Executive Summary

Montrose Air Quality Services, LLC (MAQS) was retained by Packaging Corporation of America (PCA) to perform testing for heat content and hydrogen sulfide (H_2S), of the biogas routed to EUBOILER4A or EUBIOGASFLARE (biogas flare). The biogas flare is located at the PCA facility in Filer City, Michigan. Testing was conducted on April 7, 2021.

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1.0 Introduction

Montrose Air Quality Services, LLC (MAQS) was retained by Packaging Corporation of America (PCA) to perform testing for heat content and hydrogen sulfide (H_2S), of the biogas routed to the EUBIOGASFLARE (biogas flare). The biogas flare is located at the PCA facility in Filer City, Michigan.

1.1 Purpose of Test

Testing was done to demonstrate compliance with EGLE permit number MI-ROP-B3692-2015b, special conditions V.2 and VI.1 of FGBIOGASSYSTEM. The H_2S limit is 4.49 lb/hr before combustion in a boiler or flare. The SO2 limit is 8.45 lb/hr exiting the boiler or flare and is calculated by assuming complete combustion of H_2S to SO_2. PCA is required by permit to document the BTU's in the biogas fuel on an annual basis.

1.2 Test Date

This test program was performed on April 7, 2021.

1.3 Project Contact Information

Affiliation	Address	Contact
Test Facility	Packaging Corporation of America 2246 Udell Street Flier City, Michigan 49634	Ms. Sara Kaltunas 231-510-4689 skaltunas@packagingcorp.com
Test Facility	Packaging Corporation of America 2246 Udell Street Flier City, Michigan 49634	Ms. Angela Wang 231-510-9173 angelawang@packagingcorp.com
Test Company Representative	Montrose Air Quality Services, LLC 4949 Fernlee Avenue Royal Oak, Michigan 48073	Mr. Steve Smith (734)-751-9701 ssmith@montrose-env.com

This test program was performed by Steve Smith and Ben Durham of MAQS. Ms. Angela Wang of PCA coordinated the test events for this project.

1.4 Summary of Results

A summary of H_2S results is presented in Table 1. Detailed results can be found appended to this report.

Table 1
Summary of EUBIOGASFLARE Emission Rates

Sampling Location	Target Analyte	Emission Rate (lb/hr)	Permit Limit (lb/hr)
SVBIOGASFLARE	post combustion H_2S	0.0287	0.0449
	pre combustion H_2S	2.87	4.49
	SO_2	5.40	8.45

The average higher heating value (HHV) of the biogas was measured to be 705 British thermal units per standard cubic foot (Btu/scf). Detailed results are contained in Appendix B.

2.0 Process Description

PCA operates the biogas flare as part of the FGBIOGASSYSTEM that is used to combust biogas during upset or malfunction conditions that may occur with the biogas generating system or the combustion boilers. If no upset conditions occur in the process, the biogas is directed to Boiler No. 4 (EUBOILER4A) and combined with natural gas to generate steam for various mill process operations, and for electrical generation.

3.0 Reference Methodologies

Triplicate minimum of sixty (60)-minute test runs were performed on the biogas in accordance with specifications stipulated in ASTM D-5504 and in accordance with EGLE requirements.

A minimum vacuum of 5 inches of mercury is required on the evacuated summa canister to ensure proper sample collection. All test runs were stopped once the minimum vacuum was attained.

3.1 Hydrogen sulfide

Hydrogen Sulfide concentrations were determined following ASTM guidelines as described in ASTM D-5504. The samples were extracted using evacuated summa canisters with low flow regulators. The sample stream was vented and aspirated to the summa canister for collection. Samples were labeled and immediately shipped for analysis within the required 24-hour period.

4.0 Quality Assurance

Each promulgated method described above is accompanied by a statement indicating that to obtain reliable results, persons using these methods should have a thorough knowledge of the techniques associated with each. To that end, MAQS attempts to minimize any factors in the field that could increase error by implementing a quality assurance program into every testing activity segment.

5.0 Discussion of Results

The measured average biogas flare H_2S emission rates are less than EGLE permit Number MI-ROP-B3692-2015b requirements.

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 PCA. MAQS will not distribute or publish this report without PCA's consent except as required by law or court order. MAQS 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:__________________________
Steve Smith
Client Project Manager

This report was reviewed by:__________________________
Matthew Young
District Manager

Tables

Table 2
EUBIOGASFLARE H_2S and SO_2 Concentrations and Emission Rates

	Start	End
Test 1	4/7/2021 8:50	4/7/2021 10:00
Test 2	4/7/2021 10:10	4/7/2021 11:10
Test 3	4/7/2021 11:15	4/7/2021 12:15

