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REPORT ON COMPLIANCE
TESTING

Detroit Refinery

Fuel Oil Heater

Marathon Petroleum Company LP
1300 South Fort Street
Detroit, MI 48217
Client Reference No. 4101004604

CleanAir Project No. 13406-2
STAC Certificate No. 2007.002.0113.1217
Revision 0, Final Report
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1. PROJECT OVERVIEW

Test Program Summary

Marathon Petroleum Company LP (MPC) contracted CleanAir Engineering (CleanAir) to successfully complete testing at the Fuel Oil Heater (EU22-FUELOILHTR-S1) at the Detroit Refinery. The test program included the following objectives:

- Perform particulate matter (PM), carbon monoxide (CO), nitrogen oxides (NO_x), and sulfuric acid mist (H₂SO₄) testing to demonstrate compliance with the Michigan Department of Environmental Quality (DEQ) Permit No. MI-ROP-A9831-2012c.

A summary of the test program results is presented below. Section 2 Results provides a more detailed account of the test conditions and data analysis. Test program information, including the test parameters, on-site schedule and a project discussion, begins on page 2.

**Table 1-1:
Summary of Compliance Results**

Source	Constituent	Sampling Method	Average Emission	Permit Limit ¹
<u>Fuel Oil Heater Stack</u>				
	PM (lb/MMBtu)	USEPA 5	0.0016	0.0019
	PM ₁₀ (lb/MMBtu)	USEPA 5 / 202	0.0045	0.0076
	H ₂ SO ₄ (lb/MMBtu)	ASTM Draft CCM	0.0003	N/A
	NO _x (lb/MMBtu)	USEPA 7E	0.09	0.10
	CO (lb/MMBtu)	USEPA 10	0.01	0.02
	NSFPM (lb/MMBtu)	USEPA 5B	0.0013	N/A

¹ Permit limits obtained from MDEQ Renewable Operating Permit No. MI-ROP-A9831-2012c.

Test Program Details

Parameters

The test program included the following emissions measurements:

- particulate matter (PM) assumed equivalent to filterable particulate matter (FPM)
- total particulate matter less than 10 microns in diameter (PM₁₀) assumed equivalent to the sum of the following constituents:
 - filterable particulate matter (FPM)
 - condensable particulate matter (CPM)
- non-sulfuric acid particulate matter (NSFPM)
- nitrogen oxides (NO_x)
- carbon monoxide (CO)
- sulfuric acid mist (H₂SO₄)
- flue gas composition (e.g., O₂, CO₂, H₂O)
- flue gas temperature
- flue gas flow rate

Schedule

Testing was performed December 20 through 22, 2017. The on-site schedule followed during the test program is outlined in Table 1-2.

**Table 1-2:
Test Schedule**

Run Number	Location	Method	Analyte	Date	Start Time	End Time
1	Fuel Oil Heater	USEPA Method 3A/7E/10	O ₂ /CO ₂ /NO _x /CO	12/20/17	14:45	15:45
2	Fuel Oil Heater	USEPA Method 3A/7E/10	O ₂ /CO ₂ /NO _x /CO	12/20/17	18:00	19:00
3	Fuel Oil Heater	USEPA Method 3A/7E/10	O ₂ /CO ₂ /NO _x /CO	12/21/17	9:53	10:53
1	Fuel Oil Heater	USEPA Method 5/202	FPM/CPM	12/20/17	12:40	14:44
2	Fuel Oil Heater	USEPA Method 5/202	FPM/CPM	12/20/17	15:51	17:57
3	Fuel Oil Heater	USEPA Method 5/202	FPM/CPM	12/21/17	09:33	12:58
4	Fuel Oil Heater	USEPA Method 5/202	FPM/CPM	12/21/17	14:00	16:10
1	Fuel Oil Heater	USEPA Method 5B	NSFPM	12/20/17	12:40	14:44
2	Fuel Oil Heater	USEPA Method 5B	NSFPM	12/20/17	15:51	17:57
3	Fuel Oil Heater	USEPA Method 5B	NSFPM	12/21/17	09:33	12:58
4	Fuel Oil Heater	USEPA Method 5B	NSFPM	12/21/17	14:00	16:10
0	Fuel Oil Heater	Draft ASTM CCM	Sulfuric Acid	12/21/17	18:45	19:45
1	Fuel Oil Heater	Draft ASTM CCM	Sulfuric Acid	12/22/17	08:05	09:05
2	Fuel Oil Heater	Draft ASTM CCM	Sulfuric Acid	12/22/17	09:25	10:25
3	Fuel Oil Heater	Draft ASTM CCM	Sulfuric Acid	12/22/17	10:32	11:32

