BTEC Inc.

TEA Emissions
Test Summary Report

Prepared for:

Gokoh Coldwater Inc.

Gokoh Coldwater Inc.
100 Concept Drive
Coldwater, Michigan

Project No. 049AS-348454
June 11, 2018

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

BTEC Inc.

EXECUTIVE SUMMARY

BT Environmental Consulting, Inc. (BTEC) was retained by Gokoh Coldwater (GCI) to evaluate triethylamine (TEA) emission rates from two Scrubbers at the Gokoh facility located in Coldwater, Michigan. The emissions test program was conducted on May 8, 2018.

Testing of the East and West Scrubbers consisted of triplicate 60-minute test runs for triethylamine (TEA). The emissions test program was required by MDEQ Air Quality Division Renewable Operating Permit (ROP) No. MI-ROP-N5815-2015. The results of the emission test program are summarized by Table I.

Table I
Scrubbers Overall Emission Summary
Test Date: May 8th, 2018

East Scrubber (EULAEMPE1)				
Test Run	**Pollutant**	**Emission Concentration (ppmv)**	**Average Concentration (ppmv)**	**Emission Limit**
1	TEA	0.144	0.182	1 ppmv
2		0.179		
3		0.224		
West Scrubber (EULAEMPE2)				
Test Run	**Pollutant**	**Emission Concentration (ppmv)**	**Average Concentration (ppmv)**	**Emission Limit**
1	TEA	0.185	0.195	1 ppmv
2		0.209*		
3		0.191		

***West Scrubber Run 2 did not pass the spike recovery. An average of Run 1 & 3 was used (which biases the results higher than using the Run 2 unadjusted catch weight). All results are less than the minimum detection limit (MDL).**

1. Introduction

BT Environmental Consulting, Inc. (BTEC) was retained by Gokoh Coldwater (GCI) to evaluate triethylamine (TEA) emission rates from two scrubbers at the Gokoh facility located in Coldwater, Michigan. The emissions test program was conducted on May 8, 2018. All testing was performed in accordance with BTEC test plan 049AS-348454, with the exceptions noted in section 5c.

Testing of the East and West Scrubbers consisted of triplicate 60-minute test runs for triethylamine (TEA). The emissions test program was required by MDEQ Air Quality Division Renewable Operating Permit (ROP) No. MI-ROP-N7624-2009. The results of the emission test program are summarized by Table 1.

1.a Identification, Location, and Dates of Test

Sampling for the emission test program was conducted on May 8, 2018 at the Gokoh facility located in Coldwater, Michigan. The test program included evaluation of TEA emissions from two LAEMPE Scrubbers.

1.b Purpose of Testing

AQD issued Renewable Operating Permit No. MI-ROP-N5814-2015 to Gokoh. This permit limits emissions from each scrubber as summarized by Table 1.

Table 1
TEA Emission Limitations
Gokoh Coldwater

Facility	Permit No.	TEA Emission Limit
GCI	MI-ROP-N5814-2015	1 ppmv or 99% reduction

1.c Source Description

Two Laempe cold box core machines.

A phenolic urethane cold box core making process. Mixed sand/resin is set to make cores. The TEA catalyst emission control is two Dakota acid scrubbers, 3850 cfm each.

Equipment includes two Laempe core making machines and two natural gas fired core ovens, 1.5 MMBtu/hr. each; 1.33 tons/hr. nominal throughput capacity.

1.d Test Program Contacts

The contact for the source and test report is:

Mr. Darrin Mynhier
Quality Manager
Gokoh Coldwater Inc.
100 Concept Drive
Coldwater, Michigan
517-279-1080 ext. 105

Mr. Barry P. Boulianne
Senior Project Manager
BT Environmental Consulting, Inc.
4949 Fernlee Avenue
Royal Oak, MI 48073
313-449-2361

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. Darrin Mynhier Quality Manager	Gokoh Coldwater Inc. 100 Concept Drive Coldwater, Michigan	(517)-279-1080 Ext. 105
Mr. Paul Diven Project Manager	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. David Trahan Environmental Technician	BTEC 4949 Fernlee Royal Oak, MI 48073	(248) 548-8070
Mr. David Patterson	MDEQ 525 West Allegan Street Lansing, MI 48909	(517) 284-6782

2. Summary of Results

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

2.a Operating Data

The process was operated at full capacity during the tests.

2.b Applicable Permit

The applicable permit for this emissions test program is Renewable Operating Permit (ROP) No. MI-ROP-N5814-2015.