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RESULTS

	H_2S Conc.		Average Flow (60°F & 1 atm)		Standard flow (70°F & 1 atm)		Mass Flow (total)		Emitted[1]		Emitted[2]	
Test 1	3603	ppm	158.06	cfm	161.100	scfm	**3.064**	**lb/hr H_2S**	**0.0306**	**lb/hr H_2S**	**5.767**	**lb/hr SO_2**
Test 2	3450	ppm	162.27	cfm	165.391	scfm	**3.012**	**lb/hr H_2S**	**0.0301**	**lb/hr H_2S**	**5.669**	**lb/hr SO_2**
Test 3	3339	ppm	140.53	cfm	143.233	scfm	**2.524**	**lb/hr H_2S**	**0.0252**	**lb/hr H_2S**	**4.752**	**lb/hr SO_2**
						Average	**2.867**	**lb/hr H_2S**	**0.0287**	**lb/hr H_2S**	**5.396**	**lb/hr SO_2**

[1] Calculated by assuming 99% destruction of H_2S during combustion

[2] Calculated by assuming complete combustion of H_2S to SO_2

CALCULATIONS:

Converting PPMv to lb/hr:

$$\frac{lb-mole\ pollutant}{MM\ lb-mole\ air}\times\frac{lb\ pollutant}{lb-mole\ pollutant}\times\frac{lb-mole\ air}{386.5\ ft^3\ air}\times\frac{ft^3\ air}{min}\times\frac{60\ min}{hr}=lb/hr$$

$$\frac{2758\ lb-mole\ H2S}{MM\ lb-mole\ biogas}\times\frac{34\ lbs\ H2S}{1\ lb-mol\ H2S}\times\frac{1\ lb-mole\ biogas}{386.5\ ft^3\ biogas}\times\frac{141.673\ ft^3\ biogas}{min}\times\frac{60\ min}{hr}=2.062\frac{lb}{hr}H2S$$

Converting flow to SCFM (70°F & 1 atm) from CFM (60°F & 1 atm):

$$Q_{scfm}=Q_{acfm}\times\frac{460+70°F}{460+T_o}\times\frac{P_o}{P_s}$$

$$141.673_{scfm}=139.00_{acfm}\times\frac{460+70°F}{460+60°F}\times\frac{1\ atm}{1\ atm}$$

Where:

P_o = Pressure at multivariable flow meter (1 atm)

T_o = Temperature at multivariable flow meter (60°F)

Converting H2S lbs/hr to SO2 lbs/hr:

$$H_2S+1.5O_2\rightarrow SO_2+H_2O$$

$$\frac{lb\ H2S}{hr}\times\frac{1\ lb-mole\ H2S}{34\ lbs\ H2S}\times\frac{1\ lb-mole\ SO2}{1\ lb-mole\ H2S}\times\frac{64\ lbs\ SO2}{1\ lb-mole\ SO2}=\frac{lb}{hr}SO2$$

$$\frac{2.062\ lb\ H2S}{hr}\times\frac{1\ lb-mole\ H2S}{34\ lbs\ H2S}\times\frac{1\ lb-mole\ SO2}{1\ lb-mole\ H2S}\times\frac{64\ lbs\ SO2}{1\ lb-mole\ SO2}=3.882\frac{lb}{hr}SO2$$

Figures

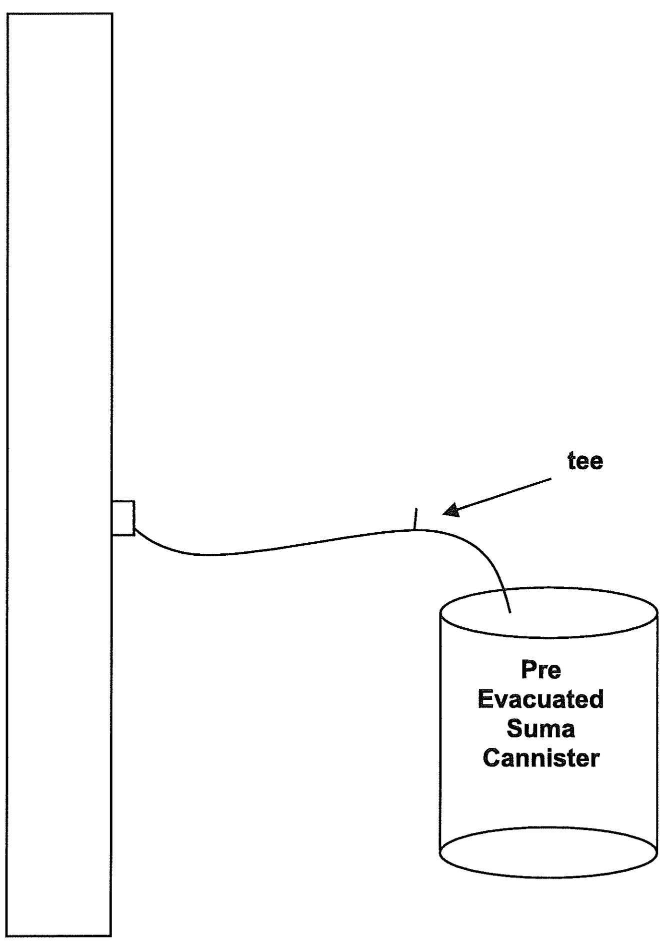

Figure No. 1

Site: **Sampling Schematic** **Packaging Corporation of America** **Filer City, Michigan**	**Sampling Date:** **April 7, 2021**	**Montrose Air Quality Services, LLC** **4949 Fernlee Avenue** **Royal Oak, Michigan**