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REPORT ON COMPLIANCE TESTING

Performed for:
MARATHON PETROLEUM COMPANY LP
DETROIT REFINERY

CRUDE/VACUUM HEATER STACK (SV04-H1-05-H1)

Client Reference No: 4100665755
CleanAir Project No: 13019-2
Revision 0: October 10, 2016

To the best of our knowledge, the data presented in this report are accurate, complete, error free, legible and representative of the actual emissions during the test program. Clean Air Engineering operates in conformance with the requirements of ASTM D7036-04 Standard Practice for Competence of Air Emission Testing Bodies.

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PROJECT OVERVIEW

INTRODUCTION

Marathon Petroleum Company LP (MPC) contracted Clean Air Engineering (CleanAir) to perform emission measurements at the Detroit refinery for compliance purposes.

All testing was conducted in accordance with the regulations set-forth by the United States Environmental Protection Agency (USEPA) and the Michigan Department of Environmental Quality (MDEQ). The permit limits are referenced in Michigan Department of Environmental Quality, Air Quality Division Permit to Install No. 63-08D, issued May 12, 2014.

Key Project Participants

Individuals responsible for coordinating and conducting the test program were:

Crystal Davis – MPC
Joe Reidy – MPC
Tom Maza – MDEQ
Andy Obuchowski – CleanAir

Test Program Parameters

Testing was performed at the Crude/Vacuum Heater Stack (Emission Unit ID No. EU05-CRUDEHTR-S1 and EU04-VACHTR-S1; Common Stack ID No. SV04-H1-05-H1) on August 23, 2016, and included the following emissions measurements:

- particulate matter (PM), assumed equivalent to filterable particulate matter (FPM) only
- flue gas composition (e.g., O_2, CO_2, H_2O)
- flue gas flow rate

TEST PROGRAM SYNOPSIS

Test Schedule

The on-site schedule followed during the test program is outlined in Table 1-1.

Table 1-1:
Schedule of Activities

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	Crude/Vacuum Heater Stack	USEPA Method 5	FPM	08/23/16	10:17	12:44
2	Crude/Vacuum Heater Stack	USEPA Method 5	FPM	08/23/16	14:20	16:30
3	Crude/Vacuum Heater Stack	USEPA Method 5	FPM	08/23/16	17:16	19:30

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PROJECT OVERVIEW

Results Summary

Table 1-2 summarizes the results of the test program. A more detailed presentation of the test conditions and results of analysis are shown on pages 2-1 through 2-2.

Table 1-2:
Summary of Emission Compliance Test Results

Source Constituent (Units)	Sampling Method	Average Emission	Permit Limit[1]
Crude/Vacuum Heater Stack			
PM (lb/MMBtu)	USEPA 5	0.0011	0.0019

[1] Permit limits obtained from MDEQ Permit To Install No. 63-08D.

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Discussion of Test Program

FPM Testing - USEPA Method 5

For this test program, PM emission rate is assumed equivalent to FPM emission rate. Three (3) 120-minute Method 5 test runs were performed on August 23, 2016, at the Crude/Vacuum Heater Stack. The final result was expressed as the average of three (3) valid runs.

Calculation of Final Results

Emission results in units of dry volume-based concentration (lb/dscf) were converted to units of pounds per million Btu (lb/MMBtu), where applicable, by calculating an oxygen-based fuel factor (F_d) for refinery gas per USEPA Method 19 specifications. The heat content and F_d factor were calculated from percent volume composition analytical data provided by MPC and tabulated heating values for each of the measured constituents.

Two fuel gas analyses were performed by MPC on the test day (3:30 and 15:30). The analysis used to calculate the emissions results for each test run was selected by choosing the analysis performed nearest to each emissions test run interval.

