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Gaseous Emissions Test Report

Michigan State University
South Campus Dairy Farm
Anaerobic Digester Gas-fired Engine
East Lansing, Michigan
October 5, 2016

Report Submittal Date
October 26, 2016

Project No. M164002

888 Industrial Drive
Elmhurst, Illinois 60126
630-993-2100

1.0 EXECUTIVE SUMMARY

MOSTARDI PLATT conducted a gaseous emissions compliance test program for Michigan State University on October 5, 2016 at the South Campus Dairy Farm on the Anaerobic Digester Gas-fired Engine in East Lansing, Michigan. This report summarizes the results of the test program and test methods used.

The test location, test date, and test parameters are summarized below.

Test Location	Test Date	Test Parameters
Anaerobic Digester Gas-fired Engine	October 5, 2016	Nitrogen Oxides (NO_x), Carbon Monoxide (CO), Carbon Dioxide (CO_2), Oxygen (O_2), Volatile Organic Compounds (VOCs), and Moisture

The purpose of the test program was to demonstrate emissions of the above test parameters to satisfy the limits of the regulatory permit. Selected results of the test program are summarized below. A complete summary of emission test results follows the narrative portion of this report.

TEST RESULTS				
Test Location	**Test Date**	**Test Parameter**	**Emission Limits**	**Emission Rates**
Anaerobic Digester Gas-fired Engine	10/5/16	VOC (as C_3H_8)	80 ppmvd @ 15% O_2	4.4 ppmvd @ 15% O_2
		CO	610 ppmvd @ 15% O_2	198.9 ppmvd @ 15% O_2
		NO_x	150 ppmvd @ 15% O_2	97.9 ppmvd @ 15% O_2

The identifications of the individuals associated with the test program are summarized below.

TEST PERSONNEL INFORMATION		
Location	**Address**	**Contact**
Test Facility	Michigan State University South Campus Dairy Farm 4075 N College Road Lansing, Michigan 48910	Mr. Tom Grover Environmental Compliance Officer (517) 355-6651 (phone) grovert@msu.edu
Testing Company Representative	Mostardi Platt 888 Industrial Drive East Lansing, Michigan 60126	Mr. Mark Peterson Senior Project Manager (630) 993-2100 (phone) mpeterson@mp-mail.com

The test crew consisted of Messrs. M. Karum and M. Peterson of Mostardi Platt.

2.0 TEST METHODOLOGY

Emission testing was conducted following the methods specified in 40 CFR, Part 60, Appendix A. Schematics of the test section diagrams and sampling trains used are included in Appendix A and B, respectively. Calculation examples and nomenclature are included in Appendix C. Copies of analyzer print-outs and field data sheets for each test run are included in Appendices D and E, respectively.

The following methodologies were used during the test program:

Gaseous Sampling Plan

Three points along 17%, 50%, and 83% of the stack diameter were used to sample gaseous emissions.

Method 3A Oxygen (O_2)/Carbon Dioxide (CO_2) Determination

Stack gas O_2 and CO_2 were determined in accordance with Method 3A. Servomex analyzers were used to determine stack gas oxygen and carbon dioxide content. All of the equipment used was calibrated in accordance with the specifications of the Method and calibration data are included in Appendix F. Copies of the gas cylinder certifications are included in Appendix G.

Method 4 Moisture Determination

USEPA Method 4 was utilized to determine water (H_2O) content of the exhaust gas. 100 milliliters (ml) of water were added to each of the first two impingers, the third impinger was left empty, and the fourth impinger was charged with approximately 200 grams of silica gel. The impingers were placed in an ice bath to maintain the sampled gas passed through the silica gel impinger outlet below 68°F in order to increase the accuracy of the sampled dry gas volume measurement. The water volumes of the impinger train were measured and the silica gel was weighed before and after each test run to determine the mass of moisture condensed.

