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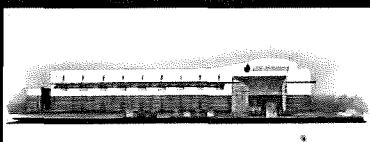
AIR QUALITY DIVISION

EMISSION COMPLIANCE TEST
FOR THE
FUEL GAS HEATER, UNIT #FGH2
PREPARED FOR
INDECK NILES, LLC
AT THE
INDECK NILES ENERGY CENTER
NILES, MICHIGAN
JUNE 23, 2022

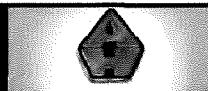
Permit No: 75-16B

Report Date: July 15, 2022

N6921-test-20220623(2)



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Sr. Project Manager

I, Cole McBride
Sr. Project Manager
certify that this testing was conducted and
this report was created in conformance
with the requirements of ASTM D7036

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CERTIFICATION OF INFORMATION

I certify under penalty of law that I believe the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine or imprisonment or both, for submitting false, inaccurate or incomplete information.



Cole McBride, QSTI
Sr. Project Manager
Air Hygiene International, Inc.

July 4, 2022
Date

FACILITY CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attached documents and, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine or imprisonment or both, for submitting false, inaccurate or incomplete information.

I am the responsible official with direct knowledge and overall responsibility for the information contained in this report.

Name

Title

Signature

Date

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**Emissions Compliance Test
Fuel Gas Heater, Unit #FGH2
Indeck Niles, LLC
Indeck Niles Energy Center
Niles, Michigan
June 23, 2022**

1.0 INTRODUCTION

Air Hygiene International, Inc. (Air Hygiene) has completed the Emissions Compliance Test for particulate matter (PM) from the exhaust of the Fuel Gas Heater, Unit #FGH2 for Indeck Niles, LLC at the Indeck Niles Energy Center in Niles, Michigan. This report details the background, results, process description, and the sampling/analysis methodology of the stack sampling survey conducted on June 23, 2022.

1.1 TEST PURPOSE AND OBJECTIVES

The purpose of the test was to conduct an initial compliance emission test to document levels of selected pollutants at maximum load. The information will be used to confirm compliance with the operating permit issued by the Michigan Department of Environment, Great Lakes, and Energy (EGLE). The specific objective was to determine the emission concentration of PM from the exhaust of Indeck Niles, LLC's Fuel Gas Heater, Unit #FGH2.

1.2 SUMMARY OF TEST PROGRAM

The following list details pertinent information related to this specific project:

- 1.2.1 Participating Organizations
 - Michigan Department of Environment, Great Lakes, and Energy (EGLE)
 - Indeck Niles, LLC
 - Kiewit Corporation
 - Air Hygiene
- 1.2.2 Industry
 - Electric Utility / Electric Services
- 1.2.3 Air Permit Requirements
 - Permit Number: 75-16B
- 1.2.4 Plant Location
 - Indeck Niles Energy Center in Niles, Michigan
 - GPS Coordinates [Latitude 41.85831, Longitude -86.22417]
 - Physical Address: 2200 Progressive Dr., Niles, Michigan 49120
 - Federal Registry System / Facility Registry Service (FRS) No. – 110017413985
 - Source Classification Code (SCC) – 20100201
- 1.2.5 Equipment Tested
 - Fuel Gas Heater, Unit #FGH2
- 1.2.6 Emission Points
 - Exhaust from the Fuel Gas Heater, Unit #FGH2
 - For O₂/CO₂ one sample point in the stack from the Fuel Gas Heater, Unit #FGH2, determined after conducting a stratification test
 - For all PM testing, 24 sampling points in the stack from the Fuel Gas Heater, Unit #FGH2

1.2.7 Emission Parameters Measured

- PM
- Flow
- H₂O
- CO₂
- O₂

1.2.8 Date of Emission Test

- June 23, 2022

1.2.9 Federal Certifications

- Stack Testing Accreditation Council AETB Certificate No. 3796.02
- International Standard ISO/IEC 17025:2005 Certificate No. 3796.01

1.3 KEY PERSONNEL

Indeck Niles, LLC:	Tom Krysiak (tkrysiak@indeckenergy.com)	716-225-6478
Kiewit Corporation:	Derek Goettemoeller (Derek.Goettemoeller@Kiewit.com)	913-905-9068
Air Hygiene:	Cole McBride (cmcbride@airhygiene.com)	918-307-8865
Air Hygiene:	Swanson Bierman	918-307-8865
Air Hygiene:	Colby Gniech	918-307-8865
Air Hygiene:	Harold Jones	918-307-8865
Air Hygiene:	Jason Hass	918-307-8865
Air Hygiene:	Trevor Thompson	918-307-8865
Air Hygiene:	Sean Barnes	918-307-8865

2.0 SUMMARY OF TEST RESULTS

Results from the sampling conducted on Indeck Niles, LLC’s Fuel Gas Heater, Unit #FGH2 located at the Indeck Niles Energy Center on June 23, 2022 are summarized in the following table and relate only to the items tested.

The results of all measured pollutant emissions were below the required limits. All testing was performed without any real or apparent errors. All testing was conducted according to the approved testing protocol.

**TABLE 2.1
SUMMARY OF FUEL GAS HEATER, UNIT #FGH2
RESULTS**

Parameter	Max Load Emissions	Permit Limits
Boiler Fuel Flow (SCFH)	3,158	--
Heat Input (MMBtu/hr)	3.39	--
Filterable PM (mg)	1.30	--
Filterable PM (gr/dscf)	8.99E-04	--
Filterable PM (lb/hr)	0.01	--
Filterable PM (lb/MMBtu)	0.0017	0.002

3.0 SOURCE OPERATION

3.1 PROCESS DESCRIPTION

Indeck Niles, LLC owns and operates the Indeck Niles Energy Center located at 2200 Progressive Dr., in Niles, Michigan. The facility includes two combined-cycle natural gas fired combustion turbine generators (CTGs). The two CTGs are rated at 3,651 million British thermal unit per hour (MMBtu/hr) and are coupled with heat recovery steam generators (HRSG) in a two-on-one configuration with a steam turbine generator. Each HRSG is equipped with a natural gas-fired duct burner rated at 71 MMBtu/hr to provide heat for additional steam production. The HRSGs are not capable of operating independently from each CTG. Each CTG/HRSG is equipped with dry low NOx burners (DLNB), selective catalytic reduction (SCR), and an oxidation catalyst. In addition, two fuel gas heaters (FGHs) are located at the facility to support unit startup.

3.2 SAMPLING LOCATION

The FGH stacks are vertical, circular, and measure 1.94 feet (ft) (23.25 inches) in diameter at the test ports which are approximately 14 ft above grade level with an exit elevation of approximately 30 ft above grade level. The test ports are located approximately 9.17 ft (110 inches) [4.7 dia] downstream and approximately 16 ft (192 inches) [8.3 dia] upstream from the nearest disturbances. Air Hygiene has field verified the measurable dimensions. Non-field verified dimensions are provided by Indeck Niles, LLC. All exhaust samples for gaseous emissions were continuously drawn from the exhaust system at the sample ports from a single point determined after conducting a stratification test for oxides of nitrogen (NOx) and O₂. During the stratification test six points were traversed from each of the two ports. The probe was allowed to remain at a point for at least two times the system response time. For PM testing, an initial velocity traverse was performed across the stack from 24 total points to confirm the absence of cyclonic flow. All PM sampling occurred from the same 24 points by leaving the probe at each for an equal amount of time.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

4.1 TEST METHODS

The emission test on the Fuel Gas Heater, Unit #FGH2 at the Indeck Niles Energy Center was performed following United States Environmental Protection Agency (EPA) methods described by the Code of Federal Regulations (CFR). Table 4.1 outlines the specific methods performed on June 23, 2022.

