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EMISSION TEST REPORT

REGULATION(S): 40 CFR 63 SUBPART ZZZZ AND MDEQ PERMIT
POLLUTANT(S): HCHO

TRANSCANADA US PIPELINES
WOOLFOLK COMPRESSOR STATION
MECOSTA COUNTY, MI

RECEIVED
MAY 14 2018
AIR QUALITY DIVISION

PERMIT NUMBER: MI-ROP-B7220-2017
STATE REGISTRATION NUMBER (SRN): B7220
FRS # / EPA REGISTRY ID: 110040962303
SOURCE CLASSIFICATION CODE (SCC): 20200253

SOURCE ID: EUWL004
EMISSION SOURCE: SPARK-IGNITED ENGINE
4-STROKE/2-STROKE: 4-STROKE
RICH/LEAN BURN: RICH BURN
MAKE & MODEL: INGERSOLL-RAND KVG-103
UNIT NUMBER: ENGINE 2004
SERIAL NUMBER: 103HL523

TEST DATE: MARCH 15, 2018

	NSPS ZZZZ Limit		
	CORE [%]		
Pollutant	ZZZZ Limit	Emitted	PASS/FAIL
HCHO	37.6%	86.8%	PASS

Limits obtained from 40 CFR 63, Subpart ZZZZ.

The contents of this document relate only to the items tested. 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.

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Revision History

Version	Revision Date	Comments
0	*original*	Original Version of Document.

Project Information

CECO Project No: 20180314-0412-2

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Introduction

CECO Training & Technical Services, a division of Compressor Engineering Corporation, conducted source emission testing at TransCanada US Pipelines, Woolfolk Compressor Station to fulfill the requirements of 40 CFR 63 Subpart ZZZZ and MDEQ Permit. This report details the test purpose, objectives, testing procedures, sampling and analysis methodology, and results of the source testing conducted on March 15, 2018.

Process Description

The following source was tested:

- Unit Number Engine 2004 (Source ID EUWL004) SN 103HL523 – one (1) Ingersoll-Rand KVG-103 natural gas-fired, 4-Stroke, Rich Burn internal combustion engine, rated to 1000 brake horsepower (BHP) at 330 revolutions per minute (RPM). This source is equipped with a NSCR with an air-fuel ratio controller for emission control and drives a natural gas compressor.

Test Purpose and Objectives

The purpose of this test was to fulfill the requirements of 40 CFR 63 Subpart ZZZZ and MDEQ Permit. The objective of this test was to conduct the required three (3) 60-minute test runs to measure the applicable emission species at the maximum achievable load.

Results – Inlet

Ingersoll-Rand KVG-103 SN: 103HL523	Test Run			
Source ID: EUWL004 Unit ID: Engine	1st	2nd	3rd	Average
Test Date & Time				
Date	3/15/2018	3/15/2018	3/15/2018	
Start Time	2:31 PM	3:44 PM	4:55 PM	
End Time	3:32 PM	4:44 PM	5:56 PM	
Interval (minutes)	60	60	60	60
Measured Concentrations (bias-corrected where applicable)				
O_2 (%vd)	4.89	4.94	4.95	4.93
HCHO (ppmvd)	9.667	9.433	9.439	9.513
Operating Conditions				
Engine Horsepower (BHP)	974	977	986	979
Load (%)	97.4	97.7	98.6	97.9
Torque Load (%)	97.4	97.9	98.4	97.9
Engine Speed (RPM)	330	329	331	330
Calculated Emissions				
HCHO (ppmvd at 15% O_2)	3.5625	3.4871	3.4915	3.5137

Results - Outlet

Ingersoll-Rand KVG-103 SN: 103HL523	Test Run			
Source ID: EUWL004 Unit ID: Engine	1st	2nd	3rd	Average
Test Date & Time				
Date	3/15/2018	3/15/2018	3/15/2018	
Start Time	2:31 PM	3:44 PM	4:55 PM	
End Time	3:32 PM	4:45 PM	5:56 PM	
Interval (minutes)	60	61	61	61
Measured Concentrations (bias-corrected where applicable)				
O_2 (%vd)	5.21	4.99	5.43	5.21
HCHO (ppmvd)	1.265	1.214	1.227	1.235
Operating Conditions				
Engine Horsepower (BHP)	974	977	986	979
Load (%)	97.4	97.7	98.6	97.9
Torque Load (%)	97.4	97.9	98.4	97.9
Engine Speed (RPM)	330	329	331	330
Calculated Emissions				
HCHO (ppmvd at 15% O_2)	0.4757	0.4502	0.4680	0.4646

Methodology and Sampling Procedures

Methodology

Parameter	Sampling Method
Oxygen (O_2)	40 CFR 60, Appendix A, Method 3A
Volumetric Exhaust Flow Rate	40 CFR 60, Appendix A, Method 19
Gas Dilution System	40 CFR 60, Appendix A, Method 205
Formaldehyde (HCHO)	ASTM D6348

Horsepower and Fuel Flow Determination

For this test, horsepower was calculated from the load percentage displayed on the engine panel and fuel flow was obtained from the engine panel. The Engine Torque Load averaged 97.9% for the test. This was the highest achievable load based on the operating parameters during the test, which are included in Appendix A.