Discussion

Test Scope Synopsis

PM & PM₁₀ Testing

A total of four (4) 120-minute EPA Method 5/202 test runs were performed. FPM/CPM emission results were calculated in units of pounds per million Btu (lb/MMBtu). The final result was expressed as the average of the four (4) valid runs.

A fourth run was conducted because the field Test Leader noted visible 'flecks' on the sample filter of Run 1. At the time, the 'flecks' were considered debris from the inner walls of the heater that accumulated inside the heater due to seldom utilization and, therefore, were not considered representative of duct conditions. Run 1 yielded 0.0041 lb/MMBtu FPM, whereas Runs 2 through 4 yielded an average of 0.0008 lb/MMBtu. Despite the elevated Run 1 results for FPM, taking an average of the first three (3) runs still yields a passing test.

PM₁₀ is assumed equivalent to the sum of FPM less than 10 micrometers (μm) in diameter (FPM₁₀) and CPM. The Method 5/202 sample train yields a front-half, FPM result and a back-half, CPM result. The total PM result (FPM plus CPM) from Method 5/202 can be used as a worst-case estimation of total PM₁₀ since Method 5 collects all FPM present in the flue gas (regardless of particle size).

NSFPM Testing

A total of four (4) 120-minute EPA Method 5B test runs were performed for diagnostic purposes. NSFPM emission results were calculated in units of lb/MMBtu. The final result was expressed as the average of the four (4) valid runs.

NO_x & CO Testing

NO_x and CO emissions were determined using EPA Methods 7E and 10. NO_x and CO testing was comprised of three (3) 60-minute test runs. NO_x and CO emission results were calculated in units of lb/MMBtu. The final result was expressed as the average of the three (3) valid runs.

H₂SO₄ Testing

H₂SO₄ emissions were determined referencing the Draft ASTM Controlled Condensation Method (CCM).

Three (3) 60-minute Draft ASTM CCM test runs were performed. H₂SO₄ emission results were calculated in units of lb/MMBtu. The final results were expressed as the average of three (3) valid runs.

Prior to the first official test run, a 60-minute sample conditioning run (Run 0) was performed in order to minimize the absorption capacity of the front-half components of the sample train (upstream of the H₂SO₄-collecting portion of the sample train). The conditioning run was recovered in the same manner as the official test runs, but the condenser rinse and SAM filter were not analyzed.

Fuel Analysis

Emission results in units of dry volume-based concentration (lb/dscf, ppm_{dv}) were converted into units of lb/MMBtu by calculating an oxygen-based fuel factor (F_d) for refinery gas per EPA Method 19 specifications. The F_d factor was calculated from percent volume composition analytical data provided by MPC and tabulated heating values for each of the measured constituents.

Test Conditions

The unit was operated at the maximum normal operating capacity during each of the emissions compliance test runs. MPC was responsible for logging any relevant process-related data and providing it to CleanAir for inclusion in the test report.

End of Section

2. RESULTS

This section summarizes the test program results. Additional results are available in the report appendices, specifically Appendix C Parameters.

