TEST NUMBER 72-CI-14

ROCK DEFLUORINATION

BORDEN CHEMICAL COMPANY

PLANT CITY, FLORIDA

FEBRUARY 24 - 25, 1972

PEDCo-ENVIRONMENTAL
SUITE 8 · ATKINSON SQUARE
CINCINNATI, OHIO 45246
513/771-4330

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By
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Cincinnati, Ohio

Contract No. 68-02-0237, Task 1

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I. INTRODUCTION

Stack emission tests were conducted, and related process samples were taken during the period February 22 to 25, 1972, at the Borden Chemical Company's phosphate animal feed plant in Plant City, Florida. Three tests were made to determine total fluoride emissions on the rock defluorination operations during the period of February 24 and 25.

According to the terms of PEDCo's contract with EPA, only stack gas measurements, selected feed and product samples, and scrubber water samples were to be taken by PEDCo. Three simultaneous sets of samples were taken to determine the fluoride content of the kiln exit gases before and after the spray chamber/scrubber section at the locations shown in Figure 1. In addition, samples of the rock feed, clinker product, and scrubber water were taken during each run. Moisture, carbon dioxide, and oxygen contents of the gas streams were also measured as well as gas velocity, temperature, and total volume. All process data and operating procedures were obtained by EPA personnel. Sample analyses and emission calculations were also to be performed by EPA staff.

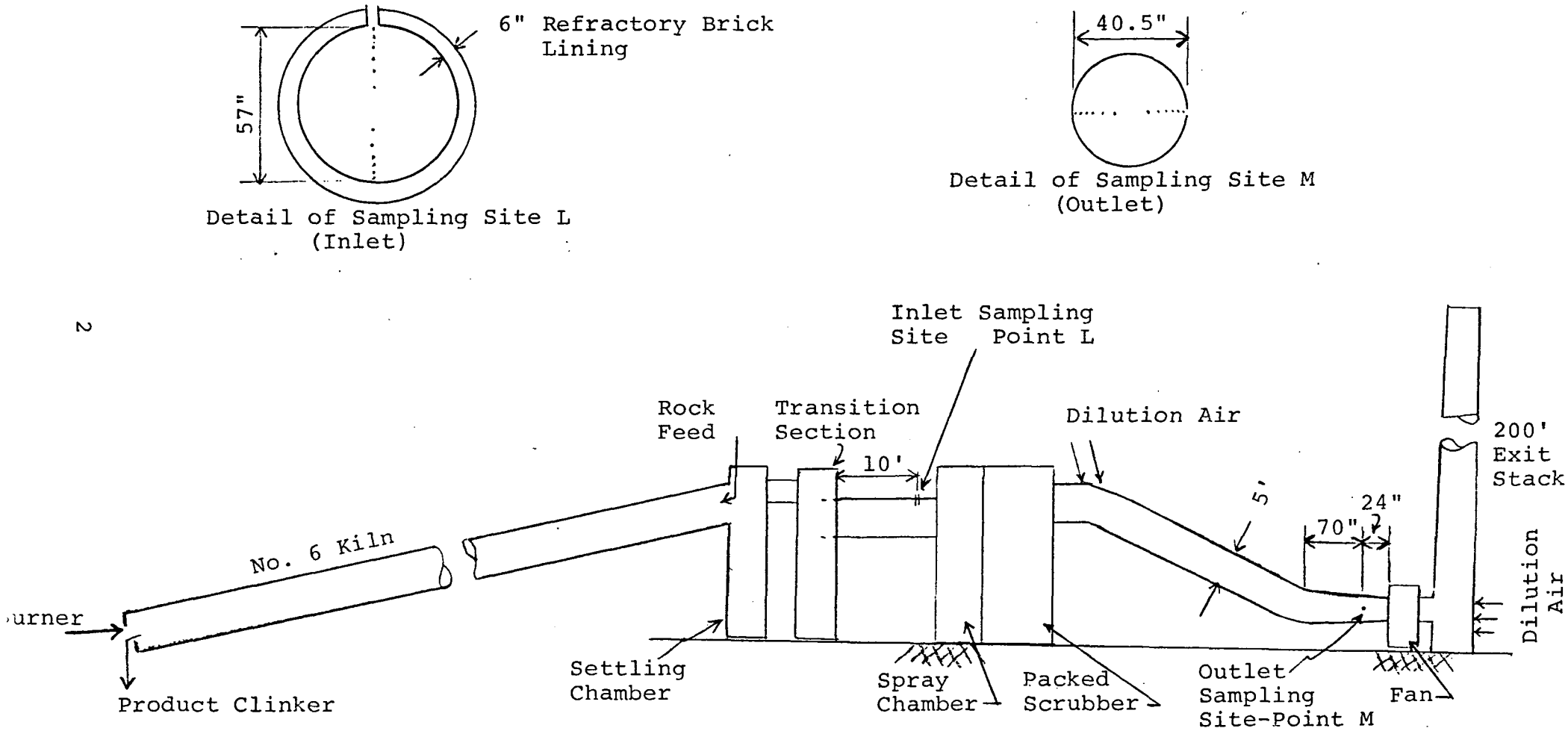


FIGURE 1. DIAGRAM OF ROCK DEFLUORINATION PROCESS AND SAMPLING SITES

II. SUMMARY OF RESULTS

The plant was operating under normal process conditions during all of the test runs. Two sampling problems were encountered while testing the scrubber inlet and should be noted. First, the probe clogged during all runs. Due to this problem, the first run was cut short; the probe was cleared of particulate during the other two runs. Secondly, the silica gel turned a dark color during the test runs at the inlet. A visible fume was noticed passing through the first three impingers and the filter and apparently was reacting with the silica gel. Also, it should be noted that the emission levels for the second run at the outlet are considerably higher than for the other two runs.

A complete summary of stack gas conditions and emission levels for each test run are given in Tables 1 and 2.

TABLE 1. SUMMARY OF RESULTS--SCRUBBER INLET

Run Number	1	2	3
Date	2/24/72	2/24/72	2/25/72
Stack pressure, inches Hg	30.24	30.24	30.25
Stack gas moisture, % volume	15.3	15	8.4
Average stack gas temperature, ^{o}F.	726	724	758
Stack gas flow rate @ S.T.P.*, SCFM	18394	15258	17283
Vol. gas sampled @ S.T.P.*, SCF	48.43	17.05	33.89
Fluoride, water soluble, mg	9100	2800	5000
Fluoride, total, mg	9324	2893	5112
Fluoride, water soluble, gr/SCF	2.9	2.5	2.3
Fluoride, total, gr/SCF	3.0	2.6	2.3
Fluoride, water soluble, gr/CF stk. cond.	1.1	1.0	0.9
Fluoride, total, gr/CF stk. cond.	1.1	1.0	1.0
Fluoride, water soluble, lb/hour	456	331	336
Fluoride, total, lb/hour	467	342	344
Fluoride, water soluble, lb/ton P_2O_5 Fed.	157	114	116
Fluoride, total, lb/ton P_2O_5 Fed.	161	118	119

* Dry, 70^{o}F., 29.92 inches Hg.

