I. INTRODUCTION

Network Environmental, Inc. was retained by the Cabot Corporation in Midland, Michigan to perform an emission study at their facility. The purpose of the study was to conduct emission sampling on the Fumed Silica Manufacturing Process in order to document compliance with Michigan Department of Environment, Great Lakes and Energy (EGLE) Renewable Operating Permit (ROP) No. MI-ROP-N6251-2020. MI-ROP-N6251-2020 has established the following emission limits for this source:

Source	Emission Limit
TF-13 Exhaust (SV-2)	HCl: 0.95 Lbs/Hr
Scrubber Exhaust (SV-7)	HCl: 0.61 Lbs/Hr Total Chloromethanes: 21 PPM(v) & 8.9 Tons/Year

Sampling was conducted on the Fumed Silica Manufacturing Process as follows:

TF-13 Exhaust (SV-2)

- Hydrogen Chloride (HCl) – U.S. EPA Method 26A
- Exhaust Gas Parameters (air flow rate, temperature, moisture and density) – U.S. EPA Methods 1 through 4

Scrubber Exhaust (SV-7)

- Hydrogen Chloride (HCl) – U.S. EPA Method 26A
- Carbon Tetrachloride & Chloroform – U.S. EPA Method 18 (Charcoal Tubes)
- Methyl Chloride (chloromethane) & Methylene Chloride (dichloromethane) – U.S. EPA Method 18 (Tedlar Bags)
- Exhaust Gas Parameters (air flow rate, temperature, moisture and density) – U.S. EPA Methods 1 through 4

The sampling was performed over the period of December 1-2, 2020 by Stephan K. Byrd, R. Scott Cargill, Richard D. Eerdmans and David D. Engelhardt of Network Environmental, Inc.. Assisting with the study were Mr. Kevin Musser of the Cabot Corporation and the operating staff of the facility. Ms. Lindsey Wells and Mr. Ben Witkopp of the Michigan Department of Environment, Great Lakes and Energy (EGLE) – Air Quality Division were present to observe the sampling and source operation.

II. PRESENTATION OF RESULTS

II.1 TABLE 1
HCL EMISSION RESULTS
CABOT CORPORATION
MIDLAND, MICHIGAN
FUMED SILICA PROCESS

Source	Sample	Date	Time	Air Flow Rate DSCFM (1)	HCl Concentration		HCl Mass Rate Lbs/Hr (4)
					PPM (2)	Mg/M^3 (3)	
TF-13 Exhaust (SV-2)	1	12/1/20	10:41-11:46	904	65.13	98.59	0.334
	2	12/1/20	12:30-13:34	914	66.00	99.92	0.342
	3	12/1/20	14:03-15:10	899	64.10	97.04	0.327
	Average			**906**	**65.08**	**98.52**	**0.334**
Scrubber Exhaust (SV-7)	1	12/2/20	09:37-10:41	2,823	0.54	0.82	0.0087
	2	12/2/20	10:59-12:04	2,777	0.21	0.32	0.0033
	3	12/2/20	12:20-13:24	2,788	0.21	0.32	0.0033
	Average			**2,796**	**0.32**	**0.49**	**0.0051**

(1) DSCFM = Dry Standard Cubic Feet Per Minute (68 °F & 29.92 in. Hg)
(2) PPM = Parts Per Million (v/v) on a Dry Basis
(3) Mg/M^3 = Milligrams Per Dry Standard Cubic Meter
(4) Lbs/Hr = Pounds Per Hour

II.2 TABLE 2
CHLOROMETHANE EMISION RESULTS (PPM) [1]
CABOT CORPORATION
MIDLAND, MICHIGAN
FUMED SILICA PROCESS SCRUBBER (SV-7)
DECEMBER 2, 2020

Compound	Sample 1 (09:28-10:28)	Sample 2 (10:53-11:53)	Sample 3 (12:12-13:12)	Average
Carbon Tetrachloride	0.895	0.838	0.786	0.839
Chloroform	0.217	0.206	0.189	0.204
Methyl Chloride	N.D. [2]	N.D. [2]	N.D. [2]	N.D. [2]
Methylene Chloride	N.D. [2]	N.D. [2]	N.D. [2]	N.D. [2]
Total Chloromethanes [3]	**1.596**	**1.529**	**1.460**	**1.528**

(1) PPM = Parts Per Million (v/v) On A Dry Basis
(2) N.D. = Non Detected at detection limits of 0.242 PPM for Methyl Chloride and 0.243 PPM for Methylene Chloride.
(3) Total = Additive total for chloromethane concentrations in PPMv. Detection limit values were added into the totals.