**TABLE 4.1
SUMMARY OF SAMPLING METHODS**

Pollutant or Parameter	Sampling Method	Analysis Method
Sample Point Location	EPA Method 1	Equal Area Method
Stack Flow Rate	EPA Method 2	S-Type Pitot Tube
Oxygen	EPA Method 3A	Paramagnetic Cell
Carbon Dioxide	EPA Method 3A	Nondispersive Infrared Analyzer

Pollutant or Parameter	Sampling Method	Analysis Method
Stack Moisture Content	EPA Method 4	Gravimetric Analysis
Particulate Matter	EPA Method 5	Front Half Filterables
Stack Flow Rate	EPA Method 19	Dry Oxygen F Factor
Fuel Content Analysis	ASTM D-1945	Fuel Gas Sample and Laboratory Analysis

4.2 INSTRUMENT CONFIGURATION AND OPERATIONS FOR GAS ANALYSIS

The sampling and analysis procedures used during these tests conform with the methods outlined in the Code of Federal Regulations (CFR), Title 40, Part 60, Appendix A, Methods 1, 2, 3A, 4, 5, and 19.

Figure 4.1 depicts the sample system used for the real-time gas analyzer tests. The gas sample was continuously pulled through the probe and transported, via heat-traced Teflon® tubing, to a stainless-steel minimum-contact condenser designed to dry the sample. Transportation of the sample, through Teflon® tubing, continued into the sample manifold within the mobile laboratory via a stainless steel/Teflon® diaphragm pump. From the manifold, the sample was partitioned to the real-time analyzers through rotameters that controlled the flow rate of the sample. Exhaust samples were routed to the wet based analyzer prior to gas conditioning.

Figure 4.1 shows that the sample system was also equipped with a separate path through which a calibration gas could be delivered to the probe and back through the entire sampling system. This allowed for convenient performance of system bias checks as required by the testing methods.

All instruments were housed in a climate controlled, trailer-mounted mobile laboratory. Gaseous calibration standards were provided in aluminum cylinders with the concentrations certified by the vendor. EPA Protocol No. 1 was used to determine the cylinder concentrations where applicable (i.e., O₂ calibration gases).

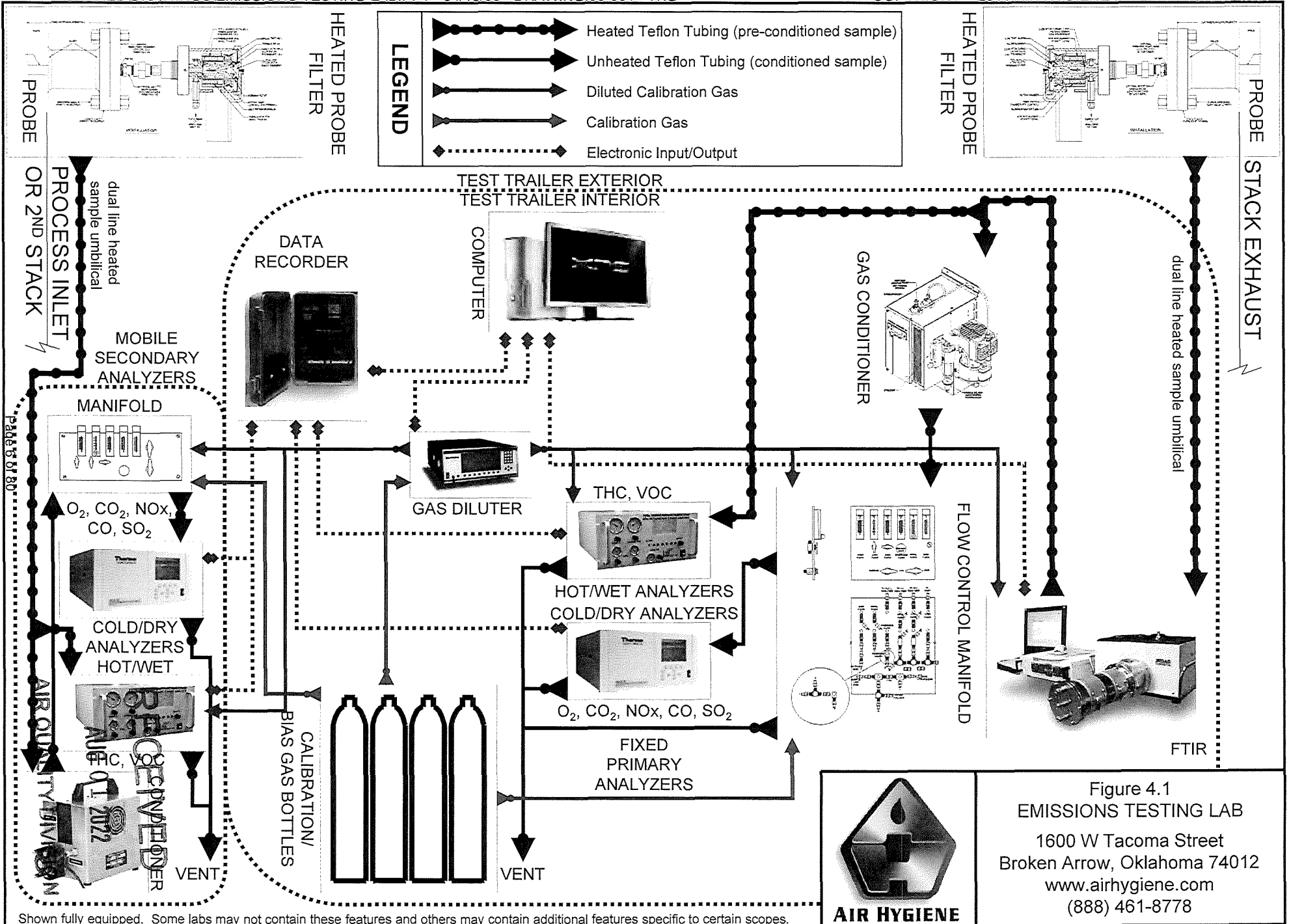
Table 4.2 provides a description of the analyzers used for the instrument portion of the tests. All data from the continuous monitoring instruments were recorded on a Logic Beach Portable Data Logging System which retrieves calibrated electronic data from each instrument every one second and reports an average of the collected data every 30 seconds.

Figure 4.2 represents the sample system used for the PM tests. A heated stainless-steel probe with a glass liner and nozzle was inserted into the sample ports of the stack to extract gas measurements from the emission stream through a filter and glass impinger train. Flow rates are monitored with oil filled manometers and total sample volumes are measured with a dry gas meter.

The stack gas analysis for O₂ and CO₂ concentrations was performed in accordance with procedures set forth in EPA Method 3A. The O₂ analyzer uses a paramagnetic cell detector and the CO₂ analyzer uses a continuous nondispersive infrared analyzer.