TABLE 2. SUMMARY OF RESULTS--SCRUBBER OUTLET

Run Number	1	2	3
Date	2/24/72	2/24/72	2/25/72
Stack pressure, inches Hg.	29.73	29.73	29.43
Stack gas moisture, % volume	4.5	4.9	4.4
Average stack gas temperature, ^{o}F.	88	93	90
Stack gas flow rate @ S.T.P.*, SCFM	42608	42390	41001
Vol. gas sampled @ S.T.P.*, SCF	52.53	50.70	51.34
Fluoride, water soluble, mg	2.9	10.6	2.2
Fluoride, total, mg	2.9	10.6	2.2
Fluoride, water soluble, gr/SCF	0.0009	0.0032	0.0007
Fluoride, total, gr/SCF	0.0009	0.0032	0.0007
Fluoride, water soluble, gr/CF stk. cond.	0.0008	0.0029	0.0006
Fluoride, total, gr/CF stk. cond.	0.0008	0.0029	0.0006
Fluoride, water soluble, lb/hour	0.31	1.17	0.23
Fluoride, total, lb/hour	0.31	1.17	0.23
Fluoride, water soluble, lb/ton P_2O_5 Fed.	0.11	0.40	0.08
Fluoride, total, lb/ton P_2O_5 Fed.	0.11	0.40	0.08
Scrubber efficiency, %	99.9	99.6	99.9

* Dry, 70^{o}F., 29.92 inches Hg.

III. ROCK DEFLUORINATION PROCESS

In the defluorination process, phosphate rock is charged to a gas-fired rotary kiln and heated to approximately 2500°F. Exit gases containing fluorides pass through a settling chamber, a round transition section, a spray chamber, a packed bed scrubber containing Tellerettes, a fan, and a 200 foot high stack. A large opening in the duct between the scrubber and fan allowed ambient air to enter the duct and caused considerably higher gas flows to occur at the outlet test site as compared to the inlet site.

IV. SAMPLING PROCEDURES

All gas streams were sampled isokinetically by using a modified EPA particulate sampling train and following the sampling procedures described in Method 5 of the Federal Register of December 23, 1971. The sampling train as shown in Figure 2 consisted of a stainless steel button-hook nozzle, a heated Pyrex glass probe contained in a steel sheath, a Greenburg-Smith impinger without a tip, a second impinger with a tip, a third impinger without a tip, an 80 millimeter Whatman No. 1 paper filter, and a final impinger containing approximately 200 grams of indicating type silica gel. The first and second impingers contained 100 ml each of distilled water at the beginning of each test. The third impinger was initially dry. All impingers were contained in an ice-water bath and the temperature of the gases leaving the fourth impinger was in the 65 to 70°F range. The filter was not heated. An air tight vacuum pump, dry gas meter, orifice, and associated valves, connectors, thermometers, and manometers completed the train.

A stainless steel probe was used on the inlet site in the defluorination process because of the high temperatures encountered there.

A type 'S' pitot tube was attached to the probe to measure the velocity head of the stack gas. The sampling rate was continually adjusted to maintain isokinetic sampling rates by

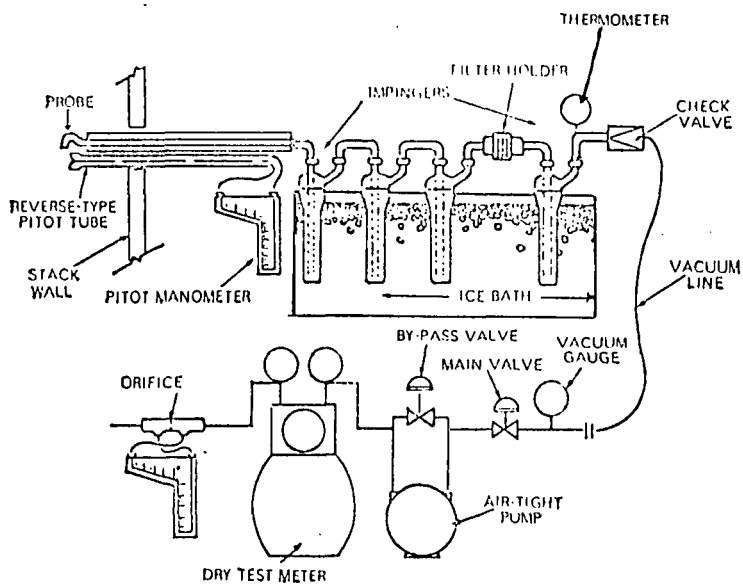


FIGURE 2. SAMPLING TRAIN USED TO DETERMINE FLUORIDE CONCENTRATIONS

means of a nomograph which related the pressure drop across the orifice after the meter with the velocity head measured by the pitot tube. Stack gas temperatures were measured with long stem dial thermometers.

In a typical run to determine fluoride concentrations, the train was assembled and checked for leaks by plugging the first impinger and drawing a vacuum of 15" Hg. The probe and nozzle assembly was then attached to the impinger and the train positioned at the first sampling point. Each point along the stack diameter was sampled for ten minutes. A two hour sampling period was used, except at the inlet site where a 90 minute sampling period was used because of heavy fluoride concentrations. At each point the velocity head, stack gas temperature, final impinger temperature, meter temperatures, meter reading, pump suction pressure, and orifice pressure drop was measured and recorded. All data sheets for these tests are attached in Part B of the Appendix.

Upon completion of sampling, the train was completely disassembled, the condensate volume measured, and the silica gel weighed on a triple beam balance at the site. The water in the impingers was poured into plastic (Nalgene) wide mouth bottles. The paper filter and all washings from the probe and

all glassware were also placed in this same container. When necessary the probe was also brushed to remove solid matter. All train components were then dried with acetone and the train reassembled for the next run. Each container was immediately labeled.

Feed, product, and scrubber water samples were also placed in plastic bottles and labeled. All samples were submitted to Mr. J. Rom of EPA for future analysis.

