1.0 EXECUTIVE SUMMARY

Post Consumer Brands operates a food production facility in Battle Creek, Michigan. The source is a flavoring process on one of the production lines in Building 29. The process is designated FG2983CoatOxdOn in the Michigan Department of the Environment, Great Lakes and Energy (EGLE) ROP NO: MI-ROP-B1548-2014d.

KBD Technic was retained by Post Consumer Brands to determine (1) the VOC capture efficiency (CE), (2) the removal efficiency (RE) of the wet rotoclone, (3) the VOC destruction efficiency (DE) of the catalytic oxidizer. The tests were conducted June 17, 2020.

The results of the tests are summarized in Table 1.1.

Table 1.1 Summary of test results

SOURCE	TEST TYPE	TEST RESULT
Flavoring process	Capture efficiency	100.3%
Wet rotoclone	Removal efficiency	25.6%
Catalytic oxidizer	Destruction efficiency	90.8%
All sources combined	Overall Control Efficiency	90.8%

2.0 INTRODUCTION

Post Consumer Brands operates a food production facility in Battle Creek, Michigan. The source is a flavoring process on one of the production lines in Building 29. The process is designated FG2983CoatOxdOn in the Michigan Department of the Environment, Great Lakes and Energy (EGLE) ROP NO: MI-ROP-B1548-2014d. KBD Technic was retained by Post Consumer Brands to determine (1) the VOC capture efficiency (CE), (2) the removal efficiency (RE) of the wet rotoclone, (3) the VOC destruction efficiency (DE) of the catalytic oxidizer and overall control efficiency. The tests were conducted June 17, 2020.

The Michigan Department of Environment, Great Lakes and Energy (EGLE) was notified in writing of the test program with the submission of the Test Protocol. Monica Brothers, Dave Patterson and Matt Karl from the Michigan Department of the Environment, Great Lakes and Energy (EGLE) witnessed the process operation and testing procedures. Cathy Sanford was the Project Coordinator for Post Consumer Brands. Mike Schappacher, Warren Wells, Derek Braun and Arron Gray of KBD Technic conducted the tests.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

3.1 Capture Efficiency

Refer to Figure 3.1 for a simplified process flow diagram and the location of the test sites for the capture efficiency tests.

The capture efficiency was determined by measuring the captured VOC emissions. The amount of flavoring was monitored and samples of the flavoring were taken by Post Consumer Brands personnel during each test run and analyzed by Trace Analytical for ethanol content using EPA Method 8015B (see Appendix B-Process Data). An ethanol content of 69.7% was used to determine the amount of ethanol available for capture. An ethanol in air calibration gas was used to determine a propane to ethanol response factor to convert the emission rates from a propane basis to an ethanol basis. Three 60-minute test runs were made.

The CE was calculated using the following equation:

$$CE = \frac{G}{A}$$

Where:

CE = Capture efficiency, %

G=Sum of the captured VOC (ethanol) emissions or VOC (ethanol) emissions at the inlet to the wet rotoclone and the inlet to the catalytic oxidizer minus the outlet of the rotoclone, lb/hr