**Table 2-1:
Fuel Oil Heater – PM & PM₁₀ Emissions**

Run No.		1	2	3	4	Average
Date (2017)		Dec 20	Dec 20	Dec 21	Dec 21	
Start Time (approx.)		12:40	15:51	09:33	14:00	
Stop Time (approx.)		14:44	17:57	12:58	16:10	
Process Conditions						
F _d	Oxygen-based F-factor (dscf/MMBtu)	7,592	7,592	7,962	7,962	
H _i	Actual heat input (MMBtu/d)	103.5	103.5	104.6	104.6	104.1
Gas Conditions						
O ₂	Oxygen (dry volume %)	16.0	16.4	12.1	11.7	14.1
CO ₂	Carbon dioxide (dry volume %)	2.3	2.2	4.0	4.1	3.2
T _s	Sample temperature (°F)	689	699	691	698	694
B _w	Actual water vapor in gas (% by volume)	11.2	11.3	11.4	11.4	11.3
Gas Flow Rate						
Q _a	Volumetric flow rate, actual (acfm)	3,170	3,250	3,260	3,290	3,240
Q _s	Volumetric flow rate, standard (scfm)	1,430	1,450	1,480	1,480	1,460
Q _{std}	Volumetric flow rate, dry standard (dscfm)	1,270	1,290	1,310	1,310	1,300
Sampling Data						
V _{mstd}	Volume metered, standard (dscf)	75.85	76.20	76.06	76.60	76.18
%I	Isokinetic sampling (%)	104.0	102.9	101.3	101.7	102.5
Laboratory Data						
m _{FPM}	Total FPM (g)	0.00434	0.00049	0.00149	0.00203	
m _{CPM}	Total CPM (g)	0.00145	0.00167	0.00304	0.01319	
m _{Part}	Total particulate matter (as PM ₁₀) (g)	0.00579	0.00216	0.00453	0.01522	
FPM Results						
C _{sd}	Particulate Concentration (lb/dscf)	1.26E-07	1.42E-08	4.32E-08	5.84E-08	6.05E-08
E _{lb/hr}	Particulate Rate (lb/hr)	0.00962	0.00110	0.00339	0.00460	0.00468
E _{Fd}	Particulate Rate - F _d -based (lb/MMBtu)	0.00409	0.000500	0.000817	0.00106	0.00161
CPM Results						
C _{sd}	Particulate Concentration (lb/dscf)	4.21E-08	4.84E-08	8.83E-08	3.80E-07	1.40E-07
E _{lb/hr}	Particulate Rate (lb/hr)	0.00321	0.00374	0.00693	0.0299	0.0109
E _{Fd}	Particulate Rate - F _d -based (lb/MMBtu)	0.00136	0.00171	0.00167	0.00687	0.00290
Total Particulate Matter (as PM₁₀) Results						
C _{sd}	Particulate Concentration (lb/dscf)	1.68E-07	6.25E-08	1.31E-07	4.38E-07	2.00E-07
E _{lb/hr}	Particulate Rate (lb/hr)	0.0128	0.00484	0.0103	0.0345	0.0156
E _{Fd}	Particulate Rate - F _d -based (lb/MMBtu)	0.00545	0.00221	0.00249	0.00793	0.00452

**Table 2-2:
Fuel Oil Heater – NO_x & CO Emissions**

Run No.		1	2	3	Average
Date (2017)		Dec 20	Dec 20	Dec 21	
Start Time (approx.)		14:45	18:00	09:53	
Stop Time (approx.)		15:45	19:00	10:53	
Process Conditions					
F _d	Oxygen-based F-factor (dscf/MMBtu)	7,997	7,997	7,997	7,997
H _i	Actual heat input (MMBtu/d)	103.5	103.5	104.6	103.9
Gas Conditions					
O ₂	Oxygen (dry volume %)	11.2	10.9	11.2	11.1
CO ₂	Carbon dioxide (dry volume %)	4.7	5.0	4.7	4.8
Nitrogen Oxides Results					
C _{sd}	Concentration (ppmdv)	44.5	46.9	47.6	46.3
C _{sd}	Concentration (lb/dscf)	5.32E-06	5.60E-06	5.68E-06	5.53E-06
E _{Fd}	Emission Rate - F _d -based (lb/MMBtu)	0.0872	0.0887	0.0976	0.0912
Carbon Monoxide Results					
C _{sd}	Concentration (ppmdv)	9.43	5.96	5.27	6.89
C _{sd}	Concentration (lb/dscf)	6.86E-07	4.33E-07	3.83E-07	5.01E-07
E _{Fd}	Emission Rate - F _d -based (lb/MMBtu)	0.0112	0.00687	0.00658	0.00823