Moisture content of the gas stream was determined by making a preliminary run with this same train without a filter. This was accomplished by running the train at a sampling rate of approximately 0.75 cfm for 30 minutes and measuring the moisture condensed and the weight gain of the silica gel.

Carbon dioxide and oxygen content of the gas stream were measured with a standard Orsat apparatus by drawing samples from the stack directly into the Orsat apparatus through a one-quarter inch diameter stainless steel probe. The probe was carefully purged with stack gas before taking the sample. This procedure was deemed sufficiently accurate to determine the molecular weight of the stack gases.

V. ANALYTICAL PROCEDURES

Water soluble fluorides were determined by a sulfuric acid distillation followed by the SPADNS-ZIRCONIUM LAKE METHOD. Water insoluble fluorides were first fused with NaOH followed by a sulfuric acid distillation then by the SPADNS-Zirconium Lake Method.

VI. APPENDIX

APPENDIX A

EMISSION CALCULATIONS AND RESULTS

NOMENCLATURE

PB - Barometric pressure, inches Hg

PS - Stack pressure, inches Hg

As - Stack area, sq. ft.

TS - Stack temperature, ^{o}R

TM - Meter temperature, ^{o}R

$\underline{H}$ - Average square root of velocity head, $\sqrt{\text{inches } H_2O}$

ΔH - Average meter orifice pressure differential, inches H_2O

AN - Sampling nozzle area, square feet

CP - S-type pitot tube correction factor

VM - Recorded meter volume sample, cubic feet (meter conditions)

VC - Condensate and silica gel increase in impingers, milliliters

Po - Pressure at the dry test meter orifice, $PB + \frac{\Delta H}{13.6}$ inches Hg

STP - Standard conditions, dry, $70^{o}F$, 29.92 inches Hg

- - - - - - - - - - - - - - - -

VWV - Conversion of condensate in milliliters to water vapor in cubic feet (STP)

VSTPD - Volume sampled, cubic feet (STP)

VT - Total water vapor volume and dry gas volume samples, cubic feet (STP)

W - Moisture fraction of stack gas

FDA - Dry gas fraction

MD - Molecular weight of stack gas, lbs/lb-mole (dry conditions)

MS - Molecular weight of stack gas, lbs/lb/-mole (stack conditions)

GS - Specific gravity of stack gas, referred to air

EA - Excess air, %

U - Stack gas velocity, feet per minute

OS _ Stack gas flow rate, cubic feet per minute (stack conditions)

OD - Stack gas flow rate, cubic feet per minute (dry conditions)

OSTPD - Stack gas flow rate, cubic feet per minute (STP)

PISO - Percent isokinetic volume sampled (method described in Federal Register)

Time - Total sample time, minutes

EQUATIONS FOR CALCULATING FLUORIDE EMISSIONS

$$VWV = (0.0474) \times (VC)$$

$$VSTPD = (17.71 \times (VM) \times (PB + \frac{H}{13.6}) \div TM$$

$$VT = (VWV) + (VSTPD)$$

$$W = (VWV) \div (VT)$$

$$FDA = (1.0) - (W)$$

$$MD = (0.44 \times \% CO_2) + (0.32 \times \% O_2) + (0.28 \times \% N_2) + (0.28 \times \% CO)$$

$$MS = (MD \times FDA) + (18 \times W)$$

$$GS = (MS) \div (28.99)$$

$$EA = \left[(100) \times (\% O_2 - \frac{\% CO}{2})\right] \div \left[(0.266 \times \% N_2) - (\% O_2 - \frac{\% CO}{2})\right]$$

$$\underline{U} = (174) \times (CP) \times (\underline{H}) \times \sqrt{(TS \times 29.92) \div (GS \times PS)}$$

$$QS = (\underline{U}) \times (AS)$$

$$QD = (QS) \times (FDA)$$

$$QSTPD = (530) \times (QD) \div (TS) \times (PS) \div (29.92)$$

$$PISO = \left[(0.00267 \times VC \times TS) + (P_o \times TS \times VM \div TM)\right] \div \left[(Time \times \underline{U} \times PS \times AN)\right]$$

Fluoride Emissions:

MG = Milligrams of fluoride from lab analysis

Grains/SCF = (0.01543) x (MG) ÷ VSTPD

Grains/CF, Stack Cond. = (17.71) x (PS) x (FDA) x (Grains/SCF) ÷ (TS)

Lbs/hour = (Grains/SCF) x (0.00857) x (QSTPD)

P_2O_5 Fed = Tons/hour, determined from plant data

Lbs/ton P_2O_5 Fed = (lbs/hour) ÷ (Tons/hour P_2O_5 Fed)

EMISSION DATA
BORDEN CHEMICAL
ROCK DEFLUORINATION
OUTLET

	1	2	3
1) Run Number	2/24/72	2/24/72	2/25/72
2) Date	12:01	16:20	9:10
3) Time Began	14:01	18:20	11:10
4) Time End	30.3	30.3	30
5) Barometric Pressure, In Hg	0.47	0.47	0.44
6) Meter Orifice Pressure Drop, in H_2O	54.57	51.94	52.59
7) Vol Dry Gas, Meter Cond. Cubic Feet	97.2	90.5	85
8) Average Gas Meter Temperature, Deg F	52.526	50.699	51.335
9) Vol Dry Gas, S.T.P., Cubic Feet	52.4	55.3	49.7
10) Total H_2O Collected, Ml	2.48	2.62	2.36
11) Vol H_2O Vapor Collected, S.T.P., Cu.Ft.	4.5	4.9	4.4
12) Stack Gas Moisture, Percent Volume	6	5	6
13) Assumed Stack Gas Moisture, Pct Vol	2.8	2.2	1.8
14) Percent CO_2	16	15.8	16
15) Percent O_2	0.2	0.2	0.2
16) Percent CO	81	81.8	82
17) Percent N_2	282	259	269
18) Percent Excess Air	29.09	28.98	28.93
19) Molecular Weight of Stack Gas, Dry	28.59	28.44	28.45
20) Molecular Weight of Stack Gas, Stk Cond.	0.99	0.98	0.98
21) Stack Gas Specific Gravity	1.519	1.521	1.466
22) Avg. Square Root (Vel Head), in H_2O	87.6	93	90
23) Average Stack Gas Temperature, Deg F	35.548	35.761	34.388
24) Avg. Square Root (Stk Temp x Vel Head)	0.83	0.83	0.83
25) Pitot Correction Factor	29.73	29.73	29.43
26) Stack Pressure, in Hg, Absolute	5186.3	5230.5	5054.9
27) Stack Gas Vel, Stack Cond, F.P.M.	8.95	8.95	8.95
28) Stack Area, Sq. Feet	8.95	8.95	8.95
29) Effective Stack Area, Square Feet	42608	42390	41001
30) Stack Gas Flow Rate, S.T.P., SCFMD	120	120	120
31) Net Time of Test, Minutes	0.125	0.125	0.125
32) Sampling Nozzle Diameter, Inches	107.8	104.7	109.6
33) Percent Isokinetic	2.9	10.6	2.2
34) Fluoride - Water Soluble, MG	2.9	10.6	2.2
35) Fluoride - Total, MG	0.0009	0.0032	0.0007
36) Fluoride - Water Soluble, GR/SCF	0.0009	0.0032	0.0007
37) Fluoride - Total, GR/SCF	0.0008	0.0029	0.0006
38) Fluoride - Water Sol., GR/CF,STK CND.	0.0008	0.0029	0.0006
39) Fluoride - Total, GR/CF,STK CND.	0.3105	1.1697	0.2319
40) Fluoride - Water Soluble, LB/HOUR	0.3105	1.1697	0.2319
41) Fluoride - Total, LB/HOUR	0.1071	0.4033	0.08
43) Fluoride - Water Sol., LB/TON P_2O_5 FED	0.1071	0.4033	0.08
44) Fluoride - Total, LB/TON P_2O_5 FED			

