of the CE test are acceptable if the results for the low and mid-level calibration gasses are within $\pm 5.0\%$ of the predicted responses as defined by the linear curve from the zero and high-level results. The sample system response time was also recorded at this time in accordance with EPA Method 25A §8.5.

Immediately following the completion of each test run, the drift determination was conducted to validate the test data in accordance with EPA Method 25A §8.6.2. The test data is valid if the calculated drift is within $\pm 3.0\%$ of the span value (EPA Method 25A §13.1.2). The THC was measured on a wet basis and was converted to a dry basis using moisture data from the concurrently run Method 5 sampling train.

4.3 Stack Gas Velocity and Moisture Determination

The moisture concentration of the gas sample was determined by the US EPA 40 CFR 60 Appendix A, Method 4. The method was modified by acquiring the Method 4 sample from a slip stream off the heated sampling line at the same sampling point of the Method 25A sampling location. The moisture concentration was determined using equations found in EPA Method 4 §12.1.

At each of the Method 2 exhaust sampling locations, stack gas velocity, and volumetric flow rate was measured in accordance with EPA Method 1 and EPA Method 2.

Each sampling period consisted of conducting a differential pressure and temperature traverse of the stack using an S-type pitot tube for exhaust stacks greater than 12” inside diameter or a standard pitot tube for exhaust stacks less than 12” and K-type thermocouple. Appendix B contains a schematic of the EPA Method 2.

The above data was combined with concurrently collected diluent data (see Appendix A) to calculate the stack gas velocity and volumetric flow rate in units of actual cubic feet per minute (acfm), dry standard (1 atmosphere and 68 degrees Fahrenheit) cubic feet per hour (dscfh), and pounds per hour (lb/hr).

4.4 EPA Method CTM-013 (ALT-133 Analysis) H₂SO₄ Determination

The H₂SO₄ emissions were determined utilizing the conditional test method 13 (CTM-013). The sample was extracted at a constant rate through a quartz lined heated probe (>350 °F), A heated quartz filter holder and filter (>500 °F), and through a Modified Graham condenser (H₂SO₄ Condenser) with Type C glass frit and 200 cm of 5-mmID glass tubing condenser coil. The H₂SO₄ condenser is maintained between 167 to 185 °F. Because SO₂ was not to be determined via this method, the sample was then passed through four impingers with the specifications delineated in EPA Method 4.

The sampling was conducted at a single point at a constant rate of about 10 L/min and the DGM readings and all temperatures were recorded every five minutes. After the completion of the test run, the samples were recovered in accordance with the test method and the samples were sent to Enthalpy Analytical for analysis via Ion Chromatography (ALT-133).

See the figure below that details the CTM-013 Sampling Train.