**TABLE 4.2
ANALYTICAL INSTRUMENTATION**

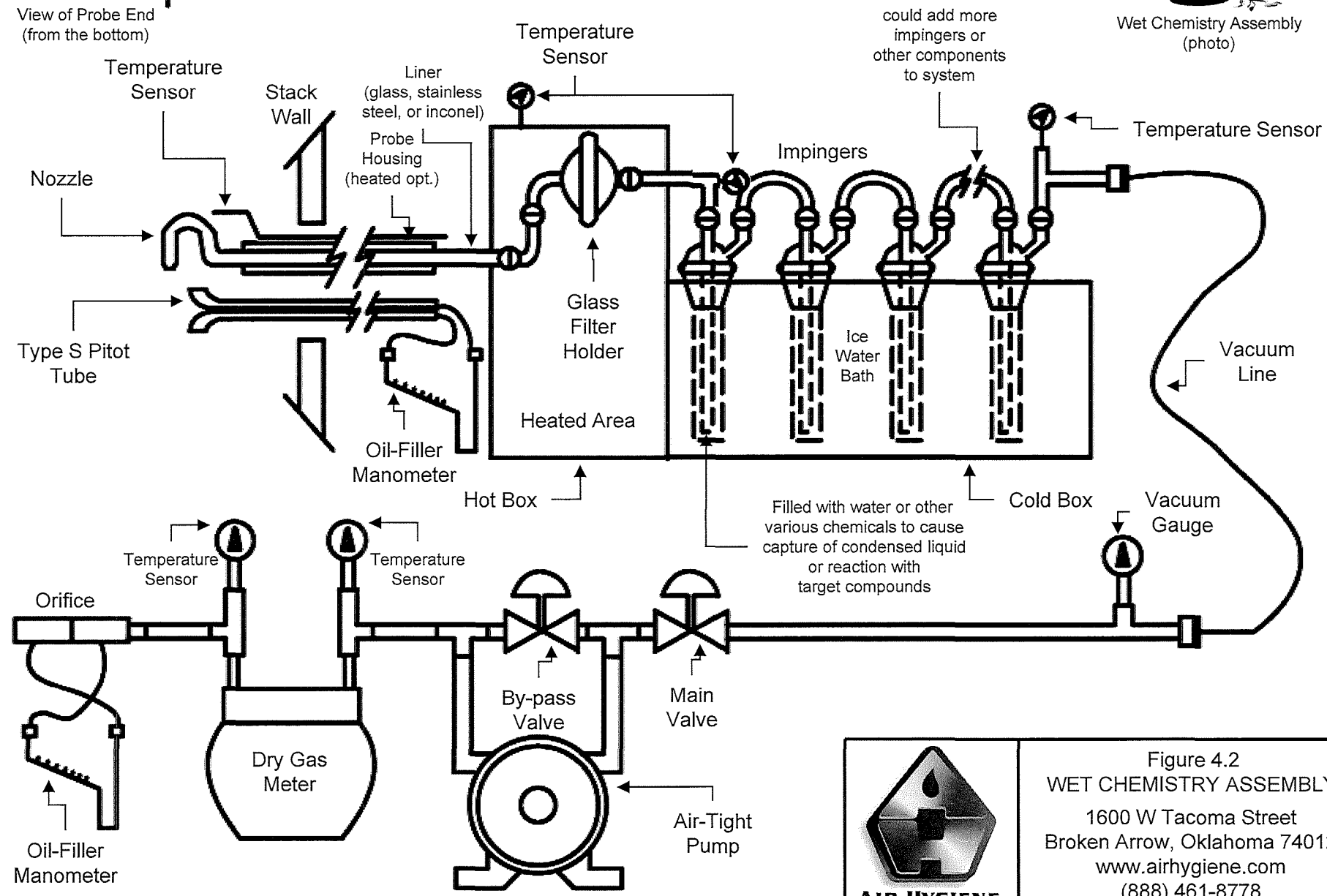
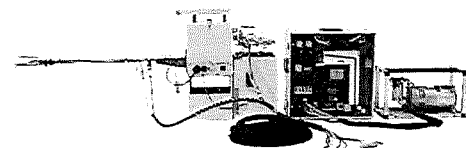
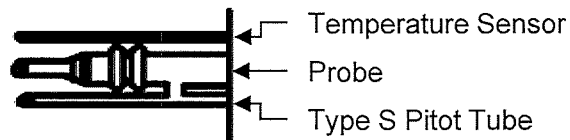
Parameter	Manufacturer and Model	Range	Sensitivity	Detection Principle
CO ₂	SERVOMEX 1440	0-20%	0.1%	Nondispersive infrared
O ₂	SERVOMEX 1440	0-25%	0.1%	Paramagnetic cell, inherently linear.



Shown fully equipped. Some labs may not contain these features and others may contain additional features specific to certain scopes.



Figure 4.1
 EMISSIONS TESTING LAB
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Figure 4.2
WET CHEMISTRY ASSEMBLY
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APPENDIX A
TEST RESULTS AND CALCULATIONS

TABLE A.1: EMISSIONS TESTING SCHEDULE

Unit	Load	Component	Run	Date	Start	Stop	Time Sync	Duration
FGH2	Max	Cyc. Flow Chk.	FGH2_PM-V1	06/23/22	13:50:00	14:00:00	DAHS	0:10:00
FGH2	Max	PM	FGH2_PM-1	06/23/22	17:24:00	18:31:00	DAHS	1:07:00
FGH2	Max	PM	FGH2_PM-2	06/23/22	18:42:00	19:48:00	DAHS	1:06:00
FGH2	Max	PM	FGH2_PM-3	06/23/22	20:04:00	21:10:00	DAHS	1:06:00

TEST RESULTS AND CALCULATIONS

PM Emissions Data

METHOD 5 (FILTERABLE PARTICULATES) - RESULTS

Plant Name	Indeck Niles Energy Center
Sampling Location	Fuel Gas Heater 2
Project #	kie-22-niles.mi-start#1

Historical Data	FGH2_PM-1	FGH2_PM-2	FGH2_PM-3	Average	Units
Run Start Time	17:24	18:42	20:04		hh:mm
Run Stop Time	18:31	19:48	21:10		hh:mm
Test Date	06/23/22	06/23/22	06/23/22		mm/dd/yy
Load	Max	Max	Max		% or w/DB
Meter Calibration Factor	0.975	0.975	0.975		
Pitot Tube Coefficient	0.8070	0.8070	0.8070		
Average Nozzle Diameter	0.372	0.372	0.372		in
Stack Test Data	FGH2_PM-1	FGH2_PM-2	FGH2_PM-3	Average	Units
Initial Meter Volume	907.870	932.220	956.570		ft ³
Final Meter Volume	931.800	956.270	980.340		ft ³
Total Meter Volume	23.930	24.050	23.770	23.917	ft ³
Total Sampling Time	60.00	60.00	60.00	60.00	min
Average Meter Temperature	78.38	78.04	75.42	77.28	°F
Average Stack Temperature	378.29	379.83	403.17	387.10	°F
Barometric Pressure	29.22	29.21	29.22	29.22	in Hg
Stack Static Pressure	-0.06	-0.06	-0.06	-0.06	in H ₂ O
Absolute Stack Pressure	29.22	29.21	29.22	29.21	in Hg
Average Orifice Pressure Drop	0.43	0.50	0.48	0.47	in H ₂ O
Absolute Meter Pressure	29.35	29.34	29.35	29.35	in Hg
Avg Square Root Pitot Pressure	0.23	0.22	0.22	0.22	√(in H ₂ O)
Moisture Content Data	FGH2_PM-1	FGH2_PM-2	FGH2_PM-3	Average	Units
Impinger Water Weight Gain	61.70	76.70	65.30	67.90	g
Silica Gel Weight Gain	9.50	4.80	5.00	6.43	g
Total Water Volume Collected	71.33	81.65	70.43	74.47	ml
Standard Water Vapor Volume	3.36	3.84	3.31	3.50	scf
Standard Meter Volume	22.4	22.5	22.3	22.4	dscf
Standard Metric Meter Volume	0.6	0.6	0.6	0.6	dscm
Calculated Stack Moisture	13.05	14.59	12.92	13.52	%
Saturated Stack Moisture	100.00	100.00	100.00	100.00	%
Reported Stack Moisture Content	13.05	14.59	12.92	13.52	%
Gas Analysis Data	FGH2_PM-1	FGH2_PM-2	FGH2_PM-3	Average	Units
Carbon Dioxide Content	8.5	8.4	7.7	8.2	%
Oxygen Content	7.0	7.1	7.2	7.1	%
Carbon Monoxide Content	0.0	0.0	0.0	0.0	ppm
Nitrogen Content	84.5	84.5	85.1	84.7	%
Stack Dry Molecular Weight	29.64	29.63	29.52	29.60	lb/lb-mole
Stack Wet Molecular Weight	28.12	27.93	28.03	28.03	lb/lb-mole
Calculated Fuel Factor	1.635	1.643	1.779	1.686	
Fuel F-Factor	8648.00	8648.00	8648.00	8648.00	dscf/MMBtu
Percent Excess Air	45.7	46.7	47.2	46.5	%