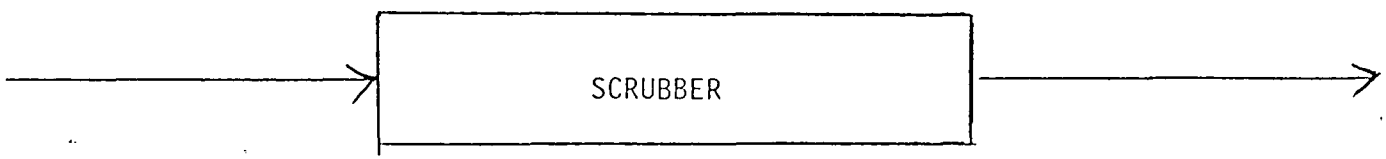
S.T.P. ↔DRY, 70 DEGREES F, 29.92 INCHES MERCURY

EMISSION DATA
BORDEN CHEMICAL
ROCK DEFLUORINATION
INLET

		1	2	3
1)	Run Number			
2)	Date	2/24/72	2/24/72	2/25/72
3)	Time Began	11:52	16:37	8:00
4)	Time End		18:32	
5)	Barometric Pressure, In Hg	30.3	30.3	30.3
6)	Meter Orifice Pressure Drop, in H_2O	1.18	0.3	0.32
7)	Vol Dry Gas, Meter Cond. Cubic Feet	49.87	17.257	34.07
8)	Average Gas Meter Temperature, Deg F	94.2	83.5	80
9)	Vol Dry Gas, S.T.P., Cubic Feet	48.433	17.054	33.89
10)	Total H_2O Collected, Ml	185.2	63.7	65.5
11)	Vol H_2O Vapor Collected, S.T.P., Cu.Ft.	8.78	3.02	3.1
12)	Stack Gas Moisture, Percent Volume	15.3	15	8.4
13)	Assumed Stack Gas Moisture, Pct Vol	15	15	15
14)	Percent CO_2	4	3	3.2
15)	Percent O_2	14.5	15.3	15.3
16)	Percent CO	0.2	0.2	0.2
17)	Percent N_2	81.3	81.5	81.3
18)	Percent Excess Air	199	235	237
19)	Molecular Weight of Stack Gas, Dry	29.22	29.09	29.12
20)	Molecular Weight of Stack Gas, Stk Cond.	27.5	27.42	28.19
21)	Stack Gas Specific Gravity	0.95	0.95	0.97
22)	Avg. Square Root (Vel Head), in H_2O	0.534	0.441	0.476
23)	Average Stack Gas Temperature, Deg F	725.6	725	758
24)	Avg. Square Root (Stk Temp x Vel Head)	18.398	15.167	16.615
25)	Pitot Correction Factor	0.83	0.83	0.83
26)	Stack Pressure, in Hg, Absolute	30.24	30.24	30.25
27)	Stack Gas Vel, Stack Cond, F.P.M.	2713.7	2240.2	2420
28)	Stack Area, Sq. Feet	17.72	17.72	17.72
29)	Effective Stack Area, Square Feet	17.72	17.72	17.72
30)	Stack Gas Flow Rate, S.T.P., SCFMD	18394	15258	17283
31)	Net Time of Test, Minutes	90.1	58	96
32)	Sampling Nozzle Diameter, Inches	.375-.25	0.25	0.25
33)	Percent Isokinetic	97.5	100.1	106.2
34)	Fluoride - Water Soluble, MG	9100	2800	5000
35)	Fluoride - Total, MG	9324	2893	5112
36)	Fluoride - Water Soluble, GR/SCF	2.8935	2.5284	2.2721
37)	Fluoride - Total, GR/SCF	2.9647	2.6123	2.3229
38)	Fluoride - Water Sol., GR/CF,STK CND.	1.1059	0.9711	0.915
39)	Fluoride - Total, GR/CF,STK CND.	1.1331	1.0033	0.3355
40)	Fluoride - Water Soluble, LB/HOUR	456.115	330.6146	336.5176
41)	Fluoride - Total, LB/HOUR	467.3424	341.5957	344.0556
43)	Fluoride - Water Sol., LB/TON P_2O_5 FED	157.281	114.005	116.0405
44)	Fluoride - Total, LB/TON P_2O_5 FED	161.1526	117.7916	118.6399

S.T.P. ↔DRY, 70 DEGREES F, 29.92 INCHES MERCURY*

BORDEN CHEMICAL
ROCK DEFLUORINATION
SCRUBBER EFFICIENCY



Run 1	Flow: 18394 (DSCFM) Total Fluoride: 467 (#/hr)	Efficiency: 99.9	Flow: 42608 Total Fluoride: 0.31
Run 2	Flow: 15258 Total Fluoride: 342	Efficiency: 99.6	Flow: 42390 Total Fluoride: 1.17
Run 3	Flow: 17283 Total Fluoride: 344	Efficiency: 99.9	Flow: 41001 Total Fluoride: 0.23

APPENDIX B

FIELD DATA

Velocity Traverse data (taken from meter data sheets) Test 2
Inlet

Velocity traverse data (taken from meter data sheets) Test 2
Outlet

Velocity traverse data (taken from meter data sheets) Test 3
Inlet

Velocity traverse data (taken from meter data sheets) Test 3
Outlet

Orsat Analyses

Preliminary velocity traverse data sheets and meter data sheets for the moisture run and three fluoride determination runs at the scrubber inlet and outlet sites are included in this section for the defluorination process. These data sheets are presented as follows:

Preliminary velocity traverse at inlet to scrubber

Preliminary velocity traverse at outlet of scrubber

Meter data sheet for moisture determination at inlet to scrubber

Meter data sheet for moisture determination at outlet to scrubber

Meter data sheet for fluoride determination at inlet to scrubber Test 1

Meter data sheet for fluoride determination at outlet to scrubber Test 1

Meter data sheet for fluoride determination at inlet to scrubber Test 2

Meter data sheet for fluoride determination at outlet to scrubber Test 2

Meter data sheet for fluoride determination at inlet to scrubber Test 3

Meter data sheet for fluoride determination at outlet to scrubber Test 3

Velocity traverse data (taken from meter data sheets) Test 1 Inlet

Velocity traverse data (taken from meter data sheets) Test 1 Outlet

GAS VELOCITY AND VOLUME DATA

Test No. PRELIMINARY

Location INLET - DEFLUOR.

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1	1.0	0.17	.412	700
2	1.83	0.18	.424	
3	3.14	0.19	.436	
4	4.50	0.20	.447	
5	6.00	0.21	.458	
6	7.50	0.23	.480	
7	9.20	0.26	.510	
8	11.10	0.27	.520	
9	13.10	0.28	.529	
10	15.50	0.28	.529	
11	18.40	0.29	.539	
12	22.70	0.30	.548	
13	34.40	0.23	.480	
14	38.60	0.21	.458	
15	41.50	0.20	.447	
16	44.00	0.18	.424	
17	46.00	0.17	.412	
18	47.70	0.22	.469	
19	49.50	0.20	.447	
20	51.00	0.17	.412	
21	52.50	0.16	.400	
22	54.00	0.15	.387	
23	55.20	0.14	.374	
24	56.30	0.11	.332	
Total		-	10.874	
Average		-	0.453	700

a) From outside of port to sampling point.

Pitot tube "S"

Manometer _____

Thermometer _____

Data Recorder G.F.

Date 2-24-72

Stack Inside Dimensions 57" I.D.

Stack Area, A_s = 17.72 sq. ft.

Barometric Pressure, P_b = 30.3 "Hg

Stack Gage Pressure = -0.75 "H_2O

Stack Abs. Pressure, P_s = $\frac{-0.75 \text{ "}H_2O}{13.6}$ + P_b = 30.23 "Hg

Stack Gas Temp., T_s = 700 °F + 460 = 1160 °R

Molecular Weight of Stack Gas, M_s = 29

$$V_s = 174 \sqrt{\Delta p}\ Cp \sqrt{T_s \times \frac{29.92}{P_s} \times \frac{29}{M_s}} \text{ ft/min.}$$

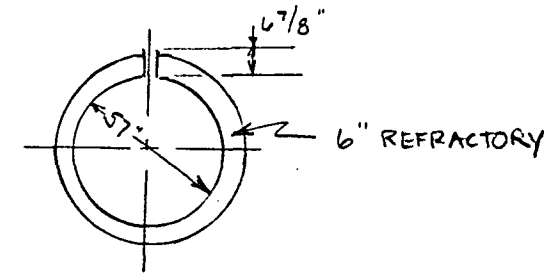
$$V_s = 174 \times .453 \times .85 \sqrt{1160 \times \frac{29.92}{30.23} \times \frac{29}{29}} = 2270$$

Q, Volume = 2270 ft/min. x 17.72 sq. ft. = 40,224 cfm

Q_w, Standard Volume at 70°F and 29.92 "Hg (Wet Basis) =

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 40{,}224 \times \frac{30.23}{1160} = 18{,}554$$

$Q_s = Q_w \times (100-W)/100$ = _____



PEDCo-ENVIRONMENTAL
SUITE 8 • ATKINSON SQUARE
CINCINNATI, OHIO 45246
513/771-4330

GAS VELOCITY AND VOLUME DATA

Test No. PRELIMINARY

Location BORDEN'S OUTLET- DEFLUORIUATIC

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1	0.65	1.90	1.378	90
2	2.00	2.00	1.414	
3	3.25	1.90	1.378	
4	5.10	2.00	1.414	
5	6.90	2.00	1.414	
6	9.00	2.10	1.449	
7	11.50	2.10	1.449	
8	15.25	2.10	1.449	
9	25.50	2.25	1.500	
10	29.00	2.30	1.516	
11	31.75	2.40	1.549	
12	34.00	2.40	1.549	
13	35.75	2.50	1.581	
14	37.20	2.20	1.483	
15	38.80	2.20	1.483	
16	40.00	2.20	1.483	
Total		-	23.489	
Average		-	1.468	90

a) From outside of port to sampling point.

Pitot tube _____

Manometer _____

Thermometer _____

Data Recorder LAE

Date 2-24-72

Stack Inside Dimensions 40.5" ϕ

Stack Area, A_s = 8.95 sq. ft.

Barometric Pressure, P_b = 30.3 "Hg

Stack Gage Pressure = -7.75 "H_2O

Stack Abs. Pressure, P_s = $\frac{-7.75 \text{ "}H_2O}{13.6}$ + P_b = 29.73 "Hg

Stack Gas Temp., T_s = 90 °F + 460 = 550 °R

Molecular Weight of Stack Gas, M_s = 29.0

$$V_s = 174 \sqrt{\Delta p}\ Cp \sqrt{T_s \times \frac{29.92}{P_s} \times \frac{29}{M_s}} \text{ ft/min.}$$

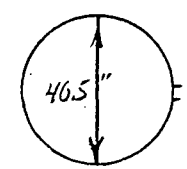
$$V_s = 174 \times 1.468 \times .85 \sqrt{550 \times \frac{29.92}{29.73} \times \frac{29}{29}} = 5108 \text{ FPM}$$

Q, Volume = 5108 ft/min. x 8.95 sq. ft. = 45,717 cfm

Q_w, Standard Volume at 70°F and 29.92 "Hg (Wet Basis) =

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 45{,}717 \times \frac{29.73}{550} = 43{,}740$$

$Q_s = Q_w \times (100-W)/100$ = _____



Horizontal

PEDCo-ENVIRONMENTAL
SUITE 8 • ATKINSON SQUARE
CINCINNATI, OHIO 45246
513/771-4330

PARTICULATE FIELD SAMPLING METER DATA

Plant BORDEN'S
Run Number MOISTURE TEST
Location INLET - DEFLUORIATION
Date 2-24-72 Time 10:00
Operator RSA
Sample Train Number 1
Meter Number 3
ΔH@ _____