End of Section 1 – Project Overview

RESULTS

Table 2-1:
Crude/Vac. Heater Stack – FPM Emissions (USEPA 5)

Run No.		1	2	3	Average
Date (2016)		Aug 23	Aug 23	Aug 23	
Start Time (approx.)		10:17	14:20	17:16	
Stop Time (approx.)		12:44	16:30	19:30	
Process Conditions					
P_1	Charge rate (bpd)	149,450	148,517	149,344	**149,104**
F_d	Oxygen-based F-factor (dscf/MMBtu)	8,208	8,208	8,208	**8,208**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	6.9	6.9	7.4	**7.1**
CO_2	Carbon dioxide (dry volume %)	7.9	7.5	7.5	**7.6**
T_s	Sample temperature (°F)	288	290	289	**289**
B_w	Actual water vapor in gas (% by volume)	12.5	13.6	13.3	**13.1**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	109,000	113,000	114,000	**112,000**
Q_s	Volumetric flow rate, standard (scfm)	77,500	80,000	80,600	**79,400**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	67,800	69,100	69,900	**68,900**
Q_a	Volumetric flow rate, actual (acf/hr)	6,550,000	6,770,000	6,810,000	**6,710,000**
Q_s	Volumetric flow rate, standard (scf/hr)	4,650,000	4,800,000	4,840,000	**4,760,000**
Q_{std}	Volumetric flow rate, dry standard (dscf/hr)	4,070,000	4,150,000	4,190,000	**4,140,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	69.49	70.93	71.47	**70.63**
%I	Isokinetic sampling (%)	102.9	103.1	102.7	**102.9**
Laboratory Data					
m_n	Total FPM (g)	0.00332	0.00270	0.00259	
n_{MDL}	Number of non-detectable fractions	N/A	N/A	N/A	
DLC	Detection level classification	ADL	ADL	ADL	
FPM Results					
C_{sd}	Particulate Concentration (lb/dscf)	1.05E-07	8.39E-08	7.99E-08	**8.97E-08**
$E_{lb/hr}$	Particulate Rate (lb/hr)	0.428	0.348	0.335	**0.370**
$E_{T/yr}$	Particulate Rate (Ton/yr)	1.88	1.52	1.47	**1.62**
E_{Fd}	Particulate Rate - F_d-based (lb/MMBtu)	0.00129	0.00103	0.00102	**0.00111**

Average includes 3 runs.

Detection level classifications are defined as follows:

ADL = Above Detection Level - all fractions are above detection limit

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RESULTS

Table 2-2:
Crude/Vac. Heater Uncertainty Analysis – FPM (USEPA 5)

		FPM Results (lb/MMBtu)		FPM Results (lb/hr)		FPM Results (Ton/yr)
Method		**5**		**5**		**5**
Run No.	**1**	0.00129	**1**	0.428	**1**	1.88
	2	0.00103	**2**	0.348	**2**	1.52
	3	0.00102	**3**	0.335	**3**	1.47
SD		1.55E-04		0.0506		0.221
AVG		**1.11E-03**		**0.370**		**1.62**
RSD		14.0%		13.6%		13.6%
N		3		3		3
SE		8.97E-05		0.0292		0.128
RSE		8.1%		7.9%		7.9%
P		95.0%		95.0%		95.0%
TINV		4.303		4.30		4.30
CI +		0.00150		0.496		2.17
AVG		**0.00111**		**0.370**		**1.62**
CI -		7.26E-04		0.245		1.07
TB +		0.00230		0.76		3.32

AVG (average) is the mean value of the runs; N is the number of individual runs.

SD (standard deviation) and RSD (relative standard deviation) are measures of the variability of individual runs.

SE (standard error) and RSE (relative standard error) are measures of the variability of the average of the runs.

P (probability) is the confidence level associated with the two-tailed Student's t-distribution.

TINV (t-value) is the value of the Student's t-distrubution as a function of P (probability) and N-1 (degrees of freedom).

CI (confidence interval) indicates that if the test is conducted again under the same conditions, the average would be expected to fall within the interval (CI- to CI+) about 95% of the time.

TB+ (upper tolerance bound) is the value below which 95% of future runs are expected to fall (assuming testing at the same conditions).

End of Section 2 – Results

DESCRIPTION OF INSTALLATION

PROCESS DESCRIPTION

MPC's facility in Detroit, Michigan, produces refined petroleum products from crude oil. MPC must continue to demonstrate that select process units are in compliance with permitted emission limits.