**Table 2-3:
Fuel Oil Heater – H₂SO₄ Emissions**

Run No.		1	2	3	Average
Date (2017)		Dec 22	Dec 22	Dec 22	
Start Time (approx.)		08:05	09:25	10:32	
Stop Time (approx.)		09:05	10:25	11:32	
Process Conditions					
F _d	Oxygen-based F-factor (dscf/MMBtu)	7,602	7,602	7,602	
H _i	Actual heat input (MMBtu/d)	103.7	103.7	103.7	103.7
Gas Conditions					
O ₂	Oxygen (dry volume %)	11.2	12.2	11.5	11.6
CO ₂	Carbon dioxide (dry volume %)	4.8	4.1	4.4	4.4
T _s	Sample temperature (°F)	664	667	664	665
B _w	Actual water vapor in gas (% by volume)	11.6	12.4	12.7	12.2
Sampling Data					
V _{msld}	Volume metered, standard (dscf)	26.47	25.93	25.99	26.13
Laboratory Data (Ion Chromatography)					
m _n	Total H ₂ SO ₄ collected (mg)	0.1856	0.2162	0.2615	
Sulfuric Acid Vapor (H₂SO₄) Results					
C _{sd}	H ₂ SO ₄ Concentration (lb/dscf)	1.55E-08	1.84E-08	2.22E-08	1.87E-08
C _{sd}	H ₂ SO ₄ Concentration (ppm dv)	0.0608	0.0722	0.0872	0.0734
E _{Fd}	H ₂ SO ₄ Rate - F _d -based (lb/MMBtu)	0.000253	0.000336	0.000375	0.000321

**Table 2-4:
Fuel Oil Heater – NSFPM Emissions**

Run No.		1	2	3	4	Average
Date (2017)		Dec 20	Dec 20	Dec 21	Dec 21	
Start Time (approx.)		12:40	15:51	09:33	14:00	
Stop Time (approx.)		14:44	17:57	12:58	16:10	
Process Conditions						
F _d	Oxygen-based F-factor (dscf/MMBtu)	7,592	7,592	7,962	7,962	
H _i	Actual heat input (MMBtu/d)	103.5	103.5	104.6	104.6	104.1
Gas Conditions						
O ₂	Oxygen (dry volume %)	15.6	16.3	11.6	11.5	13.8
CO ₂	Carbon dioxide (dry volume %)	2.6	2.2	4.2	4.3	3.3
T _s	Sample temperature (°F)	686	693	686	695	690
B _w	Actual water vapor in gas (% by volume)	11.4	11.9	11.5	11.8	11.7
Gas Flow Rate						
Q _a	Volumetric flow rate, actual (acfm)	3,160	3,260	3,170	3,280	3,220
Q _s	Volumetric flow rate, standard (scfm)	1,430	1,470	1,440	1,480	1,460
Q _{std}	Volumetric flow rate, dry standard (dscfm)	1,270	1,290	1,280	1,300	1,290
Sampling Data						
V _{mstd}	Volume metered, standard (dscf)	76.24	77.05	75.02	75.57	75.97
%I	Isokinetic sampling (%)	104.6	103.8	102.5	100.9	102.9
Laboratory Data						
m _{FPM}	Total NSFPM (g)	0.00185	0.00179	0.00165	0.00186	
NSFPM Results						
C _{sd}	Particulate Concentration (lb/dscf)	5.35E-08	5.12E-08	4.85E-08	5.43E-08	5.19E-08
E _{lb/hr}	Particulate Rate (lb/hr)	0.00408	0.00398	0.00371	0.00425	0.00400
E _{Fd}	Particulate Rate - F _d -based (lb/MMBtu)	0.00160	0.00177	0.000868	0.000961	0.00130

End of Section

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3. 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 Fuel Oil Heater (EU22-FUELOILHTR) is fired by refinery fuel gas. Emissions are vented to the atmosphere via the Fuel Oil Heater Stack (SV22-1-H1).

The testing reported in this document was performed at the Fuel Oil Heater Stack.

Test Location

The sample point locations were determined by EPA Methods 1 and 7E specifications. Table 3-1 presents the sampling information for the test location described in this report. The figures shown on pages 10 and 11 represent the layout of the test location.