2.c Results

TEA concentrations at both scrubbers were less that the permit limits.

3. Source Description

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

3.a Process Description

Equipment includes two Laempe core making machines and two natural gas fired core ovens, 1.5 MMBtu/hr. each; 1.33 tons/hr. nominal throughput capacity.

3.b Process Flow Diagram

Due to the simplicity of the natural gas compressor turbine, a process flow diagram is not necessary.

3.c Raw and Finished Materials

Sand/resin and TEA catalyst.

3.d Process Capacity

Equipment includes two Laempe core making machines and two natural gas fired core ovens, 1.5 MMBtu/hr each; 1.33 tons/hr nominal throughout capacity.

3.e Process Instrumentation

Material usage is measured.

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 Procedure

The following U.S. EPA reference test methods found in 40 CFR, Part 60, Appendix A was used:

- Method 1 - *"Sample and Velocity Traverses for Stationary Sources"*
- 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 18 - *"Determination of Gaseous Organic Compound Emissions by Gas Chromatography (Modified utilizing NIOSH 2010 for TEA)"*

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 were used to measure exhaust gas velocity pressures (using a manometer) and temperatures during testing. The s-type pitot tube dimensions 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 is 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. If the average of the absolute values of the flow angles is greater than 20 degrees, cyclonic flow exists. The flow angle was determined to be less than 20 degrees at each sampling point.

Exhaust gas moisture content was evaluated using Method 4. Exhaust gas was extracted and passed through (i) two impingers, each with 100 ml deionized water, (ii) an empty impinger, and (iii) an impinger filled with silica gel. Exhaust gas moisture content is then determined gravimetrically. Triplicate flow rate and moisture determinations were conducted on each source.

Triethylamine (TEA) (USEPA Method 18)

USEPA Method 18 (modified utilizing NIOSH 2010 for TEA) was used to measure triethylamine (TEA) concentrations at each testing location. A sample of the exhaust gas was extracted using a sample pump and passed through an impinger with 15ml 0.1N H_2SO_4 then an XAD trap at a known rate by calibrating the pump with a bios pump calibrator. (BTEC employed side by side spiked and virgin sample trains during the compliance testing. Due to low concentrations the spike was in a liquid form added to the impinger solution of the spiked train.) Both XAD traps and recovered impingers were capped and shipped to Enthalpy for triethylamine analysis by NIOSH 2010.

4.a Recovery and Analytical Procedures

Impinger solutions were collected in sample containers and liquid level marked on the outside of the container. XAD traps were capped, labeled and shipped to Enthalpy for triethylamine analysis by NIOSH 2010.

4.b Sampling Ports

A diagram of the stack showing sampling ports in relation to upstream and downstream disturbances is included as Figures 2 & 3.

4.c Traverse Points

A diagram of the stack indicating traverse point locations and stack dimensions is included as Figures 2 & 3.

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 and 5.

Table 3
Scrubbers Overall Emission Summary
Test Date: May 8th, 2018

East Scrubber (EULAEMPE1)				
Test Run	**Pollutant**	**Emission Concentration (ppmv)**	**Average Concentration (ppmv)**	**Emission Limit**
1	TEA	0.144	0.182	1 ppmv
2		0.179		
3		0.224		
West Scrubber (EULAEMPE2)				
Test Run	**Pollutant**	**Emission Concentration (ppmv)**	**Average Concentration (ppmv)**	**Emission Limit**
1	TEA	0.185	0.195	1 ppmv
2		0.209*		
3		0.191		

***West Scrubber Run 2 did not pass the spike recovery. An average of Run 1 & 3 was used (which biases the results higher than using the Run 2 unadjusted catch weight). All results are less than the minimum detection limit (MDL).**

5.b Discussion of Results

TEA concentrations were below the permit limits at both East and West Scrubbers.

See section 5.c for a discussion of the failed spike recovery on West Scrubber Run 2.

5.c Sampling Procedure Variations

Due to the low concentrations of TEA in the exhaust stream, Enthalpy laboratory was unable to prepare a spiked XAD trap and instead prepared an aqueous spike. The sampling procedure was modified from the test plan as follows: The first XAD trap (spiked and unspiked) were substituted with a midget impinger containing 15 mL of 0.1 N H_2SO_4.