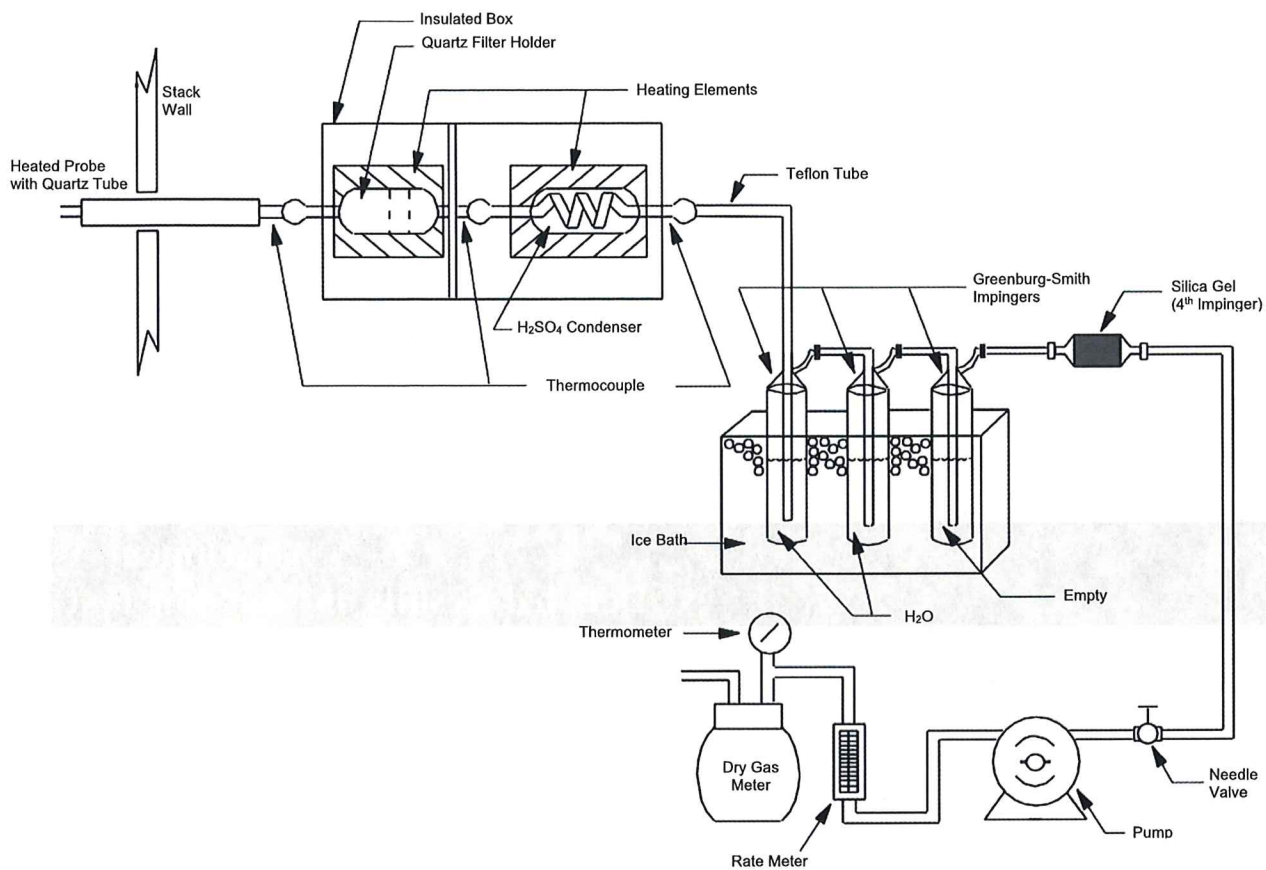


Figure 2: Example Erthwrks CTM-013 Sample System Diagram

4.5 Discussion of sampling procedure or operational variances

Erthwrks, Inc. conducted the emissions testing with no sampling or procedural variances. The FCCU Regenerator was tested and operated with no variances.

Attachment A
Detailed Results of Emission Test

Summary of Results

Client: Marathon Petroleum Company
Facility: Detroit Refinery
Unit ID: FCC Regen

Run Information				
Run Number	Run 1	Run 2	Run 3	
Date	3/6/2024	3/6/2024	3/6/2024	
Run Start Time	13:30	15:45	17:10	
Run End Time	14:30	16:45	18:10	
Operating Conditions				Average
Feed Rate (bpd)	40999.32	40997.29	41000.03	40998.88
Coke Burn (lb/hr)	19869.30	19832.02	19840.03	19847.12
Ammonia Injection (lb/hr)	49.02	49.00	48.99	49.00
Ammonia Injection (ppm)	60.55	60.58	60.72	60.62
Stack Gas Flow Rate (Method 1-4)				
Stack Gas Flow Rate, Q, (dscfh)	4,152,088	4,265,266	4,121,218	4,179,524
Emission Concentrations				
O ₂ (%vd)	2.20	2.20	2.21	2.20
CO ₂ (%vd)	16.10	15.96	15.97	16.01
THC (ppmvw)	2.60	2.64	2.65	2.63
Moisture (%)	11.32%	8.72%	11.93%	0.11
THC (ppmvd)	2.93	2.89	3.01	2.94
Emission Concentrations O ₂ Corrected		Corrected To: 0 % Oxygen		
THC (ppmv @ %O ₂)	2.91	2.95	2.96	2.94
Emission Rates (lb/scf)				
THC (lb/scf)	3.36E-07	3.31E-07	3.44E-07	3.369E-07
Emission Rates (lb/hr)				
THC (lb/hr)	1.39	1.41	1.42	1.41
Emission Rates (tpy)				
THC (tpy)	6.10	6.18	6.22	6.17

Detailed Summary of Results

Client: Marathon Petroleum Company
Facility: Detroit Refinery
Unit ID: FCC Regen
Erthwrks Tech: M. Oleszko

Run Information				
Run Number	Run 1	Run 2	Run 3	
Date	3/6/2024	3/6/2024	3/6/2024	
Run Start Time	13:30	15:45	17:10	
Run End Time	14:30	16:45	18:10	
Unit Fuel Flow Data				Averages
Fuel F Factor (F _d) (scf/MMBtu)	8710	8710	8710	8710
Emission Concentrations				
H ₂ SO ₄ (ug)	2470	7611	2559	4213.33
Train volume (scf)	21.91	21.91	21.79	21.87
O ₂ (%vd)	2.20	2.20	2.21	2.20
Emission Rates				
H ₂ SO ₄ (lb/scf)	2.49E-07	7.66E-07	2.59E-07	4.24E-07
H ₂ SO ₄ (ppm)	0.98	3.01	1.02	1.67
H ₂ SO ₄ (lb/MMBtu)	0.0024	0.0075	0.0025	0.0041