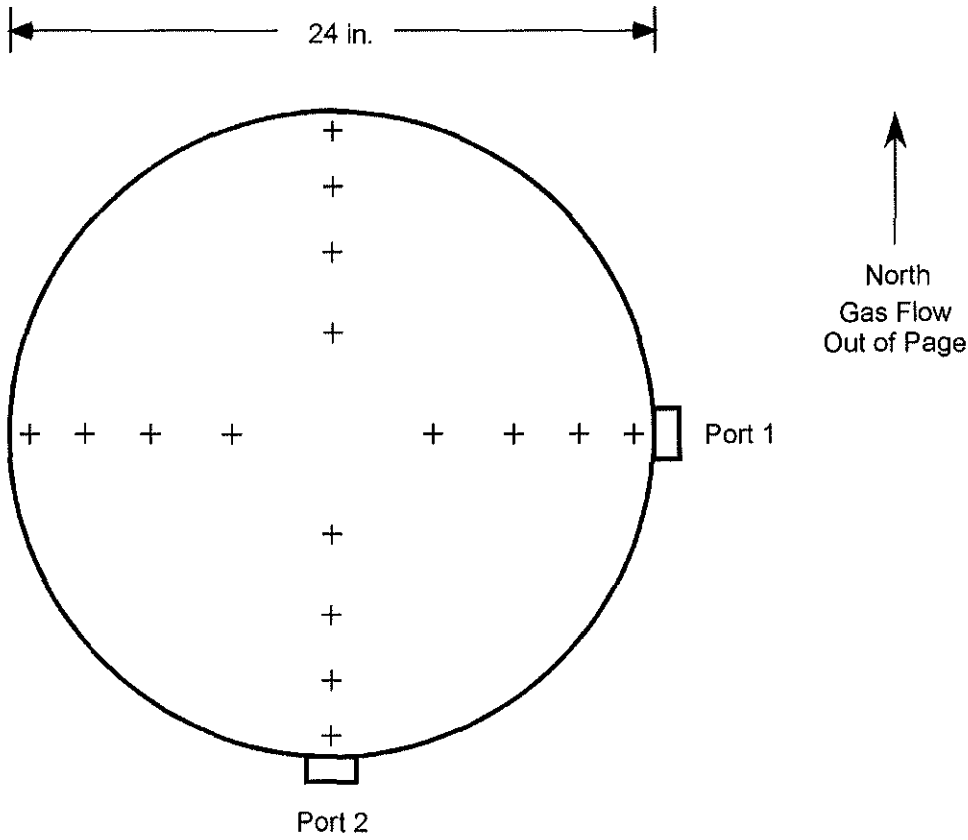
**Table 3-1:
 Sampling Point Information**

<u>Source</u>		Run	Points per	Minutes per	Total		
Constituent	Method (USEPA)	No.	Port	Point	Minutes	Figure	
<u>Fuel Oil Heater Stack</u>							
FPM / CPM	5 / 202	1-4	2	8	7.5	120	3-1
NSFPM	5B	1-4	2	8	7.5	120	3-1
H ₂ SO ₄	Draft ASTM CCM	1-3	1	1	60	60	N/A ¹
O ₂ / CO ₂ / NO _x / CO	3A / 7E / 10	1 ²	1	3	20	60	3-2
O ₂ / CO ₂ / NO _x / CO	3A / 7E / 10	2-3	1	1	60	60	3-2

¹ Draft ASTM CCM sampling will occur at a single point near the center of the duct.

² Stratification check. Points for Runs 2 and 3 were adjusted accordingly.

