BTEC Inc.

Packed Bed Water Scrubber Emissions Test Report

Prepared for:

Allnex USA Inc.

Kalamazoo, Michigan

2715 Miller Road
Kalamazoo, Michigan

Project No. 049AS-376666
October 23, 2018

BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, Michigan 48073
(248) 548-8070

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by Allnex USA Inc. (Allnex) to conduct a methanol (MeOH) and formaldehyde (HCOH) emissions test program at the Allnex facility in Kalamazoo, Michigan. The purpose of this document is to present the test report for this emissions test program.

As required by paragraph 49 of the U.S. EPA Consent Agreement and Final Order (CAFO) dated January 31, 2017 (see Appendix A), the emissions test program included performance testing of the packed bed water scrubber specified as a Supplemental Environmental Project in the CAFO. The packed bed water scrubber controls emissions from the Cyrez Intermediate Storage Tank (110-002) which includes venting of the Cyrez head tank (120-004) as well as emissions from the blending operations through the dust collector.

Testing of the packed bed water scrubber inlet and outlet consisted of triplicate 60-minute test runs completed on August 28, 2018 with a water scrubber water flowrate of 26 gallons per minute. The packed bed water scrubber includes two inlet ducts (the "product blender inlet" and the "intermediate storage tank inlet) and one outlet duct. The results of the packed bed water scrubber emissions test program are summarized by Table E-1.

Table E-1
Packed Bed Water Scrubber System Test Results

Test Run	Average Inlet Methanol Emission Rate (lbs/hr)	Average Inlet Formaldehyde Emission Rate (lbs/hr)	Average Outlet Methanol Emission Rate (lbs/hr)	Average Outlet Formaldehyde Emission Rate (lbs/hr)	HAP Removal Efficiency (%)
1	2.83	0.26	0.05	0.01	98.1
2	3.47	0.29	0.04	0.01	98.5
3	3.35	0.30	0.05	0.01	98.3
Averages	3.22	0.28	0.05	0.01	98.3

A. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Allnex USA Inc. (Allnex) to conduct a methanol (MeOH) and formaldehyde (HCOH) emissions test program at the Allnex facility in Kalamazoo, Michigan. The purpose of this document is to present the test report for this emissions test program.

As required by paragraph 49 of the U.S. EPA Consent Agreement and Final Order (CAFO) dated January 31, 2017 (see Appendix A), the emissions test program included performance testing of the packed bed water scrubber specified as a Supplemental Environmental Project in the CAFO. The packed bed water scrubber controls emissions from the Cyrez Intermediate Storage Tank (110-002) which includes venting of the Cyrez head tank (120-004) as well as emissions from the blending operations through the dust collector.

A.i Emissions Test Results

Testing of the packed bed water scrubber inlet and outlet consisted of triplicate 60-minute test runs completed on August 28, 2018 with a water scrubber water flowrate of 26 gallons per minute. The packed bed water scrubber includes two inlet ducts (the "product blender inlet" and the "intermediate storage tank inlet) and one outlet duct. The results of the packed bed water scrubber emissions test program are summarized by Table 1.

Table 1
Packed Bed Water Scrubber System Test Results

Test Run	Average Inlet Methanol Emission Rate (lbs/hr)	Average Inlet Formaldehyde Emission Rate (lbs/hr)	Average Outlet Methanol Emission Rate (lbs/hr)	Average Outlet Formaldehyde Emission Rate (lbs/hr)	HAP Removal Efficiency (%)
1	2.83	0.26	0.05	0.01	98.1
2	3.47	0.29	0.04	0.01	98.5
3	3.35	0.30	0.05	0.01	98.3
Averages	3.22	0.28	0.05	0.01	98.3

A.ii Process and Control Equipment Data Related to Calculating Emission Rates

During the testing period, the following process and control equipment data relevant for the calculation of emissions rates was monitored: the stack gas velocity, concentrations of methanol and formaldehyde, stack gas temperature, and moisture content. This data is included in Appendix D.i.

A.iii Test Errors Discussion

No errors were observed during the emissions test program.

A.iv Deviations from Reference Test Methods

Testing was conducted using Methods 1, 2, 3, 4, and 320, with specific deviations as set forth in the approved test protocol. At the beginning of the first test run, approximately 3 minutes of intermediate storage tank inlet velocity pressure data was lost due to the unexpected re-start of the data acquisition system computer. This could only bias the HAP removal efficiency low for the first test run although it is anticipated that the effect on the result was negligible. Other than the lost three minutes of data, there were no deviations from the approved test protocol during the testing. Specific test methodology is described more fully in Sections C.iii and C.iv.