A=Applied VOC (ethanol) available for capture, lb/hr

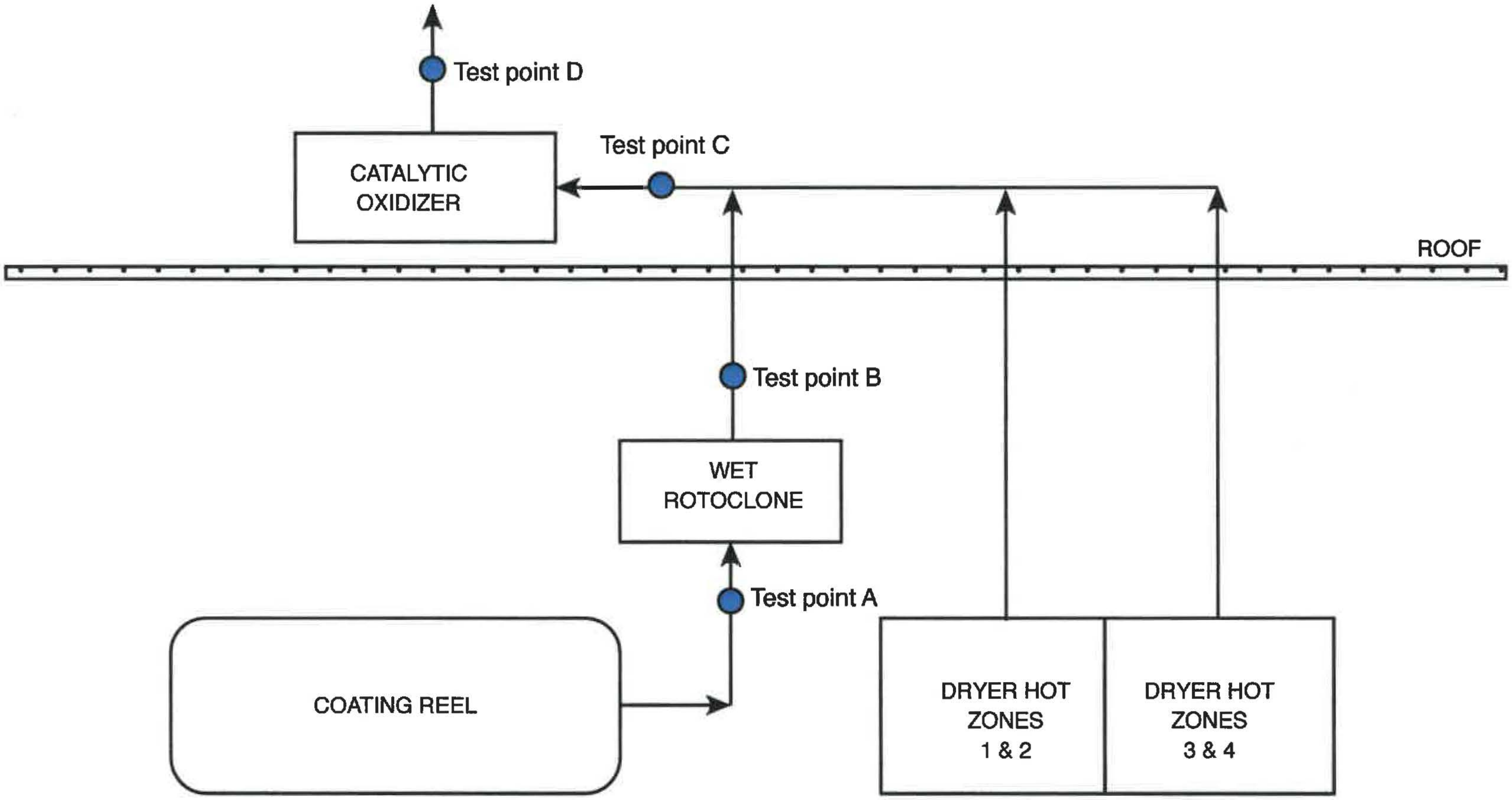
Product samples of the material exiting the dryer were taken by Post Consumer Brands personnel during each test run and analyzed by Eurofins for ethanol content. This sampling showed that there was ethanol retained in the product exiting the dryer. However, this data was not used in the calculation of overall control efficiency from the system.

3.2 VOC Removal efficiency and VOC destruction efficiency

The VOC removal efficiency (RE) of the wet rotoclone was determined by continuously monitoring the VOC concentration at the inlet and outlet for three 60-minute periods. The concentration was converted to a mass emission rate based on the stack gas flow rate. These tests were conducted simultaneously with the capture efficiency tests. In addition, samples of the wastewater discharge by the wet rotoclone were taken by Post Consumer Brands personnel during each test run and analyzed by Trace Analytical for ethanol content using USEPA Method 8015B (see Appendix B-Process Data).

The VOC destruction efficiency (DE) of the catalytic oxidizer was determined by continuously monitoring the VOC concentration at the inlet and outlet of the catalytic oxidizer for three 60-minute periods. The concentration at each measurement site was converted to a mass emission rate based on the stack gas flow rate.

The RE of the wet rotoclone was calculated as follows:



● Test sites for VOC and volumetric flow rate

$$\text{Capture efficiency} = \frac{A + (C - B)}{\text{Application rate} \times \%\text{VOC}}$$

Figure 3.1 Process flow diagram

$$RE = \frac{ER_{inlet} - ER_{outlet}}{ER_{inlet}}$$

Where:
RE = VOC removal efficiency, %
ER_{inlet} = emission rate of VOC determined at the inlet of the wet rotoclone, lb/hr as propane.
ER_{outlet} = emission rate of VOC determined at the outlet of the wet rotoclone, lb/hr as propane.