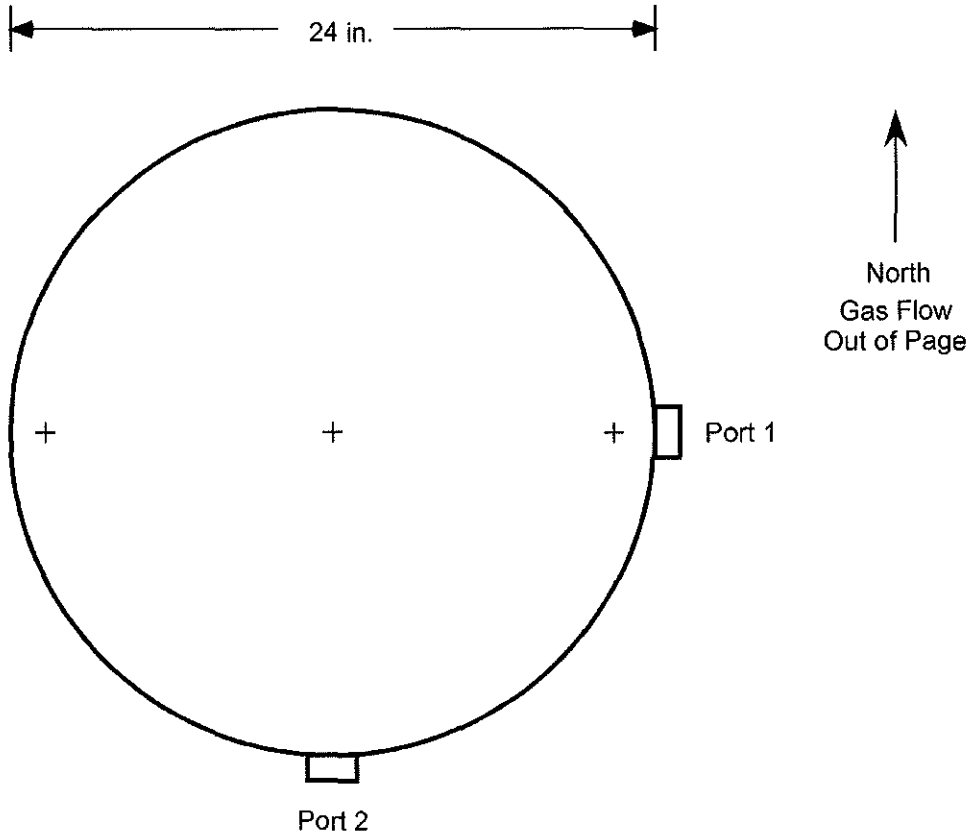
**Figure 3-1:
 PM, PM₁₀ & NSFPM Sample Point Layout (EPA Method 1)**



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	96.8	23.2
2	89.5	21.5
3	80.6	19.3
4	67.7	16.2
5	32.3	7.8
6	19.4	4.7
7	10.5	2.5
8	3.2	0.8

Duct diameters upstream from flow disturbance (A): 4.0 Limit: 0.5
 Duct diameters downstream from flow disturbance (B): 6.2 Limit: 2.0

Figure 3-2:
O₂, NO_x & CO Sample Point Layout (EPA Method 7E)



Sampling Point	% of Stack Diameter	Port to Point Distance (inches)
1	83.3	20.0
2	50.0	12.0
3	16.7	4.0

Duct diameters upstream from flow disturbance (A): 4.0 Limit: 0.5
 Duct diameters downstream from flow disturbance (B): 6.2 Limit: 2.0

End of Section

4. METHODOLOGY

Procedures and Regulations

The test program sampling measurements followed procedures and regulations outlined by the United States Environmental Protection Agency (USEPA) and the Michigan DEQ. These methods appear in detail in Title 40 of the CFR and at <https://www.epa.gov/emc>. Appendix A includes diagrams of the sampling apparatus, as well as specifications for sampling, recovery and analytical procedures.

CleanAir follows specific QA/QC procedures outlined in the individual methods and in USEPA "Quality Assurance Handbook for Air Pollution Measurement Systems: Volume III Stationary Source-Specific Methods," EPA/600/R-94/038C. Appendix D contains additional QA/QC measures, as outlined in CleanAir's internal Quality Manual.

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 4 "Determination of Moisture Content in Stack Gases"
- Method 5 "Determination of Particulate Matter Emissions from Stationary Sources"
- Method 5B "Determination of Nonsulfuric Acid Particulate Matter Emissions from Stationary Sources"
- Method 7E "Determination of Nitrogen Oxide Emissions from Stationary Sources (Instrumental Analyzer)"
- Method 10 "Determination of Carbon Monoxide Emissions from Stationary Sources"
- Method 19 "Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide and Nitrogen Oxide Emission Rates"

Title 40 CFR Part 51, Appendix M

- Method 202 "Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"

CTM-013 (Mod.)/Draft ASTM Controlled Condensation Method (Draft ASTM CCM)

"Determination of Sulfur Oxides Including Sulfur Dioxide, Sulfur Trioxide and Sulfuric Acid Vapor and Mist from Stationary Sources Using a Controlled Condensation Sampling Apparatus"

Methodology Discussion

PM and PM₁₀ Testing – USEPA Method 5/202

The front-half (Method 5 portion) of the sampling train consisted of a glass nozzle, glass liner and filter holder heated to 248°F ± 25°F and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5 requirements.