Filter No. —
Barometric Pressure, in. Hg 30.3
Assumed Moisture, % —
Assumed Meter Temp., °F —
Stack Gage Pressure — "H_2O
Probe Tip Diameter, in. —
Condensate Collected, ml. 65.2
'C' Correction Factor —

Point	Time Min.	Dry Gas Meter			Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Filter Temp. °F	Impinger ~~or Condensor~~ Temp., °F	Stack Gas Temp., °F T_s
		Volume ft^3 Vm	Inlet Temp. °F	Outlet Temp. °F						
30" IN		9.650	78	76	—	—	17	—	65	700
		19.200	90	78	—	—	19	—	70	700
	30	26.455	96	82	—	—	22	—	75	710
Total	30	16,805	264	236	—	—	58	—	210	2110
Avg.	—	—	88	79	—	—	19	—	70	703

Leakage Rate @ 10 "Hg = 0.01 cfm

$$V_{m_s} = 16.805 \times \frac{530}{544} \times \frac{30.30}{29.92} = 16.58 \text{ SCF}$$

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PARTICULATE FIELD SAMPLING METER DATA

Plant BORDEN'S
Run Number MOISTURE TEST
Location OUTLET - DEFLUORINATION
Date 2-24-72 Time 9:00-9:30
Operator LAE & JFG
Sample Train Number 2
Meter Number 2
ΔH@ 1.39 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.3
Assumed Moisture, % —
Assumed Meter Temp., °F —
Stack Gage Pressure -7.75 "H_2O
Probe Tip Diameter, in. —
Condensate Collected, ml. 24.8
'C' Correction Factor —

Point	Time Min.	Dry Gas Meter			Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Filter Temp. °F	Impinger ~~or Condenser~~ Temp., °F	Stack Gas Temp., °F T_s
		Volume ft^3 Vm	Inlet Temp. °F	Outlet Temp. °F						
20" IN		938.10	94	71	—	—	14	—	53	85
	10	949.00	106	74	—	—	14	—	55	85
	20	958.70	110	79	—	—	14	—	57	85
	30	967.90								
Total	30	29.80	310	224	—	—	42	—	165	255
Avg.	—	—	103	75	—	—	14	—	55	85

Leakage Rate @ 15 "Hg = 0.0 cfm

$$V_{m_s} = 29.80 \times \frac{530}{549} \times \frac{30.30}{29.92} = 29.13 \text{ SCF}$$

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PARTICULATE FIELD SAMPLING METER DATA

Plant BORDEN'S
Run Number 1
Location DEFLUOR. - INLET
Date 2-24-72 Time 11:52
Operator RSA & GF
Sample Train Number 1
Meter Number 3
ΔH@ 1.52 @ 0.75 CFM

Filter No. -
Barometric Pressure, in. Hg 30.30
Assumed Moisture, % 15
Assumed Meter Temp., °F 100
Stack Gage Pressure -0.75 "H_2O
Probe Tip Diameter, in. 3/8 & 1/4
Condensate Collected, ml. 185.2
'C' Correction Factor 0.74

Point	Time Min.	Dry Gas Meter			Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Filter Temp. °F	Impinger ~~or Condenser~~ Temp., °F	Stack Gas Temp., °F T_s
		Volume ft^3 Vm	Inlet Temp. °F	Outlet Temp. °F						
1	10	26.540	86	86	0.26	1.9	3.5	-	62	720
2	10	33.620	97	86	0.31	2.0	8.0	-	66	730
3	10	42.320	106	88	0.30	2.2	12.0	-	67	730
4 *	10	50.900	106	90	0.31	2.3/*.46	20.0	-	68	730
5	10	58.580	92	90	0.35	.52	4.0	-	72	710
6	10	62.820	96	90	0.37	.54	10.0	-	69	730
7	10	66.730	100	90	0.25	.35	7.0	-	70	730
8	10	70.630	102	92	0.22	.32	8.0	-	72	730
9	10	74.190	102	93	0.22		9.0	-	72	720
10	10	76.410								
11	5SEC									
12	-									
Total	90.1	49.870	887	805		10.59	81.5	-	618	6530
Avg.			99	89		1.18	9.1	-	69	726

Leakage Rate @ 15 "Hg = 0.01 cfm

*-CHANGED TO 1/4" NOZZLE - CAN'T MAINTAIN FLOW WITH 3/8"
-32 MIN-15 SEC, 52.66 CF, CHANGED FILTER & FILTER HOLDER
-PUMP PRESSURE @ 20" Hg. - COULDN'T MAINTAIN ΔH
-PROBE CLOGGED

$V_{mc} = 49.870 \times \frac{530}{554} \times \frac{30.43}{29.92} = 48.32$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant BORDEN'S
Run Number 1
Location DEFLUOR. - OUTLET
Date 2-24-72 Time 12:01
Operator LAE - JFG
Sample Train Number 2
Meter Number 2
ΔH@ 1.39 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.3
Assumed Moisture, % 6
Assumed Meter Temp., °F 100
Stack Gage Pressure -7.75 "H_2O
Probe Tip Diameter, in. 1/8
Condensate Collected, ml. 52.4
'C' Correction Factor 0.77

Point	Time Min.	Dry Gas Meter			Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Filter Temp. °F	Impinger ~~or Condenser~~ Temp., °F	Stack Gas Temp., °F T_s
		Volume ft^3 Vm	Inlet Temp. °F	Outlet Temp. °F						
1	10	968.03	88	86	2.0	0.41	5	—	56	87
2	10	972.30	93	88	2.2	0.45	5	—	54	87
3	10	976.70	98	88	1.8	0.37	5	—	57	87
4	10	980.80	100	90	2.0	0.41	5	—	56	90
5	10	985.00	103	90	2.1	0.43	5	—	56	90
6	10	989.40	104	91	2.3	0.47	5	—	56	90
7	10	993.90	104	92	2.5	0.50	5	—	56	87
8	10	998.60	106	92	2.5	0.50	5	—	56	87
9	10	1003.30	106	93	2.5	0.50	5	—	57	85
10	10	1008.00	110	94	2.7	0.54	5	—	57	87
11	10	1012.90	110	94	2.7	0.54	6.5	—	57	87
12	10	1017.70	110	94	2.5	0.50	7.5	—	57	87
		1022.50	110	94						
Total	120	54.47	1342	1186		5.62	640	—	675	1051
Avg.			103	91		.47	5.3	—	56	88