METHOD 5 (FILTERABLE PARTICULATES) - RESULTS

Plant Name	Indeck Niles Energy Center
Sampling Location	Fuel Gas Heater 2
Project #	kie-22-niles.mi-start#1

Volumetric Flow Rate Data	FGH2_PM-1	FGH2_PM-2	FGH2_PM-3	Average	Units
Average Stack Gas Velocity	15.70	15.65	15.83	15.73	ft/sec
Stack Cross-Sectional Area	2.95	2.95	2.95	2.95	ft ²
Actual Stack Flow Rate	2,778	2,768	2,801	2,782	acfm
Wet Standard Stack Flow Rate	102	102	100	102	wkscfh
Dry Standard Stack Flow Rate	89,121	87,049	87,420	87,864	dscfh
Percent of Isokinetic Rate	98.0	100.9	100.0	99.6	%
Emission Rate Data	FGH2_PM-1	FGH2_PM-2	FGH2_PM-3	Average	Units
Filterable PM Mass	2.04	0.86	1.02	1.30	mg
Filterable PM Concentration	9.10E-05	3.83E-05	4.55E-05	5.83E-05	g/dscf
	1.40E-03	5.91E-04	7.02E-04	8.99E-04	gr/dscf
Filterable PM Emission Rate	0.01	0.00	0.00	0.01	kg/hr
	0.02	0.01	0.01	0.01	lb/hr
	0.08	0.03	0.04	0.05	tpy
	0.0026	0.0011	0.0013	0.0017	lb/MMBtu

Nomenclature

- %CO = carbon monoxide concentration (%)
- %CO₂ = carbon dioxide concentration (%)
- %N₂ = nitrogen concentration (%)
- %O₂ = oxygen concentration (%)
- %O_{2,wet} = Oxygen content of gas stream, % by volume of wet gas. (Note: The oxygen percentage used in Method 201A, Equation 3 is on a wet gas basis. That means that since oxygen is typically measured on a dry gas basis, the measured percent O₂ must be multiplied by the quantity (1 - B_{ws}) to convert to the actual volume fraction. Therefore, %O_{2,wet} = (1 - B_{ws}) * %O_{2, dry})
- (%EA)_{avg} = average excess air (%)
- (F_o)_{avg} = average calculated fuel factor
- $[(\Delta p)^{0.5}]_{avg}$ = Average of square roots of the velocity pressures measured during the preliminary traverse, inches W.C.
- μ = Gas viscosity, micropoise
- 12.0 = Constant calculated as 60 percent of 20.5 square inch cross-sectional area of combined cyclone head, square inches
- 17.03 = mg/milliequivalents for ammonium ion
- 22.4 = liters of ideal gas per lb-mol of substance at 0°C and 1 atm (ref. Civil Engineering Reference Manual, 7th ed. - Michael R. Lindeburg)
- 24.04 = liters of ideal gas per lb-mol of substance at 20°C and 1 atm (ref. Civil Engineering Reference Manual, 7th ed. - Michael R. Lindeburg)
- 5.02×10^4 = constant derived from the molecular weight and correcting standard temperature and pressure (ref. Bay Area Air Quality Management District, Source Test Procedure ST-1B, Ammonia Integrated Sampling, Adopted January 20, 1982, Regulation 7-303)
- A = distance upstream (in.)
- A_D = stack diameters upstream (dia.)
- A_n = Area of nozzle, square feet
- A_s = area of stack (ft²)
- B = distance downstream (in.)
- B_D = stack diameters downstream (dia.)
- b_f = Average blockage factor calculated in Equation 26, dimensionless
- B_{wm} = meter moisture content (%)
- B_{ws} = stack moisture content (%)
- C = Cunningham correction factor for particle diameter, D_p, and calculated using the actual stack gas temperature, dimensionless
- C₁ = -150.3162 (micropoise)
- C₂ = 18.0614 (micropoise/K^{0.5}) = 13.4622 (micropoise/R^{0.5})
- C₃ = 1.19183 × 10⁶ (micropoise/K²) = 3.86153 × 10⁶ (micropoise/R²)
- C₄ = 0.591123 (micropoise)
- C₅ = 91.9723 (micropoise)
- C₆ = 4.91705 × 10⁻⁵ (micropoise/K²) = 1.51761 × 10⁻⁵ (micropoise/R²)
- C_a = Acetone blank concentration, mg/mg
- C_b = Concentration of NH₃ ion in the back half of train (breakthrough)
- C_f = Concentration of NH₃ ion in the front half of train (main catch)
- C_{fPM10} = Conc. of filterable PM₁₀, gr/dscf
- C_{fPM2.5} = Conc. of filterable PM_{2.5}, gr/dscf
- C_k = K Factor Constant, 849.8

Nomenclature

- C_n = nozzle diameter constant, 0.03575
- C_p' = Coefficient for the pitot used in the preliminary traverse, dimensionless
- C_p = Pitot coefficient for the combined cyclone pitot, dimensionless
- C_{cpm} = Concentration of the condensable PM in the stack gas, dry basis, corrected to standard conditions, milligrams/dry standard cubic foot.
- C_r = Re-estimated Cunningham correction factor for particle diameter equivalent to the actual cut size diameter and calculated using the actual stack gas temperature, dimensionless
- D_{50} = Particle cut diameter, micrometers
- $D_{50(N+1)}$ = D_{50} value for cyclone IV calculated during the N+1 iterative step, micrometers
- D_{50-1} = Re-calculated particle cut diameters based on re-estimated C_r , micrometers
- D_{50LL} = Cut diameter for cyclone I corresponding to the 2.25 micrometer cut diameter for cyclone IV, micrometer
- D_{50N} = D_{50} value for cyclone IV calculated during the Nth iterative step, micrometers
- D_{50T} = Cyclone I cut diameter corresponding to the middle of the overlap zone shown in Method 201A, Figure 10 of Section 17, micrometers
- D_e = equivalent stack diameter (in.)
- $\Delta H@$ = $\Delta H @ 0.75$ scfm (in. H₂O)
- ΔH_{avg} = average orifice pressure (in. H₂O)
- D_n = Inner diameter of sampling nozzle mounted on Cyclone I, inches
- D_{na} = actual nozzle diameter (in.)
- D_p = Physical particle size, micrometers
- Δp = velocity head (in. H₂O)
- Δp_1 = velocity head at first current traverse point (in. H₂O)
- $\Delta p'_1$ = velocity head at first preliminary traverse point (in. H₂O)
- Δp_{avg} = average pitot tube differential pressure (in. H₂O)
- Δp_n = velocity head at subsequent current traverse point (in. H₂O)
- Δp_{RM2} = method 2 velocity head (in. H₂O)
- D_s = diameter of stack (in.)
- F_d = fuel f-factor (dscf/MMBtu)
- f_{O_2} = stack gas fraction of O₂, by volume, dry basis
- I = Percent isokinetic sampling, dimensionless
- K_1 = standard volume correction, 17.65°R/in. Hg
- K_4 = isokinetic conversion constant, 0.0945min•in.Hg/sec•°R
- K_5 = water mass to std water vapor, 0.04715 ft³/g
- K_p = 85.49, ((ft/sec)/(pounds/mole -°R))
- L = length of stack (in.)
- L_{fw} = distance to far wall of stack (in.)
- L_{nw} = distance to near wall of stack (in.) [reference]
- $m_{\#x}$ = weight measurements (g)
- M_1 = Milligrams of PM collected on the filter, less than or equal to 2.5 micrometers
- M_2 = Milligrams of PM recovered from Container #2 (acetone blank corrected), greater than 10 micrometers
- M_3 = Milligrams of PM recovered from Container #3 (acetone blank corrected), less than or equal to 10 and greater than 2.5 micrometers
- M_4 = Milligrams of PM recovered from Container #4 (acetone blank corrected), less than or equal to 2.5 micrometers