A.v Production Data

As approved in the test protocol, the water scrubber water flowrate was set at 26 gallons per minute for the stack test and is representative of normal operating conditions. This rate did not vary significantly from the set point over the course of the testing. Production data recorded during the emissions test program is provided in Appendix D.v.

B. Facility Operations

Sections B.i through B.iii provide a description of facility operations.

B.i Process Description

The Cyrez intermediate storage tank (110-002) is loaded with material from the Cymel 303LF product storage tanks, as needed, typically 1 or 2 times per day. Loading the intermediate storage tank takes approximately 17 minutes.

Each blender batch takes approximately 40 to 65 minutes to complete and consists of the following steps: Load the head tank (120-004) with Cyrez 963 liquid resin from the intermediate tank (110-002) (5 minutes, completed while prior batch is still running). Load the blender (120-006) with the inert carrier (10 to 20 minutes), turn on the blender. Transfer the Cyrez 963 liquid resin from the head tank (120-004) to the blender (120-006) (15 minutes.) Mix the batch for the specified time (between 2 to 25 minutes). Material is then transferred to one of two surge bins (130-001 or 130-021) for packaging into 50 pound bags, 1000 pound sacks or 2000 pound sacks (the transfer takes about 2 minutes, packaging takes between 10 and 25 minutes depending on the final packaging.)

B.ii Emissions Control Operating Parameters

Packed bed water scrubber water flowrate is monitored at one minute intervals. Data recorded during the emissions test program is provided in Appendix D.v.

B.iii Facility Operating Parameters

Process and control equipment data monitored and recorded during the emissions test program includes:

- Water Scrubber water flowrate
- Time of transfer to storage tank (start, stop)
- Time of silica charge (start, stop)
- Time of resin Charge (start, stop)
- Time of transfer to bulk bins

Process operating conditions for each test run are summarized in Appendix D.i.

C. Sampling and Analytical Procedures

Sections C.i through C.v summarize the emissions test program Sampling and Analytical Procedures.

C.i Sampling Ports

The sampling locations are illustrated by Figures 1, 2, and 3. The product blender inlet sampling location and the scrubber outlet sampling location are both 16 inches in diameter. The intermediate storage tank inlet sampling location has an inside diameter of 4.26 inches.

C.ii Sampling Point Description

Exhaust gas velocity was measured at the center of the pipe at the intermediate storage tank inlet sampling location and exhaust gas was extracted from the center of the pipe. At the product blender inlet location and at the scrubber outlet sampling location, exhaust gas velocity was measured at Method 1 points and exhaust gas samples were extracted from the center of the pipe.

C.iii Sampling Procedure Description

Sampling and analysis procedures followed the requirements codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A) and 40 CFR 63, Appendix A:

- Method 1 - *"Sample and Velocity Traverses for Stationary Sources"* was used to determine the sampling locations.

- Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flowrate"* was used to measure exhaust gas velocity.

- Method 3 - *"Gas Analysis for the Determination of Dry Molecular Weight (Fyrite Analysis)"* was used to determine exhaust gas molecular weight.

- Method 4 - *"Determination of Moisture Content in Stack Gases"* was used to determine exhaust gas moisture content.

- Method 320 - *"Measurement of Vapor Phase Organic and Inorganic Emissions by Extractive Fourier Transform Infrared Spectroscopy"* was used to measure exhaust gas MeOH and HCOH concentrations.

At the the product blender inlet location and at the scrubber outlet sampling location, exhaust gas velocity measurements were conducted before and after each test run and the average used as the flowrate for each test run.

C.iv Method Deviations

At the beginning of the first test run, approximately 3 minutes of intermediate storage tank inlet velocity pressure data was lost due to the unexpected re-start of the data acquisition system computer. This could only bias the HAP removal efficiency low for the first test run although it is anticipated that the effect on the result was negligible. Other than the lost three minutes of data, there were no deviations from the approved test protocol during the testing.

With respect to the methods listed in Section C.iii, the following approved method variations were used during the test program:

- Because the exhaust gas flowrate is variable and because the sampling location is only 4.26 inches in diameter, exhaust gas flowrate was measured using a stationary pitot tube fixed in position at the center of the pipe. Figure 1 illustrates the location of the velocity pressure sampling location and the Method 320 sampling location.