Leakage Rate @ 15 "Hg = 0.0 cfm

$V_{ms} = 54.47 \times \frac{530}{557} \times \frac{36.3}{29.92} = 52.49$ scf

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PARTICULATE FIELD SAMPLING METER DATA

Plant BORDENS
Run Number 2
Location DEFLUOR. - INLET
Date 2-24-72 Time 4:37—6:32
Operator GF & RSA
Sample Train Number
Meter Number
ΔH@ 1.52 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.3
Assumed Moisture, % 15
Assumed Meter Temp., °F 100
Stack Gage Pressure -0.75 "H_2O
Probe Tip Diameter, in. 0.250
Condensate Collected, ml. 63.7
'C' Correction Factor 0.74

Point	Time Min.	Dry Gas Meter			Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Filter Temp. °F	Impinger ~~or Condenser~~ Temp., °F	Stack Gas Temp., °F T_s
		Volume ft^3 Vm	Inlet Temp. °F	Outlet Temp. °F						
1	8	78.565	84	84	0.16	0.24	4	—	75	720
2	8	80.570	86	84	0.22	0.31	4	—	72	735
3	8	83.370	86	84	0.27	0.39	10	—	69	725
4	8	86.480	88	83	0.08 - ?	0.12	11 - 21	—	69	720
5	8 *	89.160	82	82	0.25	0.37	5	—	70	725
6	8**	92.290	80	80	0.27	0.39	19	—	70	720
7	8***	95.070			0.23		25	—		
8	2	95.822			0.21		26	—		720
9	—				0.19					
10	—				0.17					
11	—				0.17					
12	—				0.16					
Total	58	17.257	506	497		1.82	125	—	425	5065
Avg.			84	83		.30	14	—	71	724

Leakage Rate @ 15 "Hg = 0.01 cfm

* STOPPED TESTING TO UNPLUG PROBE - SWITCHED FROM S.S. TO GLASS PROBE
35 MIN - 40 SEC INTO TEST
** STOPPED TESTING - PROBE CLOGGED
*** STOPPED IN BETWEEN POINTS — 43 MIN, 49 SEC INTO TEST

$V_{ms} = 17.257 \times \frac{536}{544} \times \frac{30.3}{29.92} = 17.03$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant BORDEN'S
Run Number 2
Location DEFLUOR. OUTLET
Date 2-24-72 Time 4:20-6.20 PM
Operator LAE & JFG
Sample Train Number 2
Meter Number
ΔH@ 1.39 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.3
Assumed Moisture, % 5
Assumed Meter Temp., °F 100
Stack Gage Pressure -7.75 "H_2O
Probe Tip Diameter, in. 1/8"
Condensate Collected, ml. 55.3
'C' Correction Factor 0.77

Point	Time Min.	Dry Gas Meter Volume ft^3 Vm	Dry Gas Meter Inlet Temp. °F	Dry Gas Meter Outlet Temp. °F	Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Filter Temp. °F	Impinger ~~or Condensor~~ Temp., °F	Stack Gas Temp., °F T_s
1	10	22.60	86	80	1.9	0.385	6.0	-	55	90
2	10	26.40	90	80	2.0	0.41	6.5	-	56	90
3	10	30.30	98	80	2.0	0.41	7.0	-	56	90
4	10	34.34	100	82	2.0	0.41	7.5	-	56	90
5	10	38.40	100	84	2.0	0.41	7.5	-	56	90
6	10	42.45	100	84	2.1	0.43	8.0	-	55	95
7	10	46.60	100	84	2.5	0.50	8.5	-	54	95
8	10	51.00	102	84	2.6	0.53	9.0	-	54	95
9	10	55.80	102	84	2.7	0.54	9.0	-	55	95
10	10	60.40	102	83	2.7	0.54	9.0	-	52	95
11	10	65.15	102	82	2.9	0.57	9.0	-	51	95
12	10	70.00	100	80	2.5	0.50	9.0	-	52	95
		74.54								
Total	120	51.94	1182	987		5.64	96.0	-	652	1115
Avg.			99	82		.47	8.0	-	54	93

Leakage Rate @ 15 "Hg = 0.0 cfm

$$V_{ms} = 51.94 \times \frac{530}{551} \times \frac{30.3}{29.92} = 50.595 \text{ SCF}$$

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PARTICULATE FIELD SAMPLING METER DATA

Plant BORDEN'S

Run Number 3

Location DEFLUOR. INLET

Date 2-25-72 Time 9:00

Operator RSA & GF

Sample Train Number 1

Meter Number 3

ΔH@ 1.52 @ 0.75 CFM

Filter No. —

Barometric Pressure, in. Hg 30.3

Assumed Moisture, % 15

Assumed Meter Temp., °F 110

Stack Gage Pressure −0.70 "H_2O

Probe Tip Diameter, in. 0.250

Condensate Collected, ml. 65.5

'C' Correction Factor 0.75

Point	Time Min.	Dry Gas Meter			Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Filter Temp. °F	Impinger ~~or Condenser~~ Temp., °F	Stack Gas Temp., °F T_s
		Volume ft^3 Vm	Inlet Temp. °F	Outlet Temp. °F						
1	8	96.73	69	69	.31 → .20	.44 → .28	5	—	68	760
2	8	99.84	72	69	0.27	0.38	4	—	68	770
3	8	102.94	78	70	0.28	0.39	5	—	68	760
4	8	106.09	80	73	0.27	0.38	5	—	68	765
5	8	109.22	82	75	0.28	0.39	5	—	68	765
6	8	112.60	86	77	0.27	0.38	5	—	68	760
7	8	115.80	86	78	0.20	0.28	5	—	68	755
8	8	118.60	87	79	0.17	0.24	6	—	68	755
9	8	121.37	89	80	0.18	0.26	5	—	69	750
10	8 *	123.82	88	81	0.19	0.27	6-18	—	69	750
11	8	126.06	85	82	0.17	0.24	4	—	70	750
12	8	128.60	86	82	0.19	0.27	6-20	—	70	755
		130.80	90	84	0.20	0.28	10	—	70	757
Total	96	34.07	1078	999		4.48	109	—	892	9852
Avg.			83	77		0.32	7.3	—	69	758

Leakage Rate @ 15 "Hg = 0.0 cfm

* STOPPED TO FREE PROBE OF BUILD-UP BY TAPPING

$$V_{ms} = 34.07 \times \frac{530}{540} \times \frac{30.3}{29.92} = 33.86 \text{ SCF}$$

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PARTICULATE FIELD SAMPLING METER DATA