Sampling System

Compressor Engineering Corporation designed and assembled a versatile, emission testing unit (ETU), which houses all analyzers, computers and auxiliary equipment. Effluent stack gas enters the ETU through a heated Teflon sample line. A heated head pump with a Teflon diaphragm pulls the sample into the trailer, through a heated filter, and sends the wet gas directly to the inlet of the FTIR. The heated pump, sample lines, and filter have their temperatures maintained at approximately 191 °C. The FTIR analyzer gas cell and gas inlet temperatures are also maintained at approximately 191 °C. The sample is routed from the exit of the FTIR through a heated Teflon line to a gas conditioner for moisture removal. The dry gas exiting the gas conditioner is routed to a gas distribution panel which sends a portion of the gas to the paramagnetic oxygen analyzer.

The MKS Instruments MultiGas 2030 FTIR analyzer is used to determine the HCHO emission concentrations. The FTIR serves as the instrument for Methods 7E and 10, and meets the requirements of Section 13 of Method 7E. All measured concentrations are corrected to a dry basis via the MKS MG2000 operating software. The FTIR analyzer is configured with a fixed optical pathlength of 5.11 meters. The measured concentrations are collected at a 0.5 cm^{-1} resolution. Each spectrum is derived from the co-addition of 60 scans. Data is collected continuously during each test run. A new data point is generated every 60 seconds.

A software package (CECOTest) is used to collect and processes data. CECOTest continually logs data every 15 seconds from the oxygen analyzer and the FTIR during the 60 minute runs.

Refer to **FIGURE 1** for a schematic of the sampling system.

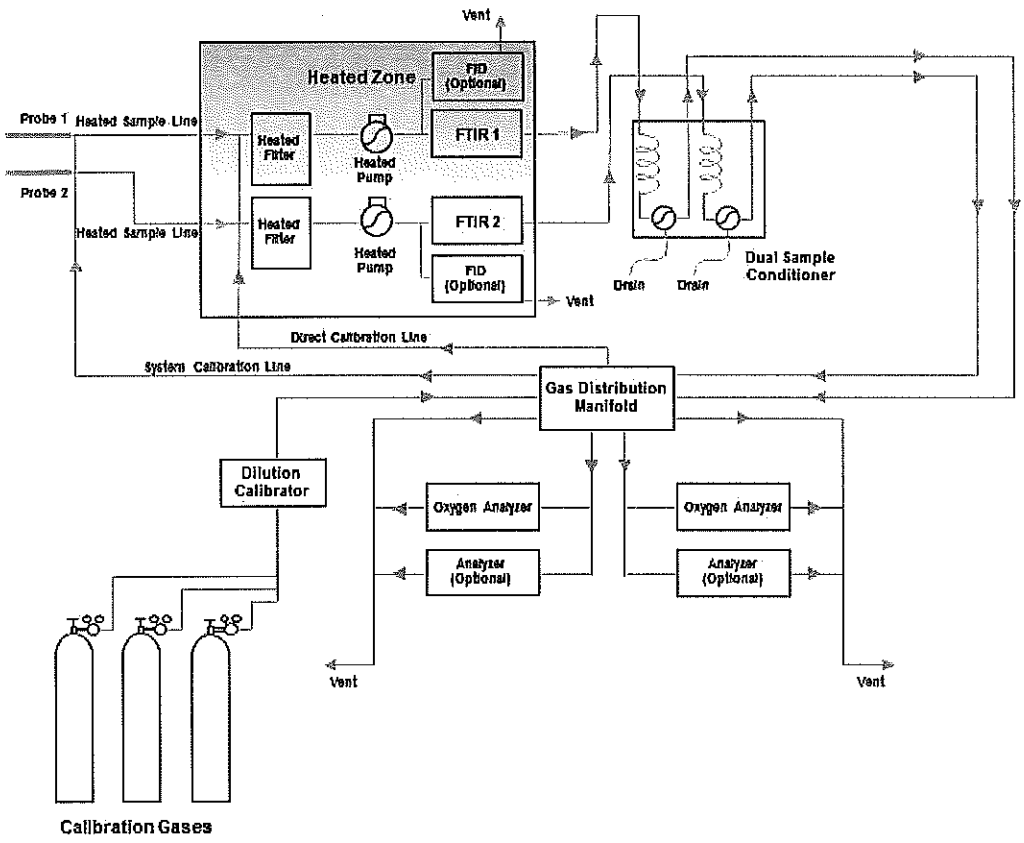


Figure 1: Sampling System Schematic

Instrument Specifications

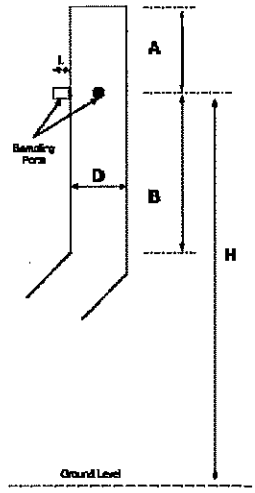
Description:	Oxygen Analyzer
Manufacturer:	Servomex
Model:	1440C
Serial Number:	2582 & 2581
Technology Type:	Paramagnetic
Range:	0-25%
Repeatability:	+/- 0.1% O2
Response Time (90%):	Typically less than 10 sec
Linearity:	+/- 0.1% O2

Description:	FTIR Analyzer
Manufacturer:	MKS Instruments
Model:	2030
Serial Number:	017641800 & 017679246
Technology Type:	FTIR Spectrometry
Range:	between 10ppb and 100% fullscale
Spectral Resolution:	0.5-128 1/cm
Scan Speed:	1/sec @ 0.5 1/cm
Detector Type:	LN2-cooled MCT

Manufacturer:	Teledyne
Model:	T700
Serial Number:	1364
Technology Type:	Mass Flow Controller
MFC's:	0LPM, 2LPM, and 200ccm
Flow Measurement Accuracy	+/-1.0% of Full Scale
Repeatability of Flow Control	+/-0.2% of full Scale
Linearity of Flow Measurement	+/-0.5% of Full Scale
Flow Range of Diluent Air	0 to 10 SLPM
Optional Ranges:	0 to 5 SLPM; 0 to 20 SLPM
Flow Range of Cylinder Gasses	0 to 100 cc/min
Optional Ranges:	0 to 50 cc/min; 0 to 200 cc/min
Zero Air Required:	10 SLPM @ 30 PSIG
Optional	20 SLPM @ 30 PSIG
CAL Gas Input Ports	4 (configurable)
Diluent Gas Input Ports	1
Response Time	60 Seconds (98%)

Description of Sampling Location

Physical Duct Parameters



D =	16	in	Duct Diameter
L =	2	in	Port Length
A =	24	in	Distance to Downstream Disturbance
B =	36	in	Distance to Upstream Disturbance
H =	25	ft	Approximate Height Above Grade
	1.5	D	Distance to Downstream Disturbance (A)
	0.5	D	EPA M1 Requirement
	TRUE		EPA M1 Requirement Met?
	2.3	D	Distance to Upstream Disturbance (B)
	2.0	D	EPA M1 Requirement
	TRUE		EPA M1 Requirement Met?
	TRUE		**EPA M1 Requirements Met for Distances to Up/Downstream Disturbances**

EPA JJJJ/ZZZZ Sampling Point Requirements

Duct Diameter	Ports	Sampling Strategy
D ≤ 6 inches	N/A	Single Point Located at Duct Centroid
6 < D ≤ 12 inches	N/A	3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
D > 12 inches	M1 Ports	3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
D > 12 inches	no M1 Ports	Stratification Check Required

REQUIRED SAMPLING STRATEGY: **3 Traverse Points (16.7, 50.0, and 83.3%) across the duct**

13.3	in	Point 1
8.0	in	Point 2
2.7	in	Point 3
15.3	in	Point 1 Probe Mark (Includes port length)
10.0	in	Point 2 Probe Mark (Includes port length)
4.7	in	Point 3 Probe Mark (Includes port length)

STRATIFICATION CHECK REQUIREMENTS

For every point (where Da=Deviation from Average (%) for a given point.)

Da < 5 %	Single Point Located at Duct Centroid
5% ≤ Da < 10 %	3 Traverse Points (16.7, 50.0, and 83.3%) across the duct
Otherwise	Full M1 Points Required

STRATIFICATION CHECK RESULTS

	Point 1	Point 2	Point 3
	4.80	4.80	4.33
	5.00	4.23	4.21
	5.20	4.50	4.22
	4.95	5.34	4.20
	4.00	5.35	4.15
	4.00	5.37	4.08
	5.00	4.74	4.42
	4.00	4.65	4.27
	5.00	4.46	4.44
	4.80	4.30	4.17
	4.00	4.20	4.14
	4.17	4.41	4.30
Point Average (% O2)	4.58	4.70	4.24
Point Deviation from Average (%)	1.58	4.22	- 5.80
Point Deviation from Average (% O2)	0.07	0.19	- 0.26
Average of Point Averages (% O2)	4.51		

STRATIFICATION CHECK RESULTANT STRATEGY **Single Point Located at Duct Centroid**