Nomenclature

- m_a = Mass of residue of acetone after evaporation, mg
- m_c = Mass of the NH_4^+ added to sample to form ammonium sulfate, mg
- m_{cpm} = Mass of the total condensable PM, mg
- M_d = Molecular weight of dry gas, pounds/pound mole
- m_{fb} = Mass of total CPM in field train recovery blank, mg
- m_{fx} = final weight, avg of last two measurements (g)
- mg = Milligram
- mg/L = Milligram per liter
- m_i = Mass of inorganic CPM, mg
- m_{ib} = Mass of inorganic CPM in field train recovery blank, mg
- M_n = total particulates (mg)
- m_o = Mass of organic CPM, mg
- m_{ob} = Mass of organic CPM in field train blank, mg
- m_r = Mass of dried sample from inorganic fraction, mg
- m_{tx} = tare weight (g)
- MW = molecular weight (lb/lb-mole)
- M_w = Molecular weight of wet gas, pounds/pound mole
- N = Normality of ammonium hydroxide titrant
- N_a = null angle (deg.)
- N_{re} = Reynolds number, dimensionless
- N_{tp} = Number of iterative steps or total traverse points
- $P_b = P_{\text{bar}}$ = barometric pressure (in. Hg)
- P_{bar} = barometric pressure (in. Hg)
- ppmCO = carbon monoxide concentration (ppm)
- ppmv = Parts per million by volume
- ppmw = Parts per million by weight
- P_s = absolute stack pressure (in. Hg)
- P_{static} = static pressure (in. H_2O)
- P_{std} = standard pressure, 29.92 in. Hg
- Θ = total sampling time (min)
- Q_{aw} = average stack wet flow rate (ascf/min)
- Q_l = Sampling rate for cyclone I to achieve specified D_{50}
- Q_m = estimated orifice flow rate, 0.750 acfm, else V_m/Q from previous run
- Q_s = Sampling rate for cyclone I to achieve specified D_{50}
- $Q_{\text{s(std)}}$ = total cyclone flow rate at standard conditions (dscf/min)
- Q_{sd} = dry standard stack flow rate (dscfm)
- Q_{sST} = Dry gas sampling rate through the sampling assembly, dscfm
- Q_{sw} = wet standard stack flow rate (ascfm)
- R_{max} = Nozzle/stack velocity ratio parameter, dimensionless
- R_{min} = Nozzle/stack velocity ratio parameter, dimensionless
- t_1 = Sampling time at point 1, min
- t_m = average gas meter temperature ($^{\circ}\text{F}$)
- t_m = average meter temperature ($^{\circ}\text{F}$)
- T_m = Meter box and orifice gas temperature, $^{\circ}\text{R}$
- t_n = Sampling time at point n, min

Nomenclature

- t_r = Total projected run time, min
- T_s = Absolute stack gas temperature, °R
- T_{std} = standard temperature, 68°F, 528°R
- T_u = absolute temperature offset, 460°R
- V_a = Volume of acetone blank, ml
- V_{aw} = Volume of acetone used in sample recovery wash, ml
- V_b = Volume of aliquot taken for IC analysis, ml
- V_c = Quantity of water captured in impingers and silica gel, ml
- V_f = final impinger volume (ml)
- V_i = initial impinger volume (ml)
- V_{ic} = Volume of impinger contents sample, ml
- V_m = Dry gas meter volume sampled, acf
- $V_{m(std)}$ = standard meter volume (dscf)
- v_{max} = Maximum gas velocity calculated from Equations 18 or 19, ft/sec
- v_{max} = maximum nozzle velocity (ft/sec)
- V_{mf} = final dry gas meter reading (dcf)
- V_{mi} = initial dry gas meter reading (dcf)
- v_{min} = Minimum gas velocity calculated from Method 201A, Equations 16 or 17, ft/sec
- V_{ms} = Dry gas meter volume sampled, corrected to standard conditions, dscf
- v_n = Sample gas velocity in the nozzle, ft/sec
- v_{org} = organics wash volume (ml)
- V_p = Volume of water added during train purge
- v_s = average stack gas velocity (ft/sec)
- v_{sl} = local velocity (ft/sec)
- V_t = total impinger volume (ml) = $(V_f - V_i)$
- V_t = Volume of NH₄OH titrant, ml
- $V_{w(std)}$ = volume of water vapor in gas sample at standard conditions (scf)
- v_x = blank volume (ml)
- W = width of stack (in.)
- $W_{2,3,4}$ = Weight of PM recovered from Containers #2, #3, and #4, mg
- W_a = Weight of blank residue in acetone used to recover samples, mg
- W_f = final impinger weight (g)
- W_i = initial impinger weight (g)
- W_t = total impinger weight (g) = $(W_f - W_i)$
- w_x = blank weight of solids (g)
- Y = meter calibration factor (a.k.a gamma)
- Z = Ratio between estimated cyclone IV D₅₀ values, dimensionless
- γ = Dry gas meter gamma value, dimensionless
- ΔH = Meter box orifice pressure drop, inches W.C.
- $\Delta H@$ = Pressure drop across orifice at flow rate of 0.75 scfm at standard conditions, inches W.C.
(Note: Specific to each orifice and meter box.)
- Δp_1 = Velocity pressure measured at point 1, inches W.C.
- Δp_{avg} = Average velocity pressure, inches W.C.
- Δp_m = Observed velocity pressure using S-type pitot tube in preliminary traverse, inches W.C.
- Δp_{max} = Maximum velocity pressure, inches W.C.

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Nomenclature

- Δp_{\min} = Minimum velocity pressure, inches W.C.
- Δp_n = Velocity pressure measured at point n during the test run, inches W.C.
- Δp_s = Velocity pressure calculated in Method 201a, Equation 25, inches W.C.
- Δp_{s1} = Velocity pressure adjusted for combined cyclone pitot tube, inches W.C.
- Δp_{s2} = Velocity pressure corrected for blockage, inches W.C.
- θ = Total run time, min
- ρ_a = Density of acetone, mg/ml (see label on bottle)
- Σ_n = total number of sampling points

EXAMPLE CALCULATIONS (Reference Method 1 - Circular Stack)

Diameter of Stack (in.)

$$D(\text{in.}) = L_{fr} - L_{mv}$$

$$D(\text{in.}) = 30.50 \text{ in.} - 7.25 \text{ in.} = 23.25 \text{ in.}$$

Stack Diameters Downstream

$$B_D(\text{dia.}) = \frac{B}{D}$$

$$B_D(\text{dia.}) = \frac{110.00 \text{ in.}}{23.25 \text{ in.}} = 4.73 \text{ diameters}$$

Area of Stack (ft²)

$$A_s(\text{ft}^2) = \pi \times \left(\frac{D}{2 \times 12} \right)^2$$

$$A_s(\text{ft}^2) = 3.14 \times \left(\frac{23.25 \text{ in.}}{2 \times 12 \text{ in./ft}} \right)^2 = 2.95 \text{ ft}^2$$

Stack Diameters Upstream

$$A_D(\text{dia.}) = \frac{A}{D}$$

$$A_D(\text{dia.}) = \frac{192.00 \text{ in.}}{23.25 \text{ in.}} = 8.26 \text{ diameters}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Reference Method 3a) [Values from Run 1 test]