II.3 TABLE 3
CHLOROMETHANE EMISSION RESULTS (LBS/HR)[1]
CABOT CORPORATION
MIDLAND, MICHIGAN
FUMED SILICA PROCESS SCRUBBER (SV-7)
DECEMBER 2, 2020

Compound	Sample 1 (09:28-10:28)	Sample 2 (10:53-11:53)	Sample 3 (12:12-13:12)	Average
Carbon Tetrachloride	0.0603	0.0556	0.0524	0.0561
Chloroform	0.0113	0.0106	0.0097	0.0106
Methyl Chloride	N.D. [2]	N.D. [2]	N.D. [2]	N.D. [2]
Methylene Chloride	N.D. [2]	N.D. [2]	N.D. [2]	N.D. [2]
Total Chloromethanes [3]	**0.0861**	**0.0804**	**0.0763**	**0.0809**

(1) Lbs/Hr = Pounds Per Hour. Calculated using 2,823 DSCFM for sample one, 2,777 DSCFM for sample two and 2,788 DSCFM for sample three.
(2) N.D. = Non Detected at detection limits of 0.0053 Lbs/Hr for Methyl Chloride and 0.0090 Lbs/Hr for Methylene Chloride.
(3) Total = Additive total for chloromethane emission rates in Lbs/Hr. Detection limit values were added into the totals.

III. DISCUSSION OF RESULTS

The results of the testing are presented in Tables 1 – 3 (Sections II.1 – II.3) as follows:

III.1 HCl Emission Results (SV-2 & SV-7) (Table 1) – The hydrochloric acid (HCl) emission results are summarized in Table 1 as follows:

- Source
- Sample
- Date
- Time
- Air Flow Rate (DSCFM) – Dry Standard Cubic Feet Per Minute (STP = 68 °F & 29.92 in Hg)
- HCl Concentration (PPM) – Parts Per Million (v/v) On A Dry Basis
- HCl Concentration (Mg/M^3) – Milligrams Per Dry Standard Cubic Meter
- HCl Mass Emission Rate (Lbs/Hr) – Pounds Per Hour

III.2 Chloromethane Concentration (PPM) Emission Results (SV-7) (Table 2) – The chloromethane concentration results are summarized in Table 2 as follows:

- Chloromethane Compound
- Sample & Time
- Chloromethane Concentration (PPM) – Parts Per Million (v/v) On A Dry Basis

Total chloromethane emission concentrations (PPM) were calculated by adding the PPM of each of the quantified species. In the cases where a compound was not detected, the detection limit value was used when calculating the total chloromethane concentration.

III.3 Chloromethane Emission Rate (Lbs/Hr) Results (SV-7) (Table 3) – The chloromethane mass emission results are summarized in Table 3 as follows:

- Chloromethane Compound
- Sample & Time
- Chloromethane Mass Emission Rate (Lbs/Hr) – Pounds Per Hour

Total chloromethane mass emission rates (Lbs/Hr) were calculated by adding the Lbs/Hr of each of the quantified species. In the cases where a compound was not detected, the detection limit value was used when calculating the total chloromethane mass emission rate.

IV. SAMPLING AND ANALYTICAL PROTOCOL

The sampling locations were as follows:

- **Scrubber Exhaust (SV-7) –** The sampling was conducted on the 18 inch I.D. off-gas line upstream of the 24 inch I.D. exhaust stack. The sampling location was approximately two (2) duct diameters downstream from the nearest disturbance and greater than two duct diameter upstream from the next disturbance.

- **TF-13 Exhaust (SV-2) –** The sampling was conducted on an 8 inch I.D. exhaust duct at a location that exceeds the eight (8) duct diameter downstream and two (2) duct diameter upstream requirements of U.S. EPA Method 1

IV.1 HCl – The HCl emission sampling was conducted in accordance with U.S. EPA Method 26A. The sampling was performed isokinetically in accordance with the method. Sample gas was extracted from the exhaust ducts isokinetically using a heated probe and filter operated at 250 °F ± 25 °F. The HCl was collected in the first two impingers of the sampling train, which contained 100 mls of 0.1 normal sulfuric acid. The sample line rinse and the impinger catch were combined and analyzed for HCl using Ion-chromatography as described in the method.

Each sample was sixty (60) minutes in duration and had a minimum sample volume of thirty (30) dry standard cubic feet. All the quality assurance and quality control requirements specified in the method were incorporated in the sampling and analysis. A diagram of the sampling train is shown in Figure 1.