The DE of the catalytic oxidizer was calculated as follows:

$$DE = \frac{ER_{inlet} - ER_{outlet}}{ER_{inlet}}$$

Where:
DE = VOC destruction efficiency, %
ER_{inlet} = emission rate of VOC determined at the inlet of the catalytic oxidizer, lb/hr as propane.
ER_{outlet} = emission rate of VOC determined at the outlet of the catalytic oxidizer, lb/hr as propane.

The following procedures were used for this survey:

° ***Measurement Sites***
The location of air volume measurement sites and the number of traverse points to be sampled was determined as specified in USEPA Reference Method 1, *"Sample and Velocity Traverses for Stationary Sources"* where possible. The test ports used for previous tests were utilized.

° ***Velocity, Flow Rate, and Temperature***
The stack gas velocity and temperature was determined by USEPA Reference Method 2, *"Determination of Stack Gas Velocity and Volumetric Flow Rate (Type "S" Pitot Tube)".* The velocity pressure was measured with Type 'S' pitot tubes and oil filled or electronic manometers. Electronic manometers were calibrated as per Section 6.2.1 of Method 2. The gas temperature was measured with Type 'K' thermocouples. One velocity traverse was made at each location during each hour of testing.

° ***Dry Molecular Weight***
The dry molecular weight was determined using USEPA Reference Method 3, *"Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight".* Several grab samples of the stack gas were analyzed with Fyrite combustion gas analyzers for oxygen and carbon dioxide. For non-combustion sources, an oxygen concentration of 21% by volume was assumed.

° ***Stack Gas Moisture-Wet rotoclone***
Stack gas moisture content was determined using USEPA Reference Method 4, *"Determination of Moisture Content in Stack Gases".* Moisture content was determined using wet bulb/dry bulb temperature measurements. The wet and dry bulb temperatures were measured with calibrated Type "K" thermocouples. The stack gas moisture was calculated from vapor pressure tables.

° ***Stack Gas Moisture-Catalytic oxidizer***

Stack gas moisture content was determined using the principles of USEPA Reference Method 4, *"Determination of Moisture Content in Stack Gases"*. The moisture content was used only to determine the dry molecular weight for the air volume calculations. The moisture content at the elevated temperature sites was determined using an impinger train that was weighed before and after each test to the nearest 0.5 g with a calibrated electronic balance. The samples were collected at a single point in the center of the duct. Reference Method 4 calls for insertion of a heated probe into the duct. An un-heated stainless steel probe and flexible connector was used to extract the sample gas from a single point in the center of the stack. Inserting an electrically heat traced probe into a duct containing solvent vapors poses risks of fire or explosion and it is against our policy to expose our clients and ourselves to this type of risk. A one-hour moisture run was made during each test. A drawing of the sample train is included in Figure 3.2.

° ***VOC Emissions***

The concentration of volatile organic compounds were determined using USEPA Reference Method 25A, *"Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"*. Continuous samples of the stack gas were extracted and analyzed with flame ionization analyzers (FIA). The sample gas was delivered to the analyzers through sampling systems that consist of heat traced, Teflon sample lines and stainless steel probes. The temperature of the sample lines was set at $\geq$110°C (230°F). The FIA output signals were recorded continuously on a strip chart recorder and instantaneously logged on a computer equipped with a data acquisition device. A drawing of the measurement system is included in Figure 3.3.

The FIA's were calibrated as specified in the Reference Method with ultra zero air (< 0.1 ppm THC), low-level, mid-level, and high-level mixtures of propane in air. The calibration standards were certified by USEPA Protocol 1 *"Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors"*. Prior to the first test and each subsequent test, the linearity of the sampling system was established by introducing the high level span gas and zero gas through the sampling system to the analyzer and making the necessary adjustments. The mid-level and the low-level calibration gases were then introduced to each sampling system to check for calibration error. The measurement system response time was determined at this time. After each test, the sampling system and analyzer response to zero air and the mid-level span gas was checked to determine drift. All calibration and drift checks met Method requirements.