The Crude Unit (EU05-CRUDE) separates crude oil into various fractions through the use of distillation processes. These fractions are sent to other units in the refinery for further processing. The crude unit consists of process vessels (including heat exchangers and fractionation columns), the Alcorn heater (EG05-CRUDEHTR), tanks, containers, compressors, pumps, piping, drains and various components (pump and compressors seals, process valves, pressure relief valves, flanges, connectors, etc.).

The Vacuum Unit (EU04-VACUUM) separates the reduced crude from the crude unit through the use of a vacuum column. The reduced crude is separated into light vacuum gas oil, medium vacuum gas oil, heavy vacuum gas oil and a bottoms product called flux. The various fractions are sent to other units in the refinery for further processing. The vacuum unit consists of process vessels (including heat exchangers and vacuum column), two process heaters, tanks, containers, two cooling towers, flare, compressors, pumps, piping drains and various components (pumps and compressor seals, process valves, pressure relief valves, flanges, connectors, etc.).

Both the crude heater and the vacuum heater are fired by refinery fuel gas. Emissions are vented to the atmosphere through a common stack known as the Crude/Vacuum Heater Stack (SV04-H1-05-H1).

The testing reported in this document was performed at the Crude/Vacuum Heater Stack.

DESCRIPTION OF SAMPLING LOCATIONS

Sampling point locations were determined according to USEPA Method 1.

Table 3-1 outlines the sampling point configurations. The figure shown on the following page illustrates the sampling points and orientation of sampling ports.

Table 3-1:
Sampling Points

Source Constituent	Method (USEPA)	Run No.	Ports	Points per Port	Minutes per Point	Total Minutes	Figure
Crude/Vacuum Heater Stack							
FPM	5	1-3	4	6	5	120	3-1

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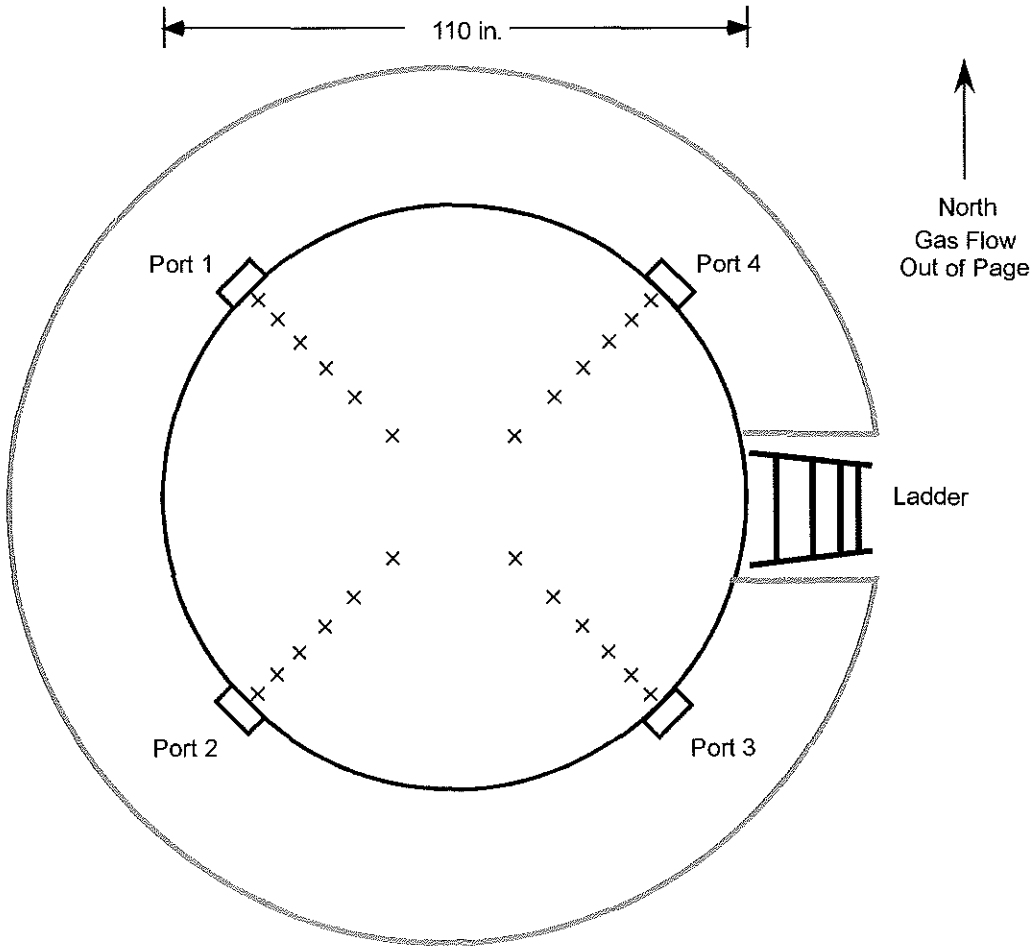
DESCRIPTION OF INSTALLATION