Carbon Monoxide Concentration (%)

$$\%CO = \frac{ppmCO}{10,000}$$

$$\%CO (\%) = \frac{0.00 \text{ ppm}}{10,000 \text{ ppm/\%}} = 0.0000 \%$$

Nitrogen Concentration (%)

$$\%N_2 = 100 - \%CO_2 - \%O_2 - \%CO$$

$$\%N_2 (\%) = 100 - 8.50 \% - 7.00 \% - 0.00 / 10,000 \% = 84.5 \%$$

Stack Dry Molecular Weight (lb/lb-mole)

$$M_d (\text{lb} / \text{lb} - \text{mol}) = \sum \left(\frac{MW_{comp}}{100} \times \%component \right)$$

$$M_d (\text{lb/lb-mol}) = \left(\frac{44 \text{ lb/lb-mol}}{100} \times 8.50 \% \right) +$$

$$\left(\frac{32 \text{ lb/lb-mol}}{100} \times 7.00 \% \right) + \left(\frac{28 \text{ lb/lb-mol}}{100} \times \left[\frac{0.00}{10,000} + 84.50 \right] \right) = \frac{29.64 \text{ lb}}{\text{lb-mol}}$$

Stack Wet Molecular Weight (lb/lb-mole)

$$M_s (\text{lb} / \text{lb} - \text{mol}) = \left[M_d \times \left(1 - \frac{B_{ws}}{100} \right) \right] + \left[MW_{H_2O} \times \frac{B_{ws}}{100} \right]$$

$$M_s (\text{lb/lb-mol}) = \left\{ \frac{29.64 \text{ lb}}{\text{lb-mol}} \times \left(1 - \frac{13.05 \%}{100} \right) \right\} + \left\{ \frac{18 \text{ lb}}{\text{lb-mol}} \times \frac{13.05 \%}{100} \right\} = \frac{28.12 \text{ lb}}{\text{lb-mol}}$$

Average Calculated Fuel Factor (F_o)

$$F_{o(avg)} = \frac{[20.9 - (\%O_2)_{avg} - (0.5 \times (\%CO)_{avg})]}{(\%CO_2)_{avg} + (\%CO)_{avg}}$$

$$F_{o(avg)} = \frac{20.9\% - 7.00 \% - (0.5 \times 0.000 \%)}{8.50 \% + 0.000 \%} = 1.635$$

Average Excess Air (%)

$$\%EA_{avg} (\%) = \frac{100 \times [(\%O_2)_{avg} - (0.5 \times (\%CO)_{avg})]}{(0.264 \times (N_2)_{avg}) - [(\%O_2)_{avg} - (0.5 \times (\%CO)_{avg})]}$$

$$(\%EA)_{AVG} = \frac{100 \times \{ 7.00 \% - (0.5 \times 0.000 \%)\}}{(0.264 \times 84.50 \%) - \{ 7.00 \% - (0.5 \times 0.000 \%)\}} = 45.73 \%$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Reference Method 2) [Values from Run 1 test]

Absolute Stack Pressure (in. Hg)

$$P_s (\text{in. Hg}) = P_b + \frac{P_{\text{static}}}{13.6}$$

$$P_s (\text{in. Hg}) = 29.22 \text{ in. Hg} + \frac{-0.06 \text{ in. H}_2\text{O}}{13.6 \text{ in. H}_2\text{O/in. Hg}} = 29.22 \text{ in. Hg}$$

Average Stack Gas Velocity (ft/sec)

$$v_s (\text{ft/sec}) = K_p \times C_p \times (\sqrt{\Delta p})_{\text{avg}} \times \sqrt{\frac{(t_s)_{\text{avg}} + T_u}{P_s \times M_s}}$$

v_{sl} (ft/sec) =

$$\left(\frac{85.49 \text{ ft (lb/lb-mol)(in. Hg)}}{\text{sec (}^\circ\text{R)(in. H}_2\text{O)}} \right)^{1/2} \times 0.81 \times 0.23 \text{ in. H}_2\text{O}^{1/2} \times \sqrt{\frac{378.29 + 460 \text{ }^\circ\text{R}}{29.22 \text{ in. Hg} \times 28.12 \text{ lb/lb-mol}}} = \frac{15.7 \text{ ft}}{\text{sec}}$$

Average Stack Dry Standard Flow Rate (dscfh)

$$Q_{sd} (\text{dscfh}) = \frac{60 \times 60 \times \left(1 - \frac{B_{ws}}{100}\right) \times v_s \times A_s \times T_{std} \times P_s}{(t_s + T_u) \times P_{std}}$$

$$Q_{sd} (\text{dscf/hr}) = \frac{3600 \text{ sec}}{\text{hr}} \times \left(1 - \frac{13.05 \%}{100}\right) \times \frac{15.70 \text{ ft}}{\text{sec}} \times 2.95 \text{ ft}^2 \times \frac{68.00 + 460 \text{ }^\circ\text{R}}{378.29 + 460 \text{ }^\circ\text{R}} \times \frac{29.22 \text{ in. Hg}}{29.92 \text{ in. Hg}} = \frac{89,121.12 \text{ dscf}}{\text{hr}}$$

Average Stack Wet Flow Rate (acfm)

$$Q_{aw} (\text{acfm}) = 60 \times v_s \times A_s$$

$$Q_{aw} (\text{acf/min}) = \frac{60 \text{ sec}}{\text{min}} \times \frac{15.70 \text{ ft}}{\text{sec}} \times 2.95 \text{ ft}^2 = \frac{2,777.54 \text{ acf}}{\text{min}}$$

Average Stack Wet Standard Flow Rate (ascfh)

$$Q_{sw} (\text{ascfh}) = \frac{60 \times Q_{aw} \times T_{std} \times P_s}{(t_s + T_u) \times P_{std}}$$

$$Q_{sw} (\text{ascf/hr}) = \frac{60 \text{ min}}{\text{hr}} \times \frac{2,777.54 \text{ acf}}{\text{min}} \times \frac{68.00 + 460 \text{ }^\circ\text{R}}{378.29 + 460 \text{ }^\circ\text{R}} \times \frac{29.22 \text{ in. Hg}}{29.92 \text{ in. Hg}} = \frac{102,495.12 \text{ ascf}}{\text{hr}}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Reference Method 4) [Values from Run 1 test]

Water Volume Weighed (scf)

$$V_{wsg(std)}(scf) = W_t \times K_5$$

$$V_{wsg(std)} = 71.20 \text{ g} \times 0.04715 \text{ ft}^3/\text{g} = 3.357 \text{ scf}$$

Standard Meter Volume (dscf)

$$V_{m(std)}(dscf) = \frac{K_1 \times Y \times V_m \times \left(P_b + \frac{\Delta H_{avg}}{13.6} \right)}{(t_m)_{avg} + T_u}$$

$$V_{m(std)} = \frac{17.65 \text{ }^\circ\text{R}}{\text{in. Hg}} \times 0.98 \times 23.93 \text{ dcf} \times \left(29.22 \text{ in. Hg} + \frac{0.43 \text{ in. H}_2\text{O}}{13.6 \text{ in. H}_2\text{O} / \text{in. Hg}} \right) = 22.37 \text{ dscf}$$

$$78.38 \text{ }^\circ\text{F} + 460 \text{ }^\circ\text{R}$$

Calculated Moisture Content (%)

$$B_{ws(calc)}(\%) = 100 \times \frac{V_{wsg(std)}}{V_{wsg(std)} + V_{m(std)}}$$

$$B_{ws(calc)} = 100 \times \frac{3.36 \text{ dscf}}{3.36 \text{ dscf} + 22.37 \text{ dscf}} = 13.05 \%$$

Saturated Moisture Content (%)

$$B_{ws(svp)}(\%) = 100 \times \frac{10^{\frac{6.691 - \frac{3144}{t_s(mg) + 390.86}}{P_b + \frac{P_{static}}{13.6}}}}{\leq 100}$$

$$B_{ws(svp)} = 100 \times \frac{10^{\left(6.691 - \frac{3144}{378.29 \text{ }^\circ\text{F} + 390.86} \right)}}{29.22 \text{ in. Hg} + \frac{-0.06 \text{ in. H}_2\text{O}}{13.6 \text{ in. H}_2\text{O} / \text{in. Hg}}} \leq 100 = 100.00 \%$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Isokinetic Sampling) [Values from Run 1 test]