- Because of the configuration of the stack test ports, BTEC used a small S-type pitot tube rather than a standard pitot tube.

- Velocity pressure was measured using a differential pressure transmitter with a range of 0 to 1 inch of water and the velocity pressure will be datalogged at one second intervals. The specified accuracy of the differential pressure transmitter is +/- 0.0025 inches of water.

- Because the exhaust flowrate and gas characteristics are variable, prior to the first test run and after the last test run, the sampling locations were checked for cyclonic flow at the center of the duct.

- Prior to and after each test run, pitot tube leak checks were conducted.

- The accuracy of the differential pressure transmitter was verified at BTEC's office in Royal Oak, Michigan before the test program. Tubing was teed to a manometer and the manometer readings checked against the high and low pressure sides of both transmitters. Each transmitter side was checked at four levels (zero, low, mid, and high) three times with values recorded on calibration data sheets.

- The static pressure was measured once before the beginning of the emissions test program and once at the end of the emissions test program.

- Exhaust gas temperature was measured and recorded at fifteen minute intervals during each test run.

- Exhaust gas moisture content was measured by Fourier Transform Infrared Spectroscopy (FTIR) used to analyze for exhaust gas HCOH and MeOH concentrations.

- Bag grab samples were collected at the exhaust from the FTIR unit and analyzed for O_2 content using a Fyrite analyzer. Exhaust gas molecular weight was determined from the measured O_2 content as well as concentration data for other compounds as measured by the FTIR used to analyze for exhaust gas HCOH and MeOH concentrations.

- FTIR data was recorded at a maximum interval of 15 seconds during the emissions test program.

- Because of the high methanol concentrations, the Method 320 MeOH and HCOH analyte spikes were performed in ambient air as opposed to the sample stream. This approach confirmed the FTIR/sampling system to accurately deliver and quantify a known concentration of MeOH.

Sampling and analysis at the product blender sampling location and at the scrubber outlet sampling location followed Methods 1, 2, 3, and 320 with exhaust gas carbon dioxide and moisture concentrations as measured by FTIR.

C.v Analytical Procedures

The emissions test program did not include collected samples. Analytical procedures for the on-site Method 320 analyses is included in the Prism Analytical Technologies report included in Appendix D.iii.

D Appendices

Sections D.i through D.vii provide identification of Appendices for the corresponding information.

D.i Results and Example Calculations

Detailed test results are summarized by Tables 2 and 3 in Appendix D.i. Example calculations are also provided in Appendix D.i.

D.ii Raw Field Data

Raw field data are provided in Appendix D.ii.

D.iii Laboratory Report

The Method 320 FTIR report from Prism Analytical Technologies is included in Appendix D.iii.

D.iv Calibration

Equipment calibration documents for the Method 320 FTIR analysis are included in the Prism Analytical Technologies report included in Appendix D.iii. Exhaust gas flowrate equipment calibration documents are included in Appendix D.iv.

D.v Process and Control Equipment Data

Raw process and control equipment data is provided in Appendix D.v.

D.vi Test Log

The test log is summarized by the field notes and data sheets included in Appendix D.ii.

D.vii Project Personnel

Project personnel are summarized by Table 4 in Appendix D.vii.

D.viii Related Correspondence

Correspondence related to the emissions test program is provided in Appendix D.viii.

Table 2
Methanol and Formaldehyde Detailed Emission Test Results
Packed Bed Water Scrubber
Allnex USA Inc.
Kalamazoo, Michigan