An ethanol in air calibration gas was used to determine a propane to ethanol response factor to convert the emission rates from a propane basis to an ethanol basis for the capture efficiency analysis.

° ***Methane***

The concentration of methane was determined at the outlet of the catalytic oxidizer using the principles of USEPA Reference Method 25A, *"Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer"*. Continuous samples of the stack gas were extracted and analyzed with a JUM Model 109A, or equivalent, flame ionization analyzer (FIA). The FIA is equipped with a heated catalyst that converts non-methane hydrocarbons to CO_2 and allows methane to pass through to the detector. The detector was calibrated with Protocol 1 standards of methane in air to determine linearity and analyzer drift.

° ***Gas dilution systems***

All of or a portion of the calibration standards were prepared using a gas dilution system. Gas standards from cylinders certified by USEPA Protocol 1 *"Traceability Protocol for*

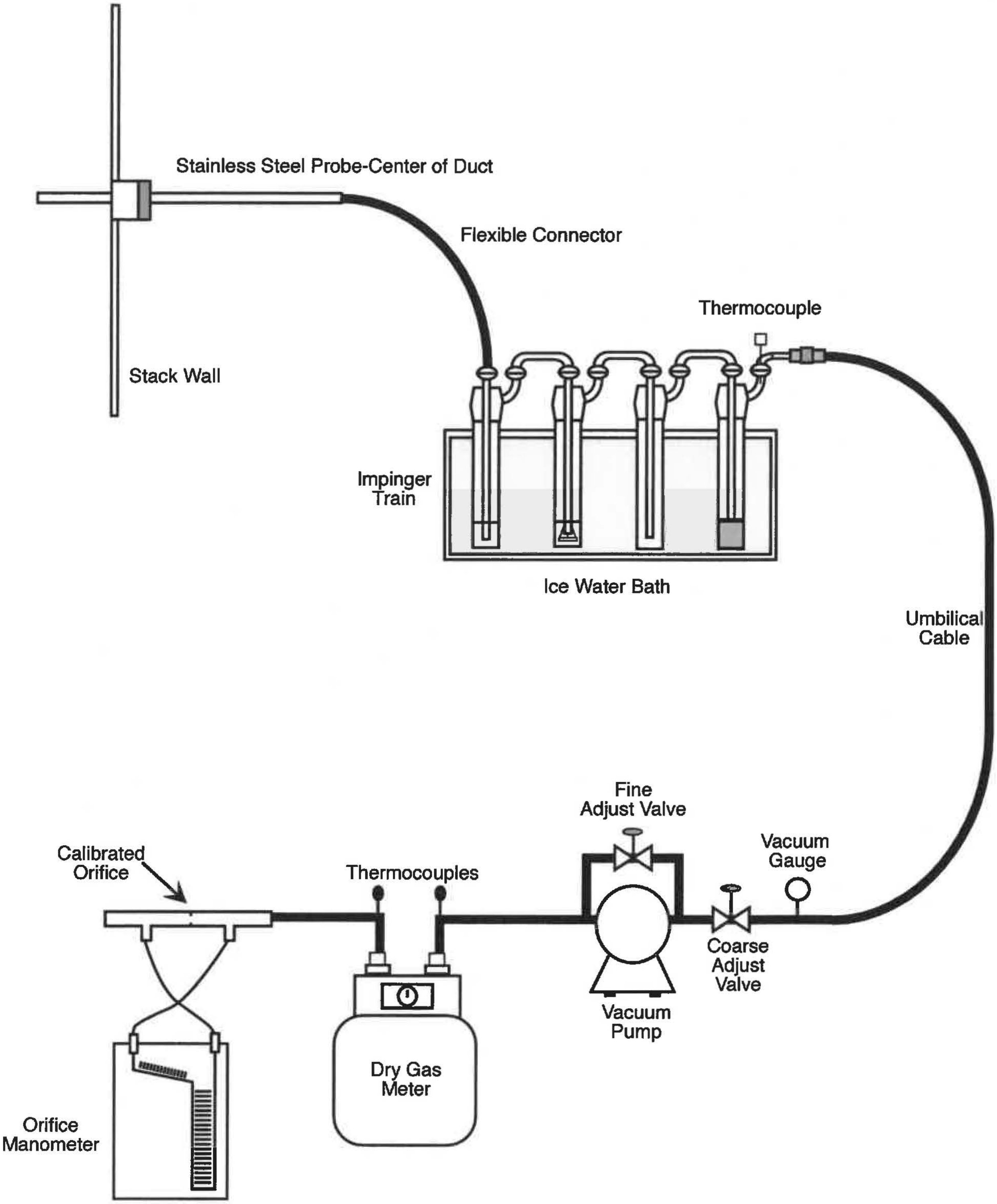


Figure 3.2 USEPA Reference Method 4 sampling train

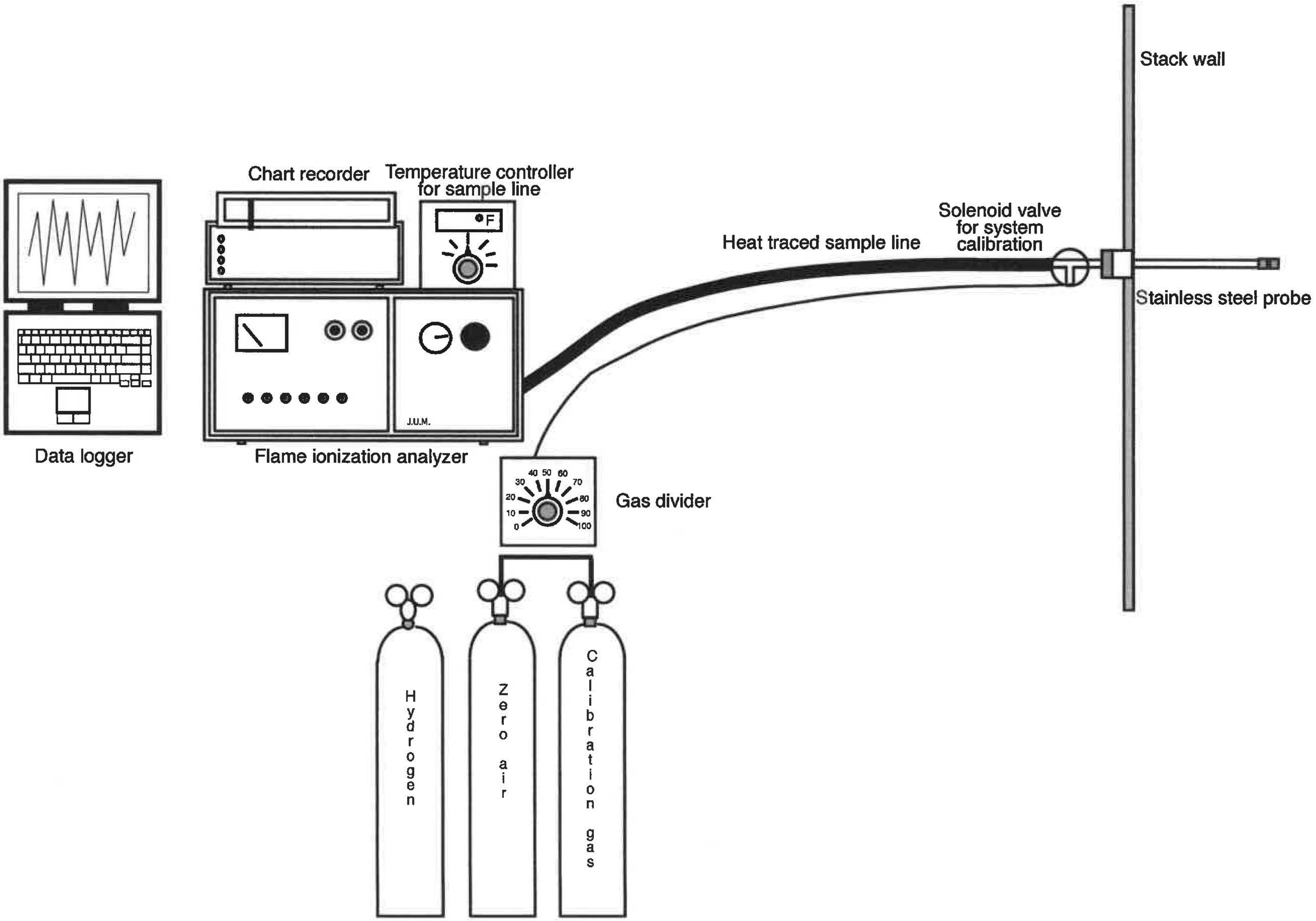


Figure 3.3 USEPA Reference Method 25A measurement system

Establishing True Concentrations of Gases Used for Calibration and Audits of Continuous Source Emission Monitors" were diluted with zero air. The gas dilution systems were verified in the field using USEPA Method 205, *"Verification of Gas Dilution Systems for Field Instrument Use"*.