Sampling Point	Port to Point Distance (in.)
1	39.2
2	27.5
3	19.5
4	13.0
5	7.4
6	2.3

Duct diameters upstream from flow disturbance (A):	5.3	Limit: 0.5
Duct diameters downstream from flow disturbance (B):	2.4	Limit: 2.0

Figure 3-1: Crude/Vac. Heater Stack Sampling Points (USEPA 5)

End of Section 3 – Description of Installation

METHODOLOGY

Clean Air Engineering followed procedures as detailed in USEPA Methods 1, 2, 3, 3A, 3B, 4, 5 and 19. The following table summarizes the methods and their respective sources.

Table 4-1:
Summary of Sampling Procedures

Title 40 CFR Part 60 Appendix A	
Method 1	"Sample and Velocity Traverses for Stationary Sources"
Method 2	"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type S Pitot Tube)"
Method 3	"Gas Analysis for the Determination of Dry Molecular Weight"
Method 3A	"Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)"
Method 3B	"Gas Analysis for the Determination of Emission Rate Correction Factor or Excess Air"
Method 4	"Determination of Moisture Content in Stack Gases"
Method 5	"Determination of Particulate Matter Emissions from Stationary Sources"
Method 19	"Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxide Emission Rates"

These methods appear in detail in Title 40 of the Code of Federal Regulations (CFR) and are located on the internet at http://ecfr.gpoaccess.gov.

Diagrams of the sampling apparatus and major specifications of the sampling, recovery and analytical procedures are summarized for each method in Appendix A.

CleanAir followed specific quality assurance and quality control (QA/QC) procedures as outlined in the individual methods and as prescribed in CleanAir's internal Quality Manual. Results of all QA/QC activities performed by CleanAir are summarized in Appendix D.

METHODOLOGY

FPM Testing - USEPA Method 5

PM emissions were determined using USEPA Method 5. For this test program, PM is assumed equivalent to filterable particulate matter (FPM).

The front-half (Method 5 portion) of the sampling train consisted of a glass nozzle, glass liner and filter holder heated to 250°F, and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5 requirements.

After exiting the filter, the flue gas passed through a Teflon line into a series of knockout jars surrounded by ice. The purpose of the knockout jars was to determine the flue gas moisture and thoroughly dry the gas. The sample gas then flowed into a calibrated dry gas meter where the collected sample gas volume was determined.

The front-half portion of the sample train (nozzle, probe and heated filter) was recovered per Method 5 requirements, using acetone as the recovery solvent.

General Considerations

O_2 and CO_2 data for the non-instrumental (wet) sampling methods (used in molecular weight calculations and calculation of F_d-based emissions) was obtained using a modified version of EPA Method 3B:

- Multi-point, integrated gas samples (IGS) were continuously collected at a constant rate from a slipstream of the exhaust of the sample trains into a flexible vinyl bag (IGS bag) per Method 3B specifications.
- A calibrated paramagnetic/IR analyzer was used in place of a traditional Orsat analyzer to measure O_2 and CO_2 concentrations of the IGS bags per Method 3A specifications.
- Documentation of preliminary instrument calibrations and post-analysis calibration checks are included in Appendix E.

H_2O data used for moisture correction of concentration data was obtained from Method 4 measurements incorporated into the Method 5 sampling and recovery procedures.

End of Section 4 – Methodology