		Product Blender Inlet					Storage Tank Inlet					Combined Inlet		Outlet				
Test Date	Test Run	Average Exhaust Gas Flowrate (scfm)	Average Formaldehyde Concentration (ppmv)	Average Methanol Concentration (ppmv)	Formaldehyde Emission Rate (lbs/hr)	Methanol Emission Rate (lbs/hr)	Average Exhaust Gas Flowrate (scfm)	Average Formaldehyde Concentration (ppmv)	Average Methanol Concentration (ppmv)	Formaldehyde Emission Rate (lbs/hr)	Methanol Emission Rate (lbs/hr)	Formaldehyde Emission Rate (lbs/hr)	Methanol Emission Rate (lbs/hr)	Average Exhaust Gas Flowrate (scfm)	Average Formaldehyde Concentration (ppmv)	Average Methanol Concentration (ppmv)	Formaldehyde Emission Rate (lbs/hr)	Methanol Emission Rate (lbs/hr)
August 28, 2018	1	3,388	15.6	158.4	0.25	2.68	1.8	325.3	4,301.5	0.01	0.2	0.26	2.83	3,539	0.8	2.6	0.01	0.05
	2	3,418	13.5	140.0	0.22	2.39	9.1	507.8	6,772.0	0.07	1.1	0.29	3.47	3,563	0.8	2.4	0.01	0.04
	3	3,417	17.0	172.9	0.27	2.95	3.9	389.9	5,609.2	0.03	0.4	0.30	3.35	3,525	0.9	2.7	0.01	0.05
		3,408	15.4	157.1	0.24	2.67	4.9	407.7	5,560.9	0.04	0.5	0.28	3.22	3,542	0.8	2.6	0.01	0.05

*Combined Inlet Emission Rates are the sum of the storage tank inlet emission rate and the product blender inlet emission rate.

Table 3
Methanol and Formaldehyde Emission Test Results
Packed Bed Water Scrubber
Allnex USA Inc.
Kalamazoo, Michigan

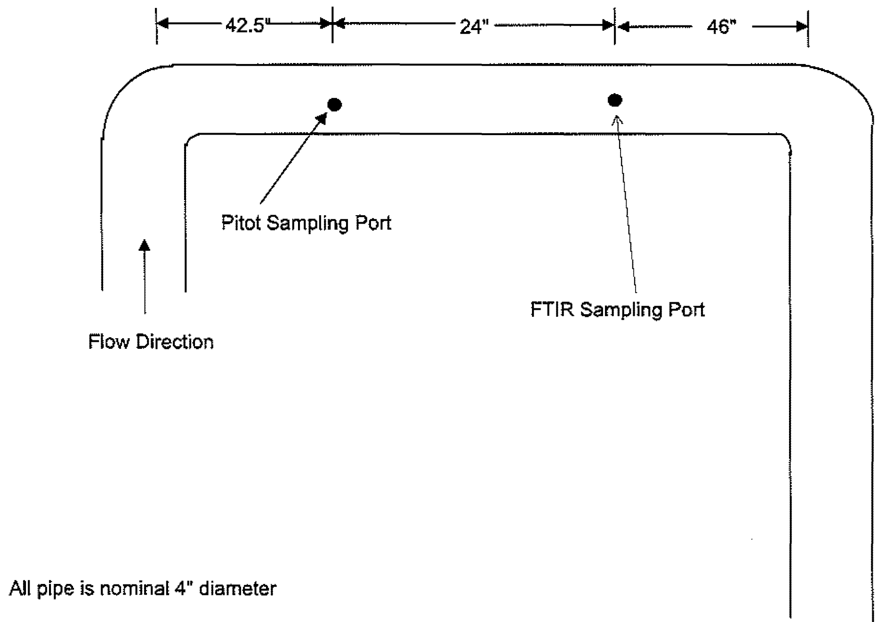
								Product Blender Inlet		Storage Tank Inlet		Combined Inlet		Outlet		
Test Date	Test Run	Test Run Time	Time of Transfer to Storage Tank	Time of Silica Charge	Time of Resin Charge	Time of Transfer to Bulk Bins	Water Scrubber Water Flowrate (gal/min)	Formaldehyde Emission Rate (lbs/hr)	Methanol Emission Rate (lbs/hr)	Formaldehyde Emission Rate (lbs/hr)	Methanol Emission Rate (lbs/hr)	Formaldehyde Emission Rate (lbs/hr)	Methanol Emission Rate (lbs/hr)	Formaldehyde Emission Rate (lbs/hr)	Methanol Emission Rate (lbs/hr)	Overall HAP Removal Efficiency (%)
August 28, 2018	1	8:24 - 9:24	N/A	8:28 - 8:43	8:44 - 9:02	9:24	26	0.25	2.68	0.01	0.2	0.26	2.83	0.01	0.05	98.1
	2	9:52 - 10:52	10:24	9:53 - 10:10	10:15 - 10:33	10:50	26	0.22	2.39	0.07	1.1	0.29	3.47	0.01	0.04	98.5
	3	11:22 - 12:22	N/A	11:22 - 11:34	11:35 - 11:52	12:09	26	0.27	2.95	0.03	0.4	0.30	3.35	0.01	0.05	98.3
							3-Test Averages:	0.24	2.67	0.04	0.5	0.28	3.22	0.01	0.05	98.3

*Combined Inlet Emission Rates are the sum of the storage tank inlet emission rate and the product blender inlet emission rate.