° ***Quality Assurance***

The Quality Assurance procedures used in this survey include equipment calibration by USEPA and manufacturer's guidelines, use of standard published procedures for sample collection and analysis, and attention to the QA procedures included in the Reference Methods. The quality assurance procedures and results for the equipment used in this survey are included in Appendix A.

4.0 PROCESS DESCRIPTION

A coating reel applies VOC (ethanol) containing flavoring to the grain based cereal product proportional to product flow. This is a continuous process (not a cyclical or batch operation) with a 1% flavor application rate (based on flake throughput). A fume hood at the entrance and exit of the coating reel captures emissions from the coating reel for control by a wet rotoclone equipped with a water washdown system, designated emission unit EU2983 in the permit. The wet rotoclone exhausts to the catalytic oxidizer. The food product is conveyed from the coating reel to a multizone dryer. The dryer has two exhausts designated EU2985 and EU29119 in the permit. The dryer exhausts to the catalytic oxidizer. After the dryer, the food is further processed before being packaged and shipped to distributors.

The inlet catalyst bed temperature was set to 725°F during the testing.

5.0 TEST RESULTS

5.1 Capture Efficiency

The capture efficiency analysis is summarized in Table 5.1. Captured ethanol emissions averaged 44.3 lb/hr. The flavor application rate during the tests averaged 63.3 lb/hr. Of this, 44.1 lb/hr was VOC (ethanol) available for capture. This results in an average capture efficiency of 100.3%.

Table 5.1 Results of capture efficiency analysis

RUN	VOC (ETHANOL) APPLICATION RATE (lb/hr)	CAPTURED EMISSIONS (lb/hr)	CAPTURE EFFICIENCY (%)
1	41.8	41.3	98.8
2	48.8	48.7	99.8
3	41.8	42.8	102.3
Average	44.1	44.3	100.3

5.2 Removal and Destruction Efficiency

The stack gas flow rates for the wet rotoclone are summarized in Table 5.2. The average flow rate measured at the inlet was 3,306 acfm (3,003 scfm) at 104°F and 6.2% moisture. The average flow rate measured at the outlet was 3,090 acfm (2,822 scfm) at 104°F and 7.2% moisture.

The VOC removal efficiency for the wet rotoclone is summarized in Table 5.3. The average inlet concentration was 932.7 ppm (as propane) which is equivalent to an emission rate of 19.2 lb/hr (as propane). The ethanol emission rate was 31.8 lb/hr. The average outlet concentration was 738.3 ppm (as propane) which is equivalent to an emission rate of 14.3 lb/hr (as propane). The ethanol emission rate was 20.2 lb/hr. The removal efficiency was 25.6%. Graphic reproductions of the VOC concentration data are included in Figures 5.1 through 5.3.

The stack gas flow rates for the catalytic oxidizer are summarized in Table 5.4. The average flow rate measured at the inlet was 7,548 acfm (6,368 scfm) at 150°F and 5.0% moisture. The average flow rate measured at the outlet was 18,075 acfm (8,562 scfm) at 625°F and 7.8% moisture.

The VOC emission rates and destruction efficiency for the catalytic oxidizer are summarized in Table 5.5. The average inlet concentration was 492.9 ppm (as propane) corrected for methane which is equivalent to an emission rate of 21.5 lb/hr (as propane). The ethanol emission rate was 32.6 lb/hr. The average outlet concentration was 34.4 ppm (as propane) corrected for methane which is equivalent to an emission rate of 2.0 lb/hr (as propane). The average VOC destruction efficiency was 90.8%. The ethanol emission rate was 3.4 lb/hr.

The inlet catalyst bed temperature was set to 725°F during the emission testing.

Graphic reproductions of the VOC concentration data are included in Figures 5.4 through 5.6.