The West Scrubber Run 2 spiked sample results indicate a TEA catch weight below the minimum detection limit. The West scrubber samples did not have a passing recovery efficiency due to Run 2. The average recovery from Run 1 and Run 3 were used to determine the West Scrubber recovery efficiency, and then the associated sample results were adjusted. West Scrubber Run 2 is reported as the average of Run 1 and Run 3 adjusted TEA catch weights. This biases the West Scrubber overall average higher than using the value reported in the laboratory results report included in Appendix D.

5.d Process or Control Device Upsets

No upset conditions occurred during testing.

5.e Control Device Maintenance

There was no control equipment maintenance performed during the emissions test program. Scrubber fan motor on Laempe 2 was changed on January 3, 2018.

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.

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5.k Laboratory Data

Laboratory results are provided electronically in Appendix D.

MEASUREMENT UNCERTAINTY STATEMENT

Both qualitative and quantitative factors contribute to field measurement uncertainty and should be taken into consideration when interpreting the results contained within this report. Whenever possible, Montrose Air Quality Services, LLC, (MAQS) personnel reduce the impact of these uncertainty factors through the use of approved and validated test methods. In addition, MAQS personnel perform routine instrument and equipment calibrations and ensure that the calibration standards, instruments, and equipment used during test events meet, at a minimum, test method specifications as well as the specifications of our Quality Manual and ASTM D 7036-04. The limitations of the various methods, instruments, equipment, and materials utilized during this test have been reasonably considered, but the ultimate impact of the cumulative uncertainty of this project is not fully identified within the results of this report.

Limitations

All testing performed was done in conformance to the ASTM D7036-04 standard. The information and opinions rendered in this report are exclusively for use by Gokoh. BTEC will not distribute or publish this report without Gokoh's consent except as required by law or court order. BTEC accepts responsibility for the competent performance of its duties in executing the assignment and preparing reports in accordance with the normal standards of the profession, but disclaims any responsibility for consequential damages.

This report was prepared by: _____
Paul Diven
Project Manager

This report was reviewed by: _____
Brandon Chase
QA/QC Manager

Table 4
East Scrubber - Triethylamine Emission Rates
Gokoh Coldwater
Coldwater, Michigan
Test Dates: 5/8/2018
BTEC Project No. 049AS-348454

Test Number	Run 1	Run 2	Run 3	Average
Test Date	5/8/2018	5/8/2018	5/8/2018	
Sampling Time	9:47-10:47	11:37-12:37	13:10-14:10	
Run Duration (min)	60.00	60.00	60.00	
Ambient Temperature (°F)	68	75	78	
Atmospheric Pressure ("Hg)	30.00	30.00	30.00	
Elevation (ft)	1090	1090	1090	
Corrected Atmospheric Pressure ("Hg)	28.91	28.91	28.91	
Volumetric Flowrate (scfm)	3,635	3,584	3,553	3,591
Sample Flowrate (L/min) - Pre	0.3678	0.3582	0.3890	0.3717
Sample Flowrate (L/min) - Post	0.3718	0.3608	0.3708	0.3678
Average Sample Flowrate (cc/min)	0.3698	0.3595	0.3799	0.3697
Sample Volume (L)	22.188	21.570	22.794	22.184
Sample Volume (L) - standard (68°F/29.92"Hg)	21.439	20.569	21.615	21.208
TEA Mass Detected (µg)	12.90	15.40	20.30	16.20
TEA Concentration (mg/m3)	0.60	0.75	0.94	0.76
TEA Concentration (PPMV, wet)	0.144	0.179	0.224	0.182

Note: All Results are below the minimum detection limit (MDL)

min : minutes
"Hg : inches of Mercury
scfm : standard cubic feet per minute
cc/min : cubic centimeters per minute
L : liters
ug : micrograms
mg/m^3 : milligrams per cubic meter
lb/hr : pounds per hour

Table 5
West Scrubber - Triethylamine Emission Rates
Gokoh Coldwater
Coldwater, Michigan
Test Dates: 5/8/2018
BTEC Project No. 049AS-348454