Table 4
Test Personnel

Name and Title	Affiliation	Telephone
Ms. Nicole Riggs SHE Manager	Allnex USA Inc. 2715 Miller Road Kalamazoo, Michigan 49001	(269) 385-1242
Mr. Randal J. Tysar Senior Environmental Engineer	BTEC 4949 Fernlee Avenue Royal Oak, Michigan 48073	(248) 548-8070
Mr. Phillip Kauppi Chemist/FTIR Specialist	Prism Analytical Technologies 2625 Denison Mt. Pleasant, Michigan 48858	(989) 772-5088
Mr. Blake Ericson Chemist/FTIR Specialist	Prism Analytical Technologies 2625 Denison Mt. Pleasant, Michigan 48858	(989) 772-5088
Mr. Trevor Tilmann Chemist/FTIR Specialist	Prism Analytical Technologies 2625 Denison Mt. Pleasant, Michigan 48858	(989) 772-5088

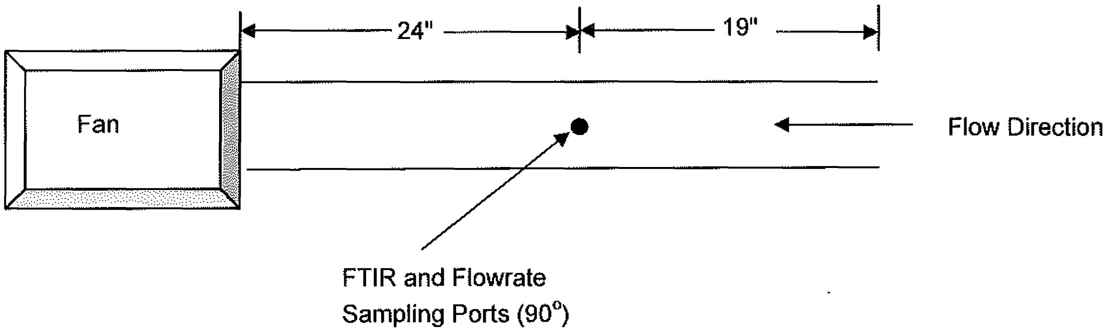
BTEC Inc.



DRAWING IS NOT TO SCALE

Figure 1

Site: **Intermediate Storage Tanks Inlet Sampling Location** **Allnex USA Inc.** **Kalamazoo, Michigan**	**Sampling Date:** **August 28, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan**

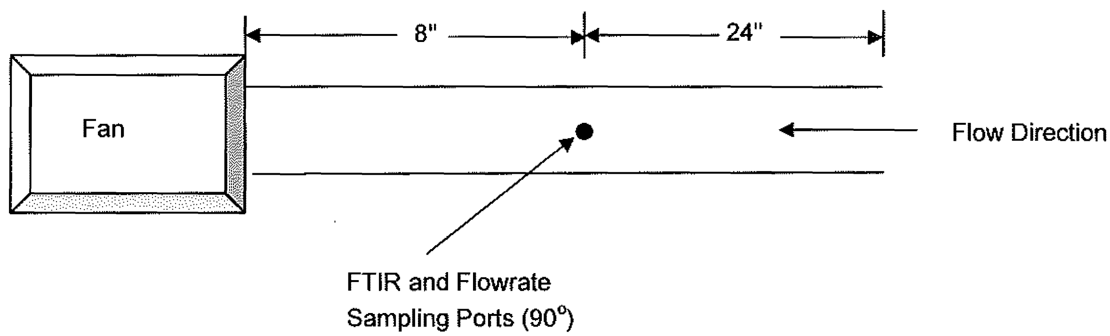


DRAWING IS NOT TO SCALE

All duct is 16" diameter

Figure 2

Site: **Blender Inlet Sampling Location** **Allnex USA Inc.** **Kalamazoo, Michigan**	**Sampling Date:** **August 28, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan**



All duct is 16" diameter

DRAWING IS NOT TO SCALE

Figure 3

Site: **Scrubber Outlet Sampling Location** **Allnex USA Inc.** **Kalamazoo, Michigan**	**Sampling Date:** **August 28, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan**