BTEC Inc.

EU-PulverDryer-Pilot Emissions Test Report

Prepared for:

Jones & Henry Engineers, Ltd.

Toledo, Ohio

Jones & Henry Engineers, Ltd.
3103 Executive Parkway, Suite 300
Toledo, Ohio 43606

Project No. 14-4587.00
December 12, 2014

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

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by Jones & Henry Engineers, Ltd. (Jones & Henry) to conduct a compliance emissions test program on the EU-PulverDryer-Pilot exhaust stack associated with a sludge drying system at the City of Battle Creek wastewater treatment plant in Battle Creek, Michigan. This emissions testing program included evaluation of total filterable particulate matter (PM), condensable particulate matter (CPM), and volatile organic compounds (VOC) concentrations and emission rates from a single sampling location associated with the EU-PulverDryer-Pilot exhaust. Testing consist of triplicate 60-minute sampling runs for PM, CPM, and VOC. The emissions test program was conducted on October 14, 2014.

The emissions test program was required by MDEQ permit No. 110-13. The results of the emission test program are summarized by Table I.

Table I
EU-PulverDryer-Pilot Overall Emission Summary
Test Date: October 14, 2014

MDEQ permit No. 110-13		
Pollutant	**Average Emission Rate**	**Emission Limit**
PM	0.003 lbs. per 1,000 lbs. of gas[1]	0.10 lbs. per 1,000 lbs. of gas[1]
PM_{10}	0.10 lb/hr	0.0016 lb/hr
VOC	0.08 lb/hr[2]	NA

[1] calculated on a wet gas basis
[2] VOC including methane subtraction

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Jones & Henry Engineers, Ltd. (Jones & Henry) to conduct a compliance emissions test program on the EU-PulverDryer-Pilot exhaust stack associated with a sludge drying system at the City of Battle Creek wastewater treatment plant in Battle Creek, Michigan. This emissions testing program included evaluation of total filterable particulate matter (PM), condensable particulate matter (CPM), and volatile organic compounds (VOC) concentrations and emission rates from a single sampling location associated with the EU-PulverDryer-Pilot exhaust. Testing consist of triplicate 60-minute sampling runs for PM, CPM, and VOC using the following reference test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations. The emissions test program was conducted on October 14, 2014. The purpose of this report is to document the results of the test program.

MDEQ Air Quality Division (AQD) has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (December 2013). The following is a summary of the emissions test plan in the format suggested by the aforementioned document.

1.a Identification, Location, and Dates of Test

Sampling and analysis for this emission test program was conducted on October 14, 2014 at the City of Battle Creek wastewater treatment plant in Battle Creek, Michigan. The test program included evaluation of particulate matter (PM), condensable particulate matter (CPM), and volatile organic compounds (VOC) concentrations and emission rates from a single sampling location associated with the EU-PulverDryer-Pilot exhaust.

1.b Purpose of Testing

The emissions test program was required by MDEQ permit No. 110-13. The emission limits are summarized by Table 1.

Table 1
PM, PM_{10}, and VOC Emission Limitations
City of Battle Creek wastewater treatment plant

MDEQ permit No. 110-13	
Pollutant	**Emission Limit**
PM	0.10 lbs. per 1,000 lbs. of gas[1]
PM_{10}	0.0016 lb/hr
VOC	NA[2]

[1] calculated on a wet gas basis
[2] VOC including methane subtraction

1.cSou rce Description

Sampled emissions originate from the baghouse system of the EU-PulverDryer-Pilot equipment which dries sewage sludge blended with sawdust, yard clippings, or similar waste.

1.d Test Program Contacts

The contact for the source and test report is:

Mr. Philip Teague
Process Engineer
Jones & Henry Engineers, Ltd.
3103 Executive Parkway, Suite 300
Toledo, Ohio 43606
419-473-9611

Names and affiliations for personnel who were present during the testing program are summarized by Table 2.

Table 2
Test Personnel

Name and Title	Affiliation	Telephone
Mr. Richard Beardslee Wastewater Collection and Treatment Superintendent	City of Battle Creek, Michigan Wastewater Treatment Plant 2000 River Road Battle Creek, Michigan 49037	(269) 966-3355 ext. 1923
Mr. Ken Lievense Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Steve Smith	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Paul Diven	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. Rex Lane Senior Environmental Quality Analyst	MDEQ 7953 Adobe Kalamazoo, MI 49009	(269) 567-3547

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions compliance test program.

2.a Operating Data

Operating data recorded includes sewage sludge feed rate in pounds, wood chip feed rate in pounds, and overall run percentage of wood chips and sludge.

2.b Applicable Permit

The applicable permit for this emissions test program is MDEQ permit No. 110-13.

2.cRes ults

The overall results of the emission test program are summarized by Table 3 (see Section 5.a). VOC emissions from EU-PulverDryer-Pilots were 0.08 lb/hr. PM emissions were 0.003 lbs. per 1,000 lbs of gas, which is below the limit of 0.10 lbs. per 1,000 lbs. of gas (both calculated on a wet gas basis). PM_{10} emissions were 0.10 lb/hr which is higher than the limit of 0.0016 lb/hr.

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

The EU-PulverDryer-Pilot system is powered electrically. It consists of a unit where a high velocity air stream breaks apart the blended feed, followed by two cyclones in series for solids separation from the air stream. The cyclones have a baghouse for pollution control. The baghouse exhausts through a single stack. EU-PulverDryer-Pilot has a dust collector for each stage: CD-2.

3.b Process Flow Diagram

Due to the simplicity of the EU-PulverDryer-Pilot, a process flow diagram is not necessary.

3.cRaw and Finished Materials

See section 3.a

3.d Process Capacity

The EU-PulverDryer-Pilot system shall not process more than 8,300 pounds of sewage sludge, determined as dry sludge input, in EU-PulverDryer-Pilot per day. Also, the permittee shall not operate the EU-PulverDryer-Pilot for more than 8 hours per day.

3.eP rocess Instrumentation

See section 3.a and 3.d.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures used.

4.a Sampling Train and Field Procedures

Sampling and analysis procedures utilized the following test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60, Appendix A):

- Method 1 - *"Location of the Sampling Site and Sampling Points"*
- Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flowrate"*
- Method 3 - *"Determination of Molecular Weight of Dry Stack Gas"(Fyrite)*
- Method 4 - *"Determination of Moisture Content in Stack Gases"*
- Method 5 - *"Determination of Particulate Emissions from Stationary Sources"*
- Method 25A - *"Determination of Total Gaseous Organic concentration using a flame ionization analyzer"*
- Method 202 - *"Determination of Condensable Particulate Emissions from Stationary Sources"*

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Method 1 and Method 2. S-type pitot tubes with thermocouple assemblies, calibrated in accordance with Method 2, Section 4.1.1, were used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The s-type pitot tube dimensions outlined in Sections 2-6 through 2-8 were within specified limits, therefore, a baseline pitot tube coefficient of 0.84 (dimensionless) was assigned.

Cyclonic flow checks were performed at the sampling location. The existence of cyclonic flow was determined by measuring the flow angle at each sample point. The flow angle is the angle between the direction of flow and the axis of the stack. The average of the absolute values of the flow angles were less than 20, which means cyclonic flow did not exists.

Molecular weight determinations were evaluated according to USEPA Method 3, "Gas Analysis for the Determination of Dry Molecular Weight." The equipment used for this evaluation consists of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Carbon dioxide and oxygen content were analyzed using the Fyrite® procedure.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted as part of the PM sampling train (see Figure 2). Exhaust gas moisture content was determined gravimetrically.

The PM and CPM content of the exhaust gas was evaluated according to procedures outlined in 40 CFR 60, Appendix A, Method 5 and Method 202. BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consists of (1) a stainless-steel nozzle, (2) a glass probe liner, (3) a heated filter holder, (4) a vertical condenser, (5) an empty pot bellied impinger, (6) an empty modified Greenburg-Smith (GS) impinger, (7) unheated filter holder with a teflon filter, (8) a second modified GS impinger with 100 ml of deionized water, and a third modified GS impinger containing approximately 300 g of silica gel desiccant, (9) a length of sample line, and (10) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice

A sampling train leak test was conducted before and after each test run. After completion of the final leak test for each test run, the filter was recovered, and the nozzle and the front half of the filter holder assembly were brushed and triple rinsed with acetone. The acetone rinses were collected in a pre-cleaned sample container. The impinger train was then purged with nitrogen for one hour at a flow rate of 14 liters per minute. The CPM filter was recovered and placed in a petri dish. The back half of the filter housing, the condenser, the pot bellied impinger, the moisture drop out impinger, and the front half of the CPM filter housing and all connecting glassware were triple rinsed with deionized water and collected in a pre-cleaned sample container. The same glassware was then single rinsed with acetone and collected in a pre-cleaned sample container labeled as the organic fraction. The glassware was then double rinsed with hexane which will be added to the same organic fraction sample bottle. The CPM samples were then sent to Maxxam for analysis.

Volatile Organic compound (VOC) concentrations were measured according to 40 CFR 60, Appendix A, Method 25A. A sample of the gas stream was drawn through a stainless steel probe with an in-line glass fiber filter to remove any particulate, and a heated Teflon® sample line to prevent the condensation of any moisture from the sample before it enters the analyzer. Data was recorded at 4-second intervals on a PC equipped with IOtech® data acquisition software. BTEC used a JUM Model 109A Methane/Non-Methane THC hydrocarbon analyzer to determine the VOC concentration.

The JUM Model 109A analyzer utilizes two flame ionization detectors (FIDs) in order to report the average ppmv for total hydrocarbons (THC), as propane, as well as the average ppmv for methane (as methane). Upon entry, the analyzer splits the gas stream. One FID ionizes all of the hydrocarbons in the gas stream sample into carbon, which is then detected as a concentration of total hydrocarbons. Using an analog signal, specifically voltage, the concentration of THC is then sent to the data acquisition system (DAS), where recordings are taken at 4-second intervals to produce an average based on the overall duration of the test. This average is then used to determine the average ppmv for THC reported as the calibration gas, propane, in equivalent units.

The second FID reports methane only. The sample enters a chamber containing a catalyst that destroys all of the hydrocarbons present in the gas stream other than methane. As with the THC sample, the methane gas concentration is sent to the DAS and recorded. The methane concentration, reported as methane, can then be converted to methane, reported as propane, by dividing the measured methane concentration by the analyzer's response factor.

The analyzer's response factor is obtained by introducing a methane calibration gas to the calibrated J.U.M. 109A. The response of the analyzer's THC FID to the methane calibration gas, in ppmv as propane, is divided by the Methane analyzer's response to the methane calibration gas, in ppmv as methane. The response factor determined during testing was 2.2.

In accordance with Method 25A, a 4-point (zero, low, mid, and high) calibration check was performed on the THC analyzer. Calibration drift checks were performed at the completion of each run.

For analyzer calibrations, calibration gases were mixed to desired concentrations using an Environics Series 4040 Computerized Gas Dilution System. The Series 4040 consists of a single chassis with four mass flow controllers. The mass flow controllers are factory-calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. A field quality assurance check of the system was performed pursuant to Method 205 by setting the diluted concentration to a value identical to a Protocol 1 calibration gas and then verifying that the analyzer response is the same with the diluted gas as with the Protocol 1 gas.

4.b Recovery and Analytical Procedures

Recovery and analytical procedures are explained in 4.a.

4.cSam pling Ports

A diagram of the stack showing sampling ports in relation to upstream and downstream disturbances is included as Figure 1.

4.d Traverse Points

A diagram of the stack indicating traverse point locations and stack dimensions is included as Figure 1.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The overall results of the emissions test program are summarized by Table 3. Detailed results for the emissions test program are summarized by Tables 4-5.

Table 3
EU-PulverDryer-Pilot Overall Emission Summary
Test Date: October 14, 2014

MDEQ permit No. 110-13		
Pollutant	**Average Emission Rate**	**Emission Limit**
PM	0.003 lbs. per 1,000 lbs. of gas[1]	0.10 lbs. per 1,000 lbs. of gas[1]
PM_{10}	0.10 lb/hr	0.0016 lb/hr
VOC	0.08 lb/hr[2]	NA

[1] calculated on a wet gas basis
[2] VOC including methane subtraction

5.b Discussion of Results

The overall results of the emission test program are summarized by Table 3 (see Section 5.a). VOC emissions from EU-PulverDryer-Pilots were 0.08 lb/hr. PM emissions were 0.003 lbs. per 1,000 lbs of gas, which is below the limit of 0.1 lbs. per 1,000 lbs. of gas (both calculated on a wet gas basis). PM_{10} emissions were 0.10 lb/hr which is higher than the limit of 0.0016 lb/hr.

The PM_{10} lb/hr emission limit included in the permit is believed to be in error. Sampling performed on air that is at one half the concentration of the EPA's National Ambient Air Quality Standards (NAAQS) for PM_{10} (NAAQS for PM_{10} = 150 $\mu g/m^3$) would yield an emission rate above the permitted limit.

5.cSam pling Procedure Variations

During sampling for all three test runs, an incorrect pitot tube correction factor of 1.014 (instead of the correct factor, 0.84) was used. Changing the correction factor to the correct value (0.84) resulted in all three test results being super-isokinetic (average of 120.1%) which biases the PM results low. Due to the permitted concentration limit being approximately 33 times the measured concentration this does not affect the passing status of the results. The PM_{10} lb/hr emission rate is already above the permitted limit, and thus also not affected by the emission rate being biased low.

5.d Process or Control Device Upsets

No upset conditions occurred during testing.

5.eCont rol Device Maintenance

There was no control equipment maintenance performed during the emissions test program.

5.f Re-Test

The emissions test program was not a re-test.

5.g Audit Sample Analyses

No audit samples were collected as part of the test program.

5.h Calibration Sheets

Relevant equipment calibration documents are provided in Appendix B.

5.i Sample Calculations

Sample calculations are provided in Appendix C.

5.j Field Data Sheets

Field documents relevant to the emissions test program are presented in Appendix A.

5.k Laboratory Data

The laboratory results for this test program are located in Appendix D.

Tables

Table 4
EU-PulverDryer-Pilot Particulate Matter Emission Rates

Company	Jones & Henry			
Source Designation	Pulver Dryer Bag House			
Test Date	10/14/2014	10/14/2014	10/14/2014	
Meter/Nozzle Information	P-1	P-2	P-3	Average
Meter Temperature Tm (F)	85.0	86.1	85.5	85.5
Meter Pressure - Pm (in. Hg)	29.0	29.0	29.1	29.0
Measured Sample Volume (Vm)	48.6	52.3	53.8	51.6
Sample Volume (Vm-Std ft3)	46.3	49.8	51.3	49.1
Sample Volume (Vm-Std m3)	1.31	1.41	1.45	1.39
Condensate Volume (Vw-std)	1.103	1.514	1.636	1.418
Gas Density (Ps(std) lbs/ft3) (wet)	0.0739	0.0737	0.0737	0.0737
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	3.50	3.78	3.90	3.73
Total weight of sampled gas (m g lbs) (dry)	3.45	3.71	3.82	3.66
Nozzle Size - An (sq. ft.)	0.000167	0.000167	0.000167	0.000167
Isokinetic Variation - I	118.2	121.5	120.4	120.1
Stack Data				
Average Stack Temperature - Ts (F)	92.0	92.3	98.2	94.1
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.6	28.5	28.5	28.5
Stack Gas Specific Gravity (Gs)	0.987	0.985	0.984	0.985
Percent Moisture (Bws)	2.33	2.95	3.09	2.79
Water Vapor Volume (fraction)	0.0233	0.0295	0.0309	0.0279
Pressure - Ps ("Hg)	28.4	28.4	28.4	28.4
Average Stack Velocity -Vs (ft/sec)	73.4	77.3	81.4	77.4
Area of Stack (ft2)	1.8	1.8	1.8	1.8
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	7,777	8,195	8,623	8,198
Flowrate ft^3 (Standard Wet)	7,065	7,440	7,746	7,417
Flowrate ft^3 (Standard Dry)	6,900	7,220	7,506	7,209
Flowrate m^3 (standard dry)	195	204	213	204
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	0.0	0.0	0.0	0.0
Organic Condensible Particulate	1.1	1.3	1.1	1.2
Inorganic Condensible Particulate	6.6	5.8	5.3	5.9
Condensible Blank Correction	2.0	2.0	2.0	2.0
Total Condensible Particulate	5.7	5.1	4.4	5.1
Total Filterable and Condensible Particulate	5.7	5.1	4.4	5.1
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.000	0.000	0.000	0.000
lb/1000 lb (dry)	0.000	0.000	0.000	0.000
mg/dscm (dry)	0.0	0.0	0.0	0.0
gr/dscf	0.0000	0.0000	0.0000	0.0000
Filterable Particulate Emission Rate				
lb/ hr	0.00	0.00	0.00	0.00
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.004	0.003	0.002	0.003
lb/1000 lb (dry)	0.004	0.003	0.003	0.003
mg/dscm (dry)	4.3	3.6	3.0	3.7
gr/dscf	0.0019	0.0016	0.0013	0.0016
Condensible Particulate Emission Rate				
lb/ hr	0.11	0.10	0.09	0.10
Total Particulate Concentration				
lb/1000 lb (wet)	0.004	0.003	0.002	0.003
lb/1000 lb (dry)	0.004	0.003	0.003	0.003
mg/dscm (dry)	4.3	3.6	3.0	3.7
gr/dscf	0.0019	0.0016	0.0013	0.0016
Total Particulate Emission Rate				
lb/ hr	0.11	0.10	0.09	0.10

Table 5
EU-PulverDryer-Pilot VOC Emission Rates
Battle Creek WWTP
Battle Creek, Michigan
BTEC Project No. 14-4587.00
Sampling Date: 10/14/14

Parameter	Run 1	Run 2	Run 3	Average
Test Run Date	10/14/2014	10/14/2014	10/14/2014	
Test Run Time	9:40-10:40	11:31-12:31	13:15-14:15	
Outlet Flowrate (dscfm)	6,900	7,220	7,506	**7,209**
Outlet Flowrate (scfm)	7,065	7,440	7,746	**7,417**
Outlet VOC Concentration (ppmv as propane)	2.55	2.74	2.74	**2.68**
Outlet Methane Concentration (ppmv as methane)	2.16	2.15	2.13	**2.15**
Outlet VOC Concentration (ppmv, corrected as per USEPA 7E)	2.49	2.49	2.43	**2.47**
Outlet Methane Concentration (ppmv, corrected as per USEPA 7E)	1.92	1.90	2.03	**1.95**
Outlet VOC Concentration (ppmv as propane, -Methane)	1.56	1.76	1.77	**1.70**
Outlet VOC Concentration (ppmv as propane, -Methane, corrected as per USEPA 7E)	1.62	1.62	1.50	**1.58**
VOC Emission Rate as Propane (-Methane) (lb/hr)	**0.08**	**0.09**	**0.09**	**0.09**
VOC Emission Rate as Propane (-Methane) (lb/hr) (corrected as per USEPA 7E)	**0.08**	**0.08**	**0.08**	**0.08**

VOC Correction			
Co	0.06	0.31	0.40
Cma	29.8	29.8	29.8
Cm	29.83	29.39	29.20

Methane Correction			
Co	0.27	0.30	0.15
Cma	29.8	29.8	29.8
Cm	29.62	29.38	29.25

response factor = **2.2**

scfm = standard cubic feet per minute

dscfm = dry standard cubic feet per minute

ppmv = parts per million on a volume-to-volume basis

lb/hr = pounds per hour

MW = molecular weight (C_3H_8 = 44.10)

24.14 = molar volume of air at standard conditions (70°F, 29.92" Hg)

35.31 = ft^3 per m^3

453600 = mg per lb

Equations

lb/hr = ppmv * MW/24.14 * 1/35.31 * 1/453,600 * ***scfm*** * 60 *for* VOC

Concentration (ppmv as propane, -Methane) = Concetration (as propane) - Concentration (as methane)/RF

Figures

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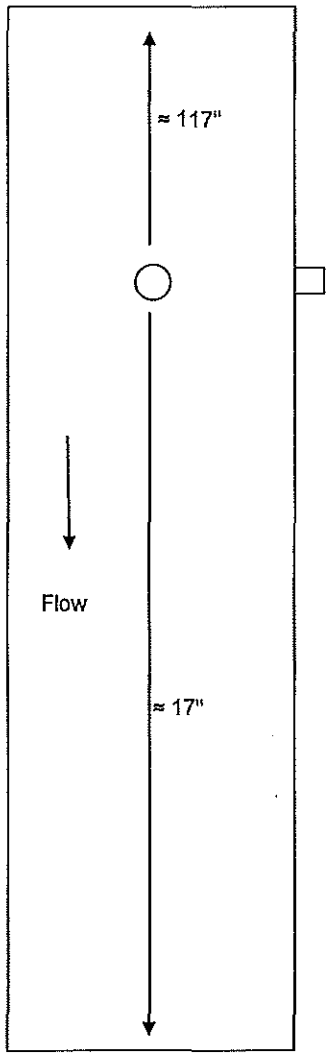
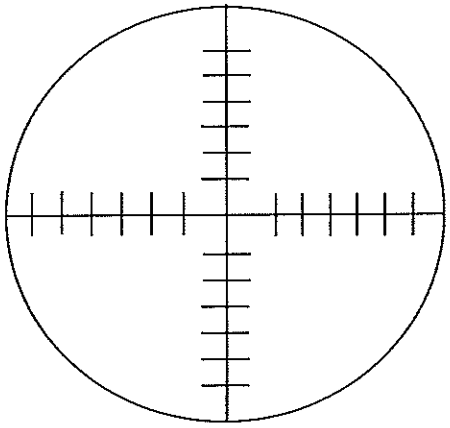
diameter = 18 inches





Not to Scale

Points	Distance "
1	0.4
2	1.2
3	2.1
4	3.2
5	4.5
6	6.4
7	11.6
8	13.5
9	14.8
10	15.9
11	16.8
12	17.6

Figure No. 1

Site:	Sampling Date:	
EU-PulverDryer-Pilot Exhaust	October 14, 2014	BT Environmental Consulting, Inc.
City of Battle Creek Wastewater Treatment Plant		4949 Fernlee Avenue
Battle Creek, MI		Royal Oak, Michigan 48073

BTEC Inc.

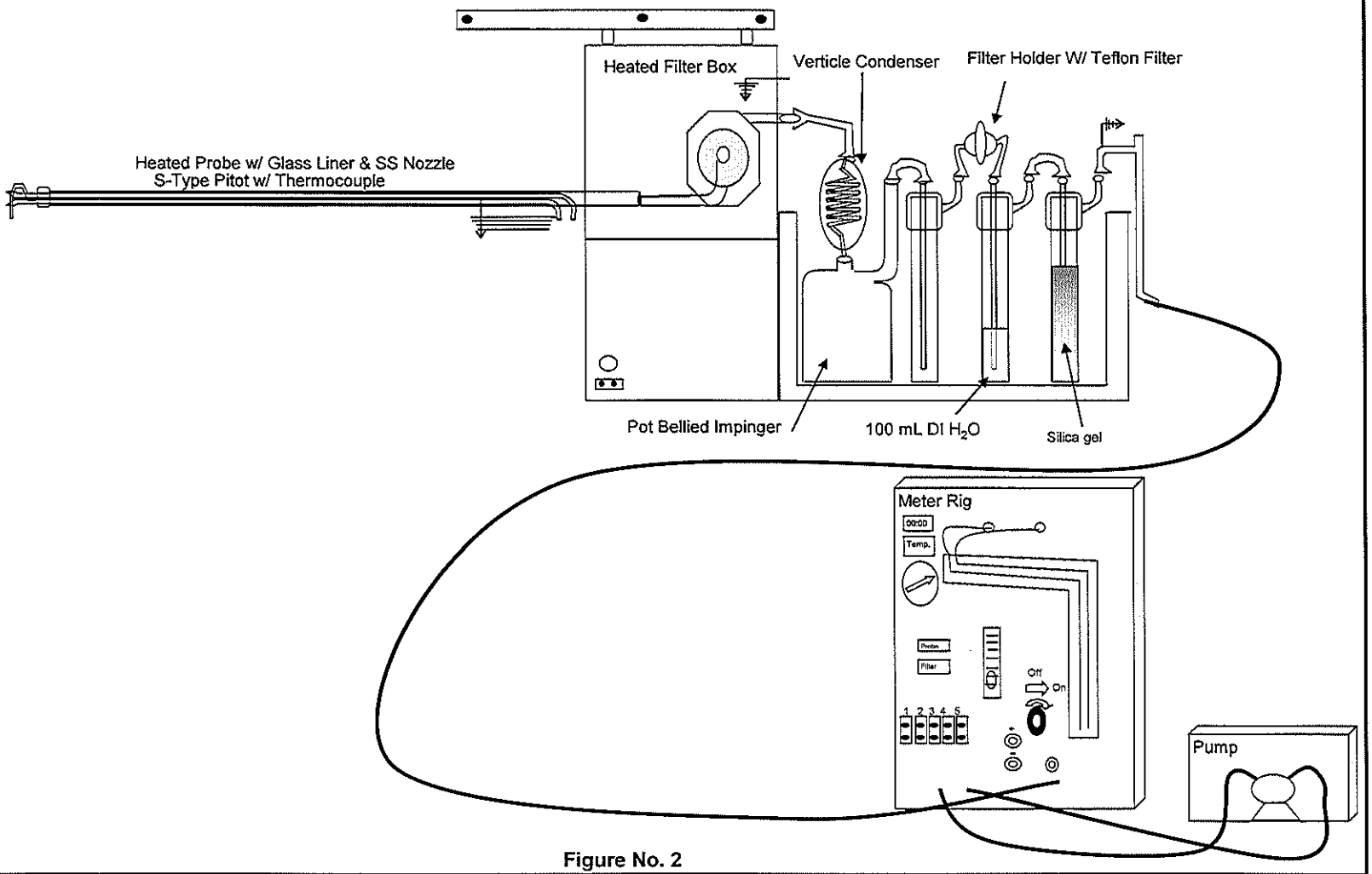


Figure No. 2

Site: **USEPA Method 5/202** **City of Battle Creek Wastewater Treatment Plant** **Battle Creek, MI**	**Sampling Date:** **October 14, 2014**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

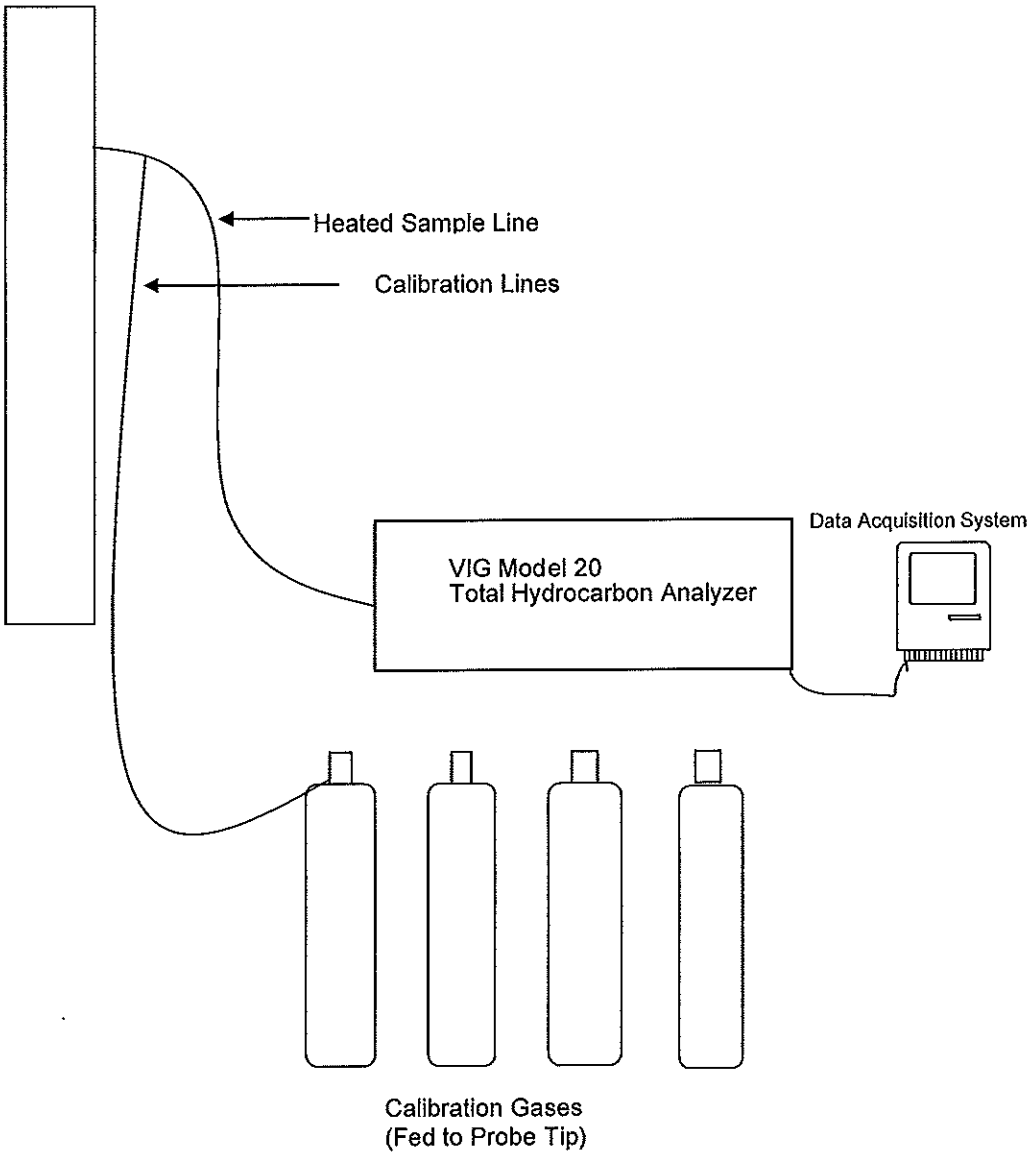


Figure No. 3

Site: **Sampling Date:** **USEPA Method 25A** **October 14, 2014** **City of Battle Creek Wastewater Treatment Plant** **Battle Creek, MI**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**