The back-half (Method 202 portion) of the sampling train is designed to mimic ambient conditions and collect only the particles that would truly form CPM in the atmosphere by minimizing the sulfur dioxide (SO₂) and NO_x interferences observed with earlier versions of the method, in which flue gas was bubbled through cold water, and SO₂ and NO_x were absorbed and partially oxidized before they could be purged out with nitrogen (N₂).

Flue gas exiting the front-half heated filter passed through a coiled condenser and dry impinger system jacketed by water continually circulated at ambient temperature. Moisture was removed from the flue gas without bubbling through the condensed water. Flue gas then passed through a tetrafluoroethane (TFE) membrane filter at ambient temperature. The temperature of the flue gas at the exit of the filter was directly measured with an in-line thermocouple and maintained in the temperature range of 65°F to 85°F.

After exiting the ambient filter, the flue gas passed through two (2) additional impingers surrounded by ice in a “cold” section of the impinger bucket. The moisture collected in these impingers were not analyzed for CPM and was only collected 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. The back-half of the sample train (heated filter outlet, condenser, dry impingers and TFE membrane filter) was recovered per Method 202 requirements. The impinger train was purged with N₂ at a rate of 14 liters per minute (lpm) for one (1) hour following each test run and prior to recovery.

A field train blank was assembled, purged and recovered as if it were an actual test sample; analysis of the field train blank was used to blank-correct the test run results. Reagent blanks were also collected to quantify background contamination. All samples and blanks were returned to CleanAir Analytical Services for gravimetric analysis. Method 202 samples were maintained at a temperature < 85°F during transport to the laboratory.

NSFPM Testing – USEPA Method 5B

The front-half (Method 5 portion) of the sampling train consisted of a glass nozzle, glass liner and filter holder heated to 320°F ± 25°F and a quartz fiber filter. Flue gas samples were extracted isokinetically per Method 5B requirements.

The back-half of the sample train consisted of a series of knock-out jars. The moisture collected in these knock-out jars were only collected 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 5B requirements, using acetone as the recovery solvent. All samples and blanks were returned to CleanAir Analytical Services for gravimetric analysis.

O₂, CO₂, NO_x and CO Testing – USEPA Methods 3A, 7E and 10

Reference method O₂ and carbon dioxide (CO₂) emissions were determined using a paramagnetic/NDIR analyzer per EPA Method 3A. Reference method NO_x emissions were determined using a chemiluminescent analyzer per EPA Method 7E. Reference method CO emissions were determined using a gas filter correlation IR analyzer per EPA Method 10.

Sample gas was extracted at a constant rate, conditioned to remove moisture, and delivered to an analyzer bank which measured concentration on a dry basis (units of %dv or ppm_{dv}).

Calibration error checks were performed by introducing zero N₂, high range and mid-range calibration gases to the inlet of each analyzer during calibration error checks. Bias checks were performed before and after each sampling run by introducing calibration gas to the inlet of the sampling system's heated filter. Per Methods 3A, 7E and 10, the average results for each run were drift-corrected.

H₂SO₄ Testing – Draft ASTM CCM

A gas sample was extracted from the source at a constant flow rate using a quartz-lined probe maintained at a temperature of 650°F ± 25°F (depending on the required probe length) and a quartz fiber filter maintained at the same temperature as the probe to remove particulate matter.

The sample then passed through a glass coil condenser for collection of sulfuric acid vapor and/or mist. A second quartz fiber filter (referred to as the sulfuric acid mist (SAM) filter) was located at the condenser outlet for the collection of residual SAM not collected by the condenser. The condenser temperature was regulated by a water jacket and the SAM filter was regulated by a closed oven. Both the water jacket and SAM filter oven were maintained at 140°F ± 9°F. After exiting the SAM filter, the sample gas continued through a series of four (4) glass knock-out jars; two (2) containing water, one (1) empty and one (1) containing silica gel for residual moisture removal. The exit temperature from the knock-out jar set was maintained below 68°F. The sample gas then flowed into a dry gas meter, where the collected sample gas volume was determined by means of a calibrated, dry gas meter or an orifice-based flow meter.

The H₂SO₄-collecting portion of the sample train (condenser and SAM filter) was recovered into a single fraction using deionized (DI) H₂O as the recovery/extraction solvent; any H₂SO₄ disassociates into sulfate ion (SO₄²⁻) and is stabilized in the H₂O matrix until analysis.

Samples and blanks were returned to CleanAir Analytical Services for ion chromatography analysis.