IV.2 Carbon Tetrachloride & Chloroform – The sampling for these compounds was conducted by employing U.S. EPA Method 18. The samples were collected on charcoal sorbent tubes using pumps equipped with calibrated critical orifices (at approximately 500 cc/min). Prior to collection in the charcoal tubes, the exhaust gas was passed through midget impingers containing DI water (the first with 15 ml & the second empty) in order to condense any stack moisture before entering the tubes. A duplicate spiked sample was run simultaneously with each sampling run. Six (6) samples (3 sample runs & 3 spiked/duplicates) were collected from the scrubber exhaust. Each sample was sixty (60) minutes in duration.

The impingers and tubes were recovered and refrigerated until submitted to the laboratory. The samples (water fraction & charcoal tubes) were analyzed for the compounds by gas chromatography (GC). All the quality assurance and quality control procedures listed in the method were incorporated in the sampling and analysis.

Results were corrected for recovery efficiencies. The recovery efficiency for each compound was as follows:

Compound	Sample	Date	Time	% Recovery
Carbon Tetrachloride	1	12/2/20	09:28-10:28	108 (1)
	2	12/2/20	10:53-11:53	108 (1)
	3	12/2/20	12:12-13:12	108 (1)
Chloroform	1	12/2/20	09:28-10:28	115
	2	12/2/20	10:53-11:53	111
	3	12/2/20	12:12-13:12	108

(1) Originally it was thought that the laboratory prepared spiked charcoal tubes used for the duplicate samples of 99.6 ug of carbon tetrachloride and 93.2 ug of chloroform. After analysis of the samples and Laboratory Control Samples (spiked tubes retained by the laboratory), it was discovered that the laboratory made a mistake and did not spike the tubes with carbon tetrachloride and double spiked (186.4 ug) chloroform. The value of 108 % recovery for carbon tetratchloride was obtained from a second series of laboratory spikes performed after the sampling and then analyzed. Because the % recovery values could not be determined for the carbon tetratchloride field spike/dupes, 100% Recovery was used for the carbon tetrachloride calculations.

A diagram of the sampling train can be seen in Figure 2.

IV.3 Methyl Chloride (chloromethane) & Methylene Chloride (dichloromethane) – The Methyl Chloride & Methylene Chloride emissions were determined in accordance with U.S. EPA Reference Method 18. Three (3) samples were collected from the scrubber exhaust. Each sample was sixty (60) minutes in duration. The samples were collected in Tedlar bags. Prior to collection in the Tedlar bag, the exhaust gas was passed through midget impingers containing DI water (the first with 15 ml & the second empty) in order to condense any stack moisture before entering the bag. The water impinger contents and bags were sent to the analytical laboratory over night and analyzed for Methyl Chloride & Methylene Chloride by GC.

All the quality assurance and quality control procedures (QA/QC) listed in the methods were incorporated in the sampling and analysis. As part of the QA/QC, the laboratory spiked a bag with Methyl Chloride & Methylene Chloride to determine the recovery efficiency. The recovery efficiency for the spiked bag was 94.1% for Methyl Chloride & 93.5% for Methylene Chloride. These recovery efficiencies were used by the laboratory to adjust the results before reporting.

A diagram of the sampling train can be seen in Figure 3.

IV.4 Exhaust Gas Parameters – In addition to the other determinations, the exhaust gas parameters (air flow rate, temperature, moisture, and density) were determined by employing U.S. EPA Reference Methods 1 through 4.

Moisture was determined from the Method 26A sampling train. Integrated bag samples were collected from the back of the Method 26A sampling train and analyzed for oxygen and carbon dioxide concentrations (gas density) by Orsat in accordance with U.S. EPA Method 3.

All the quality control and quality assurance requirements listed in the methods were incorporated in the sampling and analysis.