Desired Orifice (in. H₂O) (first point)

$$\Delta H_d (\text{in. H}_2\text{O}) = K \times \Delta p$$

$$\Delta H_d (\text{in. H}_2\text{O}) = 9.85 \times$$

$$0.05 \text{ in. H}_2\text{O} = 0.49 \text{ in. H}_2\text{O}$$

Absolute Meter Pressure (in. Hg)

$$P_m (\text{in. Hg}) = P_b + \frac{\Delta H @}{13.6}$$

$$P_m (\text{in. Hg}) = 29.22 \text{ in. Hg} + \frac{1.83 \text{ in. H}_2\text{O}}{13.6 \text{ in. H}_2\text{O/in. Hg}} = 29.35 \text{ in. Hg}$$

Recommended Nozzle Diameter (in.)

$$D_m (\text{in.}) = \sqrt{\frac{C_n \times Q_m \times P_m}{(t_m + T_u) \times C_p} \times \left(\frac{1 - \frac{B_{wm}}{100}}{1 - \frac{B_{ws}}{100}} \right) \times \sqrt{(t_s + T_u) \times \frac{M_d \times \left(1 - \frac{B_{wm}}{100} \right) + \left(18 \times \frac{B_{ws}}{100} \right)}{P_s \times \Delta p_{avg}}}}$$

$$D_{ni} (\text{in.}) = \frac{0.03575 (\text{lb-mole} \cdot \text{°R} \cdot \text{in. H}_2\text{O})^{1/2} \cdot \text{min} \cdot \text{in.}^2}{\text{acf} \cdot \text{in. Hg}^{3/4} \cdot \text{lb}^{1/2}} \times 0.75 \text{ acf} \times 29.35 \text{ in. Hg} \times \left(\frac{1 - \frac{0.00 \%}{100}}{1 - \frac{13.05 \%}{100}} \right) \times \frac{1}{\left(\frac{78.38 \text{ °F} + 460 \text{ °R}}{378.29 \text{ °F} + 460 \text{ °R}} \right) \times \frac{\frac{29.64 \text{ lb}}{\text{lb-mole}} \times \left(1 - \frac{13.05 \%}{100} \right) + \left(\frac{18 \text{ lb}}{\text{lb-mol}} \times \frac{13.05 \%}{100} \right)}{29.22 \text{ in. Hg} \times 0.23 \text{ in. H}_2\text{O}}} = 0.329 \text{ in.}$$

ΔP to ΔH Isokinetic Factor

$$K = C_k \times C_p^2 \times \Delta H @ \times D_{na}^4 \times \frac{M_d \times \left(1 - \frac{B_{wm}}{100} \right) + \left(18 \times \frac{B_{ws}}{100} \right)}{M_d \times \left(1 - \frac{B_{ws}}{100} \right) + \left(18 \times \frac{B_{ws}}{100} \right)} \times \left(\frac{1 - \frac{B_{ws}}{100}}{1 - \frac{B_{wm}}{100}} \right)^2 \times \left(\frac{t_m + T_u}{t_s + T_u} \right) \times \frac{P_s}{P_m}$$

$$K = \frac{849.8}{\text{in. H}_2\text{O} \cdot \text{in.}^4} \times 0.81^2 \times 1.83 \text{ in. H}_2\text{O} \times 0.37^4 \times \left(\frac{1 - \frac{13.05 \%}{100}}{1 - \frac{0.00 \%}{100}} \right)^2 \times \frac{78.38 \text{ °F} + 460 \text{ °R}}{378.29 \text{ °F} + 460 \text{ °R}} \times \frac{\left(\frac{29.64 \text{ lb}}{\text{lb-mole}} \times \left(1 - \frac{0.00 \%}{100} \right) + \left(\frac{18 \text{ lb}}{\text{lb-mol}} \times \frac{0.00 \%}{100} \right) \right)}{\left(\frac{29.64 \text{ lb}}{\text{lb-mole}} \times \left(1 - \frac{13.05 \%}{100} \right) + \left(\frac{18 \text{ lb}}{\text{lb-mol}} \times \frac{13.05 \%}{100} \right) \right)} \times \frac{29.22 \text{ in. Hg}}{29.35 \text{ in. Hg}} = 9.85$$

Percent Isokinetic (%) (first point)

$$I (\%) = \frac{K_4 \times ((t_s)_{avg} + T_u) \times V_{m(std)}}{\left(\Theta \times (v_{s(l)})_{avg} \times P_s \times \pi \times \left(\frac{D_{na}}{2} \times \frac{1}{12} \right)^2 \right) \times \left(1 - \frac{B_{ws}}{100} \right)}$$

$$I (\%) = \frac{0.0945 \text{ min} \cdot \text{in. Hg}}{\text{sec} \cdot \text{°R}} \times (358.00 \text{ °F} + 460 \text{ °R}) \times 0.97 \text{ dscf} \div \left(2.50 \text{ min} \times \frac{15.39 \text{ ft}}{\text{sec}} \times 29.22 \text{ in. Hg} \times 3.14 \times \left(\frac{0.37 \text{ in.}}{2} \times \frac{\text{ft.}}{12 \text{ in.}} \right)^2 \times \left(1 - \frac{13.05 \%}{100} \right) \right) = 101.51 \%$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Isokinetic Sampling) [Values from Run 1 test]

Cumulative Percent Isokinetic (%) (weighted average of all points)

Using Method 5, Eq 5-8 to determine intermediate isokinetics at each point, weighted averaging of the cumulative isokinetics is necessary since all points are not equal, and determined by using the dry standard meter volume collected at each point to weight the cumulative average. Intermediate isokinetics and dry standard meter volumes are found at each point. At each point the cumulative sum is found of each value and the quotient of the two used to determine the cumulative isokinetics for each residual point (n).

$$I(\%) = \sum_{1-n} \frac{I(\%) \times V_{m(std)}}{V_{m(std)_{1-n}}}$$

Pt	In (%)	x	Vm(std)n	=	I(%)n	Σ(I(%)n)	/	Σ(Vm(std)n)	=	I(%)	Pt	In (%)	x	Vm(std)n	=	I(%)n	Σ(I(%)n)	/	Σ(Vm(std)n)	=	I(%)
A-1	101.51	x	0.969	=	98.36	98.36	/	0.97	=	101.5	B-9	100.10	x	0.924	=	92.54	1907.90	/	19.59	=	97.4
A-2	95.13	x	0.913	=	86.81	185.16	/	1.88	=	98.4	B-10	101.30	x	0.924	=	93.64	2001.54	/	20.51	=	97.6
A-3	94.60	x	0.917	=	86.75	271.91	/	2.80	=	97.2	B-11	102.09	x	0.924	=	94.37	2095.91	/	21.44	=	97.8
A-4	98.26	x	0.954	=	93.78	365.69	/	3.75	=	97.4	B-12	103.69	x	0.934	=	96.82	2192.73	/	22.37	=>	98.0
A-5	97.78	x	0.872	=	85.23	450.92	/	4.62	=	97.5	Last Pt										
A-6	103.99	x	0.935	=	97.28	548.20	/	5.56	=	98.6											
A-7	102.38	x	0.934	=	95.60	643.80	/	6.49	=	99.1											
A-8	97.98	x	0.907	=	88.91	732.71	/	7.40	=	99.0											
A-9	100.15	x	0.954	=	95.56	828.27	/	8.36	=	99.1											
A-10	92.58	x	0.896	=	82.99	911.26	/	9.25	=	98.5											
A-11	97.88	x	0.962	=	94.14	1005.40	/	10.21	=	98.4											
A-12	90.34	x	0.896	=	80.98	1086.38	/	11.11	=	97.8											
B-1	97.83	x	0.980	=	95.91	1182.29	/	12.09	=	97.8											
B-2	90.87	x	0.915	=	83.15	1265.44	/	13.01	=	97.3											
B-3	99.62	x	0.999	=	99.53	1364.98	/	14.00	=	97.5											
B-4	91.70	x	0.906	=	83.06	1448.03	/	14.91	=	97.1											
B-5	96.66	x	0.943	=	91.16	1539.20	/	15.85	=	97.1											
B-6	96.13	x	0.934	=	89.76	1628.96	/	16.79	=	97.0											
B-7	98.86	x	0.943	=	93.23	1722.19	/	17.73	=	97.1											
B-8	99.78	x	0.934	=	93.17	1815.36	/	18.66	=	97.3											

Percent Isokinetic (%) (intermediate equation, all points)

[equivalent to taking an average of point-by-point isokinetics without weighting the average (e.g. all points equal)]

$$I(\%) = \frac{K_4 \times ((t_s)_{avg} + T_u) \times V_{m(std)}}{\left(\Theta \times (v_{s(t)})_{avg} \times P_s \times \pi \times \left(\frac{D_{na}}{2} \times \frac{1}{12} \right)^2 \right) \times \left(1 - \frac{B_{ws}}{100} \right)}$$

$$I(\%) = \frac{0.0945 \text{ min} \cdot \text{in. Hg}}{\text{sec} \cdot ^\circ\text{R}} \times (378.29 \text{ } ^\circ\text{F} + 460 \text{ } ^\circ\text{R}) \times 22.37 \text{ dscf}$$

$$60.00 \text{ min} \times \frac{15.70 \text{ ft}}{\text{sec}} \times 29.22 \text{ in. Hg} \times 3.14 \times \left(\frac{0.37 \text{ in.}}{2} \times \frac{\text{ft.}}{12 \text{ in.}} \right)^2 \times \left(1 - \frac{13.05 \text{ \%}}{100} \right) = 98.11 \text{ \%}$$

Raw Data Percent Isokinetic (%)

[utilizes the raw data equation for isokinetics from Method 5]

$$I(\%) = \frac{100 \left((t_s)_{avg} + T_u \right) \left[K_4 V_{1c} + \frac{V_m Y}{(t_m)_{avg} + T_u} \left(P_{bar} + \frac{\Delta H}{13.6} \right) \right]}{60 \left(\Theta \times (v_{s(t)})_{avg} \times P_s \times \pi \times \left(\frac{D_{na}}{2} \times \frac{1}{12} \right)^2 \right)}$$

$$100 \times (378.29 \text{ } ^\circ\text{F} + 460 \text{ } ^\circ\text{R}) \times \left[\frac{0.002669 \text{ ft}^3 \cdot \text{in. Hg}}{\text{ml} \cdot ^\circ\text{R}} \times 71.33 \text{ ml} + \frac{23.93 \text{ dcf} \times 0.975}{78.38 \text{ } ^\circ\text{F} + 460 \text{ } ^\circ\text{R}} \left(29.22 \text{ in Hg} + \frac{0.427}{13.6} \right) \right]$$

$$60 \times 60.00 \text{ min} \times \frac{15.70 \text{ ft}}{\text{sec}} \times 29.22 \text{ in. Hg} \times 3.14 \times \left(\frac{0.37 \text{ in.}}{2} \times \frac{\text{ft.}}{12 \text{ in.}} \right)^2 = 98.06 \text{ \%}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Gravimetric Analysis) [Values from Run 1 test]

Blank Concentration [Acetone Blank Weight of Solids] (mg/ml)

$$C_x (mg / ml) = \frac{1000 \times w_x}{v_x}$$

$$C_x (mg/ml) = \frac{1000 \text{ mg}}{\text{g}} \times \frac{0.0008 \text{ g}}{275.00 \text{ ml}} = \frac{0.0031 \text{ mg}}{\text{ml}} = \frac{\text{mg}}{\text{ml}}$$

Blank Adjustment [Acetone Blank Weight of Solids and Probe Wash] (mg)

$$W_x (mg) = v_x \times C_x$$

$$W_x (mg) = 150.00 \text{ ml} \times 0.0031 \text{ mg/ml} = 0.46 \text{ mg} < \text{Sample Gain}$$

Sample Gain [Probe Wash] (mg)

$$m_x (mg) = (m_f - m_t) \times 1000$$

$$m_x (mg) = \frac{1000 \text{ mg}}{\text{g}} \times (102.22 \text{ g} - 102.21 \text{ g}) = 2.15 \text{ mg}$$

Adjusted Sample Gain [Probe Wash] (mg)

$$m_{xadj} (mg) = m_x - W_x$$

$$m_{xadj} (mg) = 2.15 \text{ mg} - 0.46 \text{ mg} = 1.69 \text{ mg}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

EXAMPLE CALCULATIONS (Analysis) [Values from Run 1 test - Filterable PM Mass]

Stack Filterable Concentration (g/dscf)

$$c_s (g/dscf) = 0.001 \times \frac{M_n}{V_{m(std)}} \qquad c_s (g/dscf) = \frac{g}{1000 \text{ mg}} \times \frac{2.04 \text{ mg}}{22.37 \text{ dscf}} = \frac{9.10\text{E-}05 \text{ g}}{\text{dscf}}$$

Stack Filterable Concentration (gr/dscf)

$$c'_s (gr/dscf) = 0.001 \times \frac{M_n}{V_{m(std)}} \times \frac{7000}{453.592}$$

$$c'_s (gr/dscf) = \frac{g}{1000 \text{ mg}} \times \frac{2.04 \text{ mg}}{22.37 \text{ dscf}} \times \frac{7000 \text{ gr}}{\text{lb}} \times \frac{\text{lb}}{453.592 \text{ g}} = \frac{1.40\text{E-}03 \text{ gr}}{\text{dscf}}$$

Filterable Emissions Rate (kg/hr)

$$E (kg/hr) = c_s \times Q_{sd} \times \frac{kg}{1000 \text{ g}}$$

$$E (kg/hr) = \frac{kg}{1000 \text{ g}} \times \frac{9.10\text{E-}05 \text{ g}}{\text{dscf}} \times \frac{89,121 \text{ dscf}}{\text{hr}} = \frac{0.01 \text{ kg}}{\text{hr}}$$

Filterable Emissions Rate (lb/hr)

$$E' (lb/hr) = \frac{M_n \times Q_{sd}}{V_{m(std)}} \times \frac{\text{lb} \times g}{453.592 \text{ g} \times 1000 \text{ mg}}$$

$$E' (lb/hr) = \frac{g}{1000 \text{ mg}} \times \frac{\text{lb}}{453.592 \text{ g}} \times \frac{2.04 \text{ mg}}{22.37 \text{ dscf}} \times \frac{89,121 \text{ dscf}}{\text{hr}} = \frac{0.02 \text{ lb}}{\text{hr}}$$

Filterable Emissions Rate (tpy)

$$E'' (ton/yr) = E' \times \frac{8760}{2000}$$

$$E'' (tpy) = \frac{\text{ton}}{2000 \text{ lb}} \times \frac{8,760 \text{ hr}}{\text{yr}} \times \frac{0.02 \text{ lb}}{\text{hr}} = \frac{0.08 \text{ ton}}{\text{yr}}$$

Filterable Emissions Rate (lb/MMBtu)

Oxygen Based:

$$E''' (lb/MMBtu) = \frac{M_n \times F_d}{V_{m(std)} \times 1000 \times 453.592} \times \left(\frac{20.9}{20.9 - \%O_2} \right)$$

$$E''' (lb/MMBtu) = \frac{g}{1000 \text{ mg}} \times \frac{\text{lb}}{453.592 \text{ g}} \times \frac{2.04 \text{ mg}}{22.37 \text{ dscf}} \times \frac{8,648.00 \text{ dscf}}{\text{MMBtu}} \times \left(\frac{20.9}{20.9 - 7.0 \%} \right) = \frac{0.0026 \text{ lb}}{\text{MMBtu}}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.