Test Number	Run 1	Run 2	Run 3	Average
Test Date	5/8/2018	5/8/2018	5/8/2018	
Sampling Time	9:47-10:47	11:37-12:37	13:10-14:10	
Run Duration (min)	60.00	60.00	60.00	
Ambient Temperature (°F)	68	75	78	
Atmospheric Pressure ("Hg)	30.00	30.00	30.00	
Elevation (ft)	1090	1090	1090	
Corrected Atmospheric Pressure ("Hg)	28.91	28.91	28.91	
Volumetric Flowrate (scfm)	3,696	3,571	3,571	3,612
Sample Flowrate (L/min) - Pre	0.3879	0.3609	0.3727	0.3738
Sample Flowrate (L/min) - Post	0.3856	0.3262	0.3724	0.3614
Average Sample Flowrate (cc/min)	0.3868	0.3436	0.3726	0.3676
Sample Volume (L)	23.205	20.613	22.353	22.057
Sample Volume (L) - standard (68°F/29.92"Hg)	22.422	19.657	21.197	21.092
TEA Mass Detected (µg)	17.40	17.20	17.00	17.20
TEA Concentration (mg/m3)	0.78	0.88	0.80	0.82
TEA Concentration (PPMV, wet)	0.185	0.209	0.191	0.195

Note: All results are below the minimum detection limit (MDL).

*There was no spike recovery for Run 2. Run 2 is reported as an average of Run 1 and 3.

min : minutes
"Hg : inches of Mercury
scfm : standard cubic feet per minute
cc/min : cubic centimeters per minute
L : liters
ug : micrograms
mg/m^3 : milligrams per cubic meter
lb/hr : pounds per hour

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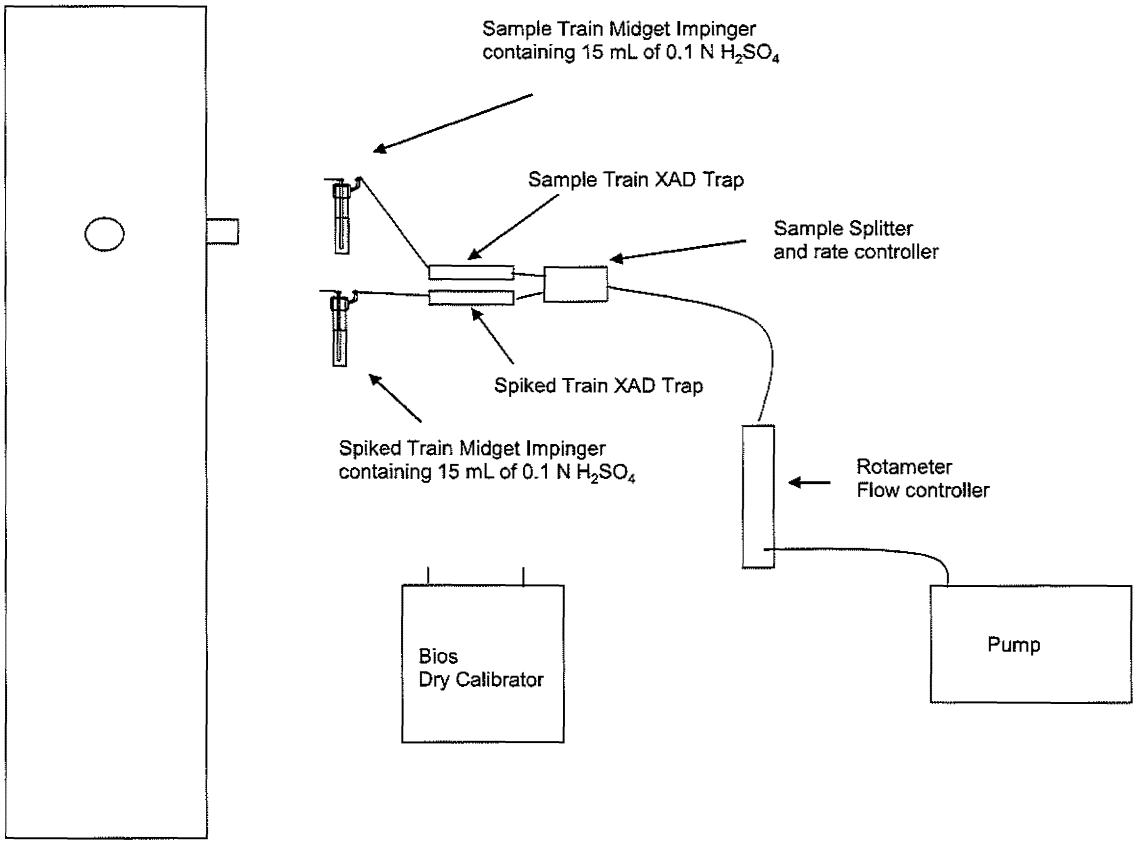

Figure No. 1

Site: **USEPA Method 18** **Gokoh Coldwater INC.** **Coldwater, Michigan**	**Sampling Date:** **May 8, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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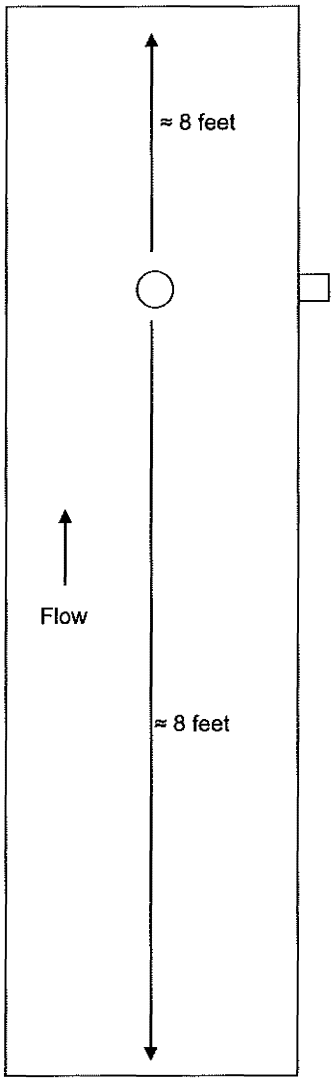
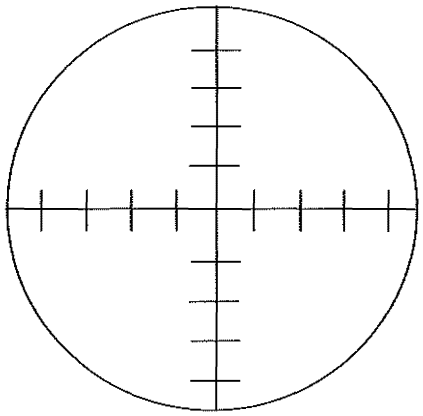
diameter = 20 inches





Not to Scale

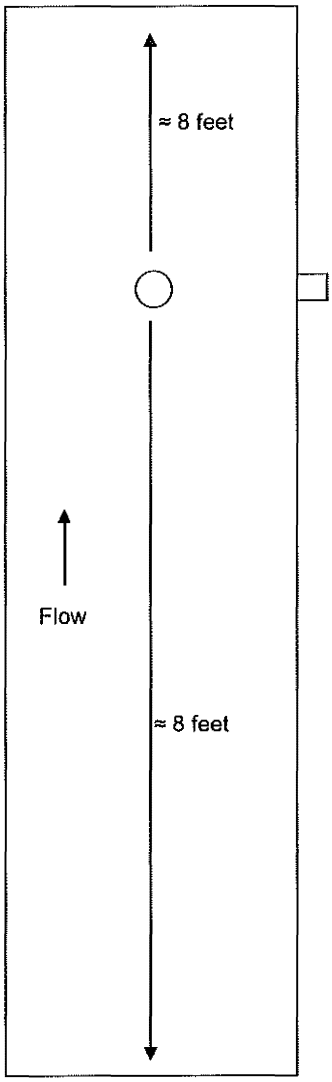
Points	Distance "
1	0.6
2	2.1
3	3.9
4	6.5
5	13.5
6	16.1
7	17.9
8	19.4

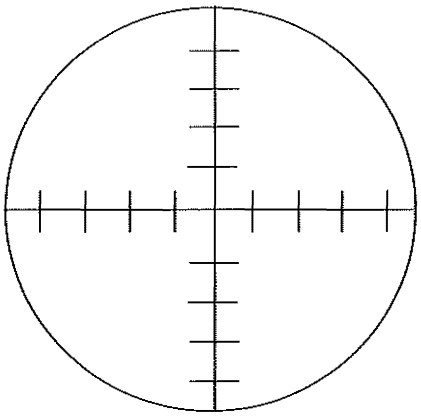
Figure No. 2

Site: **LAEMPE S1** **Gokoh Coldwater Inc.** **Coldwater, Michigan**	**Sampling Date:** **May 8, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

BTEC Inc.

diameter = 20 inches





Not to Scale

Points	Distance "
1	0.6
2	2.1
3	3.9
4	6.5
5	13.5
6	16.1
7	17.9
8	19.4

Figure No. 3

Site: **LAEMPE S2** **Gokoh Coldwater Inc.** **Coldwater, Michigan**	**Sampling Date:** **May 8, 2018**	**BT Environmental Consulting, Inc.** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**