Each sample was extracted through a heated stainless-steel probe and filter assembly at a constant sample rate of approximately 0.75 cubic feet per minute, which was maintained throughout the course of the test run. A minimum of 21 dry standard cubic feet (dscf) was sampled for each moisture run. After each run, a leak check of the sampling train was performed at a vacuum greater than the sampling vacuum to determine if any leakage had occurred during sampling. Following the leak check, the impingers were removed from the ice bath, water levels were measured, and the silica gel weight was recorded. All of the equipment used was calibrated in accordance with the specifications of the Method. Calibration data are presented in Appendix F.

Method 7E Nitrogen Oxide (NO_X) Determination

Stack gas nitrogen oxide concentrations and emission rates were determined in accordance with Method 7E. A Thermo Fisher 42i nitrogen oxide analyzer was used to determine nitrogen oxide concentrations, in the manner specified in the Method.

Stack gas was delivered to the analyzer via a Teflon® sampling line, heated to a minimum temperature of 250°F. Excess moisture in the stack gas was removed using a refrigerated condenser. The entire system was calibrated in accordance with the Method, using certified calibration gases introduced at the probe, before and after each test run.

A list of calibration gases used and the results of all calibration and other required quality assurance checks can be found in Appendix F. Copies of calibration gas certifications can be found in Appendix G.

Method 10 Carbon Monoxide (CO) Determination

Stack gas carbon monoxide concentrations and emission rates were determined in accordance with Method 10. A Thermo Fisher 48i carbon monoxide analyzer was used to determine carbon monoxide concentrations, in the manner specified in the Method.

Stack gas was delivered to the analyzer via a Teflon® sampling line, heated to a minimum temperature of 250°F. Excess moisture in the stack gas was removed using a refrigerated condenser. The entire system was calibrated in accordance with the Method, using certified calibration gases introduced at the probe, before and after each test run.

A list of calibration gases used and the results of all calibration and other required quality assurance checks can be found in Appendix F. Copies of calibration gas certifications can be found in Appendix G.

Method 18/25A Volatile Organic Compound (VOC) Determination

Non-methane hydrocarbon (NMHC) concentrations and emission rates and methane (CH_4) concentrations were determined in accordance with Methods 18 and 25A. A Thermo 55i Gas Chromatograph/Flame Ionization Detector (GC/FID) was used to determine NMHC concentrations and CH_4 concentrations. Stack gas was delivered to the system via a Teflon® sampling line, heated to a minimum temperature of 300°F.

The system was calibrated before and after each test run using certified calibration gases of propane for the NMHC determination and methane for the CH_4 determination. Calibration data are presented in Appendix F, field sheets are presented in Appendix D, and copies of gas certifications are presented in Appendix G.

3.0 TEST RESULT SUMMARY

Michigan State University South Campus Dairy Farm Anaerobic Digester Gas Engine Outlet Gaseous Summary														
Test No.	Date	Start Time	End Time	NO_x ppmvd	CO ppmvd	CO_2 % (dry)	O_2 % (dry)	Moisture, %	NMHC ppm as C_3H_8 (wet)	CH_4 ppm as CH_4 (wet)	VOC (NHMC) ppm as C_3H_8 (dry)	NOx ppmvd @15% O2	CO ppmvd @15% O2	VOC (NMHC) ppmvd @15% O2
1	10/05/16	11:25	12:24	227.0	466.3	11.0	7.1	10.1	9.4	877.0	10.5	97.1	199.4	4.5
2	10/05/16	12:45	13:44	230.3	465.8	11.0	7.1	13.3	9.0	898.0	10.4	98.5	199.1	4.4
3	10/05/16	14:01	15:00	229.8	463.8	11.0	7.1	12.4	8.8	862.0	10.0	98.2	198.3	4.3
Average				229.0	465.3	11.0	7.1	11.9	9.1	879.0	10.3	97.9	198.9	4.4

4.0 CERTIFICATION

MOSTARDI PLATT is pleased to have been of service to Michigan State University. If you have any questions regarding this test report, please do not hesitate to contact us at 630-993-2100.

CERTIFICATION

As project manager, I hereby certify that this test report represents a true and accurate summary of emissions test results and the methodologies employed to obtain those results, and the test program was performed in accordance with the methods specified in this test report.

MOSTARDI PLATT

Program Manager

Mark Peterson

Quality Assurance

Jeffrey M. Crivlare