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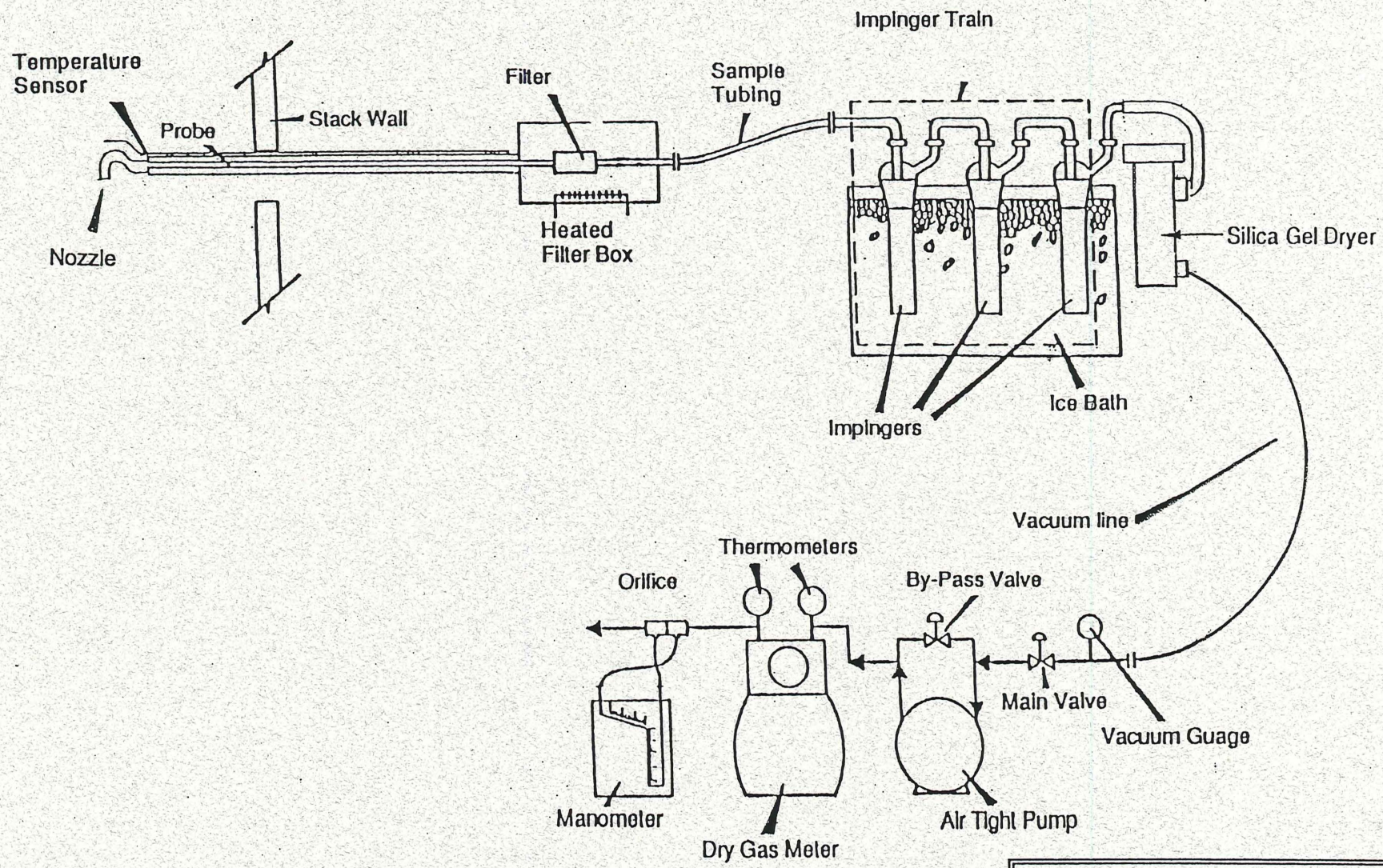

Figure 1

Method 26A
Sampling Train

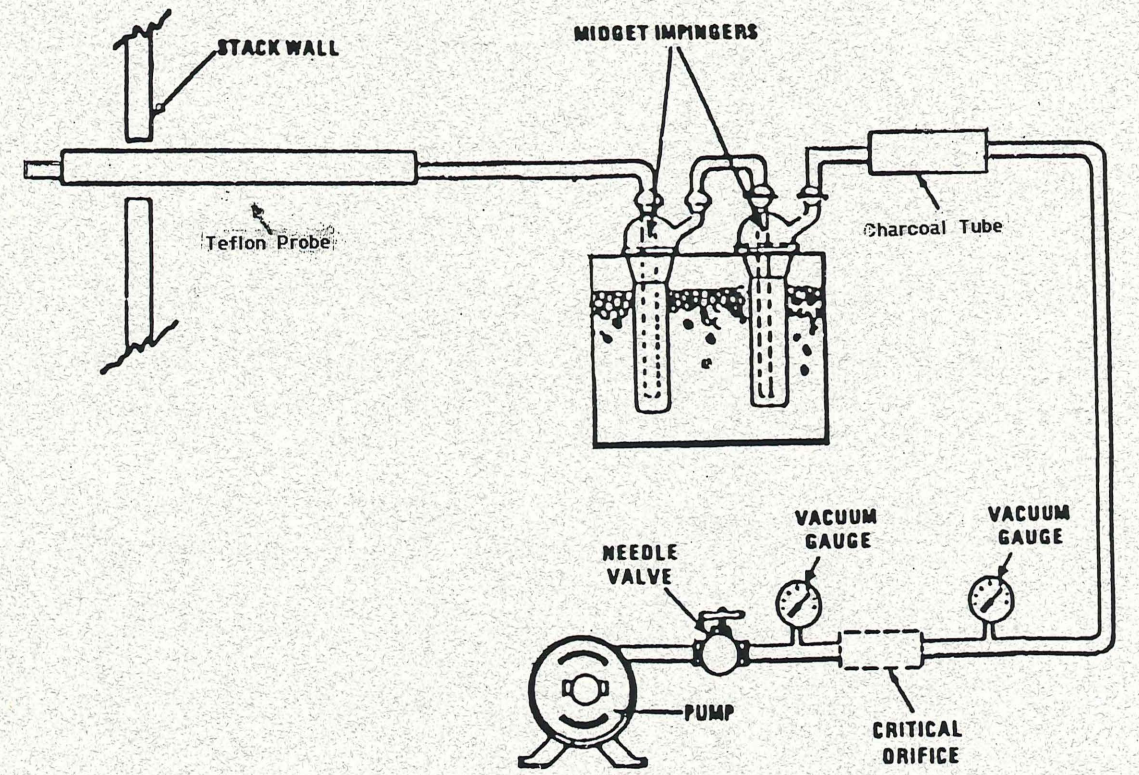

Figure 2

Method 18 - Charcoal Tube Sampling Train

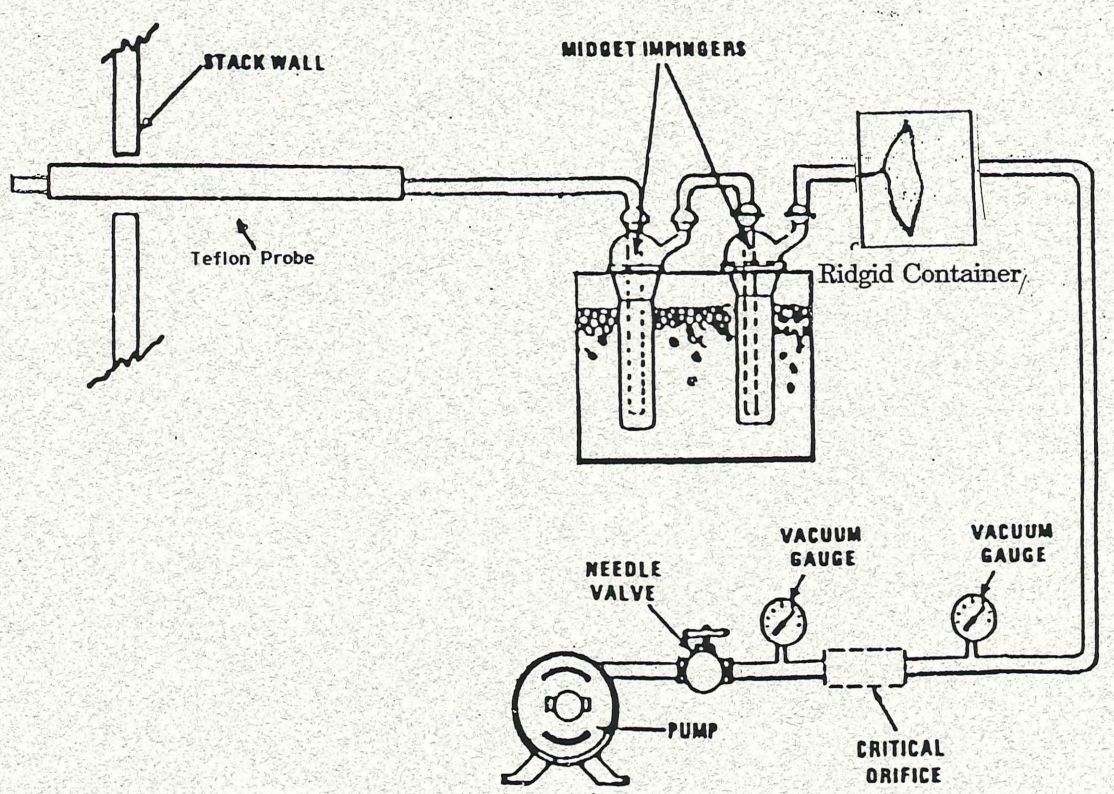

Figure 3

Method 18 - Tedlar Bag Sampling Train