Plant BORDEN'S
Run Number 3
Location DEFLUOR. - OUTLET
Date 2-25-72 Time 9:10
Operator LAE / JEG
Sample Train Number 2
Meter Number 2
ΔH@ 1.39 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.0
Assumed Moisture, % 6
Assumed Meter Temp., °F 100
Stack Gage Pressure -7.75 "H_2O
Probe Tip Diameter, in. .125
Condensate Collected, ml. 49.7
'C' Correction Factor 0.77

Point	Time Min.	Dry Gas Meter			Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Filter Temp. °F	Impinger ~~or Condenser~~ Temp., °F	Stack Gas Temp., °F T_s
		Volume ft^3 Vm	Inlet Temp. °F	Outlet Temp. °F						
1	10	74.64	72	66	1.5	0.32	5	-	48	90
2	10	78.40	80	70	1.5	0.32	5	-	50	90
3	10	82.00	84	70	1.7	0.35	5	-	51	90
4	10	85.90	88	72	1.7	0.35	5	-	51	90
5	10	89.85	90	76	2.0	0.41	5	-	52	90
6	10	94.00	93	79	2.2	0.45	6	-	52	90
7	10	98.30	97	80	2.5	0.50	6	-	53	90
8	10	103.10	100	81	2.7	0.54	6	-	53	90
9	10	107.90	100	81	2.7	0.54	6	-	53	90
10	10	112.80	102	82	2.7	0.54	6	-	54	90
11	10	117.80	103	84	2.5	0.50	7	-	56	90
12	10	122.54	103	84	2.4	0.49	7	-	57	90
		127.23								
Total	120	52.59	1112	925		5.31	69.0	—	630	1080
Avg.			93	77		.44	5.8	—	53	90

Leakage Rate @ 15 "Hg = 0.0 cfm

$$V_{ms} = 52.59 \times \frac{530}{545} \times \frac{30.0}{29.92} = 51.28 \text{ SCF}$$

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GAS VELOCITY AND VOLUME DATA

Test No. 1

Location DEFLUOR. INLET

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1	1.1+7= 8.7	0.26	.510	720
2	3.8+7=10.8	0.31	.557	730
3	6.7+7=13.7	0.30	.548	730
4 *	10.1+7=17.1	0.31	.557	730
5	14.2+7=21.2	0.35	.592	710
6	20.2+7=27.2	0.37	.608	730
7	36.8+7=43.8	0.25	.500	730
8	42.7+7=49.7	0.22	.469	730
9	46.8+7=53.8	0.22	.469	720
10	50.2+7=57.2	-	-	-
11	53.0+7=60.0	-	-	-
12	55.8+7=62.8	-	-	-
Total		-	4.810	6530
Average		-	0.534	726

a) From outside of port to sampling point.

Pitot tube "S" TYPE

Manometer _____

Thermometer _____

Data Recorder RSA ; GE

Date 2-24-72

Stack Inside Dimensions 57" ID

Stack Area, A_s = 17.72 sq. ft.

Barometric Pressure, P_b = 30.3 "Hg

Stack Gage Pressure = -0.75 "H_2O

Stack Abs. Pressure, P_s = $-.06 \frac{\text{"}H_2O}{13.6} + P_b$ = 30.24 "Hg

Stack Gas Temp., T_s = 726 °F + 460 = 1186 °R

Molecular Weight of Stack Gas, M_s = 29

$$V_s = 174 \sqrt{\Delta p}\ Cp \sqrt{T_s \times \frac{29.92}{P_s} \times \frac{29}{M_s}}\ \text{ft/min.}$$

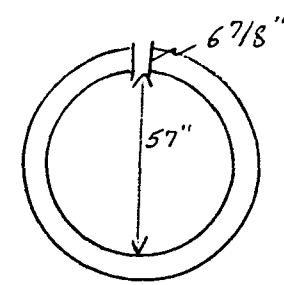
$$V_s = 174 \times .534 \times .85 \sqrt{1186 \times \frac{29.92}{30.24} \times \frac{29}{29}} = 2706$$

Q, Volume = 2706 ft/min. x 17.72 sq. ft. = 47,950 cfm

Q_w, Standard Volume at 70°F and 29.92 "Hg (Wet Basis) =

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times \frac{47,950}{1} \times \frac{30.24}{1186} = 21,640$$

$Q_s = Q_w \times (100-W)/100$ = _____



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GAS VELOCITY AND VOLUME DATA

Test No. 1

Location DEFLUOR - OUTLET

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1	0.8	2.0	1.414	87
2	2.7	2.2	1.483	87
3	4.8	1.8	1.341	87
4	7.2	2.0	1.414	90
5	10.1	2.1	1.449	90
6	14.4	2.3	1.517	90
7	26.1	2.5	1.581	87
8	30.4	2.5	1.581	87
9	33.2	2.5	1.581	85
10	35.8	2.7	1.643	87
11	37.8	2.7	1.643	87
12	39.6	2.5	1.581	87
Total		-	18.228	1051
Average		-	1.519	88

a) From outside of port to sampling point.

Pitot tube "S" TYPE

Manometer _____

Thermometer _____

Data Recorder LAE

Date 2-24-72

Stack Inside Dimensions 40.5" ϕ

Stack Area, A_s = 8.95 sq. ft.

Barometric Pressure, P_b = 30.3 "Hg

Stack Gage Pressure = -7.75 "H_2O

Stack Abs. Pressure, P_s = $-7.75 \frac{\text{"}H_2O}{13.6} + P_b$ = 29.73 "Hg

Stack Gas Temp., T_s = 88 °F + 460 = 548 °R

Molecular Weight of Stack Gas, M_s = 29

$$V_s = 174 \sqrt{\Delta p}\ Cp \sqrt{T_s \times \frac{29.92}{P_s} \times \frac{29}{M_s}} \text{ ft/min.}$$

$$V_s = 174 \times 1.519 \times .85 \sqrt{548 \times \frac{29.92}{29.73} \times \frac{29}{29}} = 5276$$

Q, Volume = 5276 ft/min. x 8.95 sq. ft. = 47,220 cfm

Q_w, Standard Volume at 70°F and 29.92 "Hg (Wet Basis) =

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 47{,}220 \times \frac{29.73}{548} = 45{,}343$$

$Q_s = Q_w \times (100-W)/100$ = _____

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CINCINNATI, OHIO 45246
513/771-4330

GAS VELOCITY AND VOLUME DATA

Test No. 2

Location DEFLUOR. INLET BORDENS

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1		0.16	.400	720
2		0.22	.469	735
3		0.27	.520	725
4		0.08 ?	void	720
5		0.25	.500	725
6		0.27	.520	720
7		0.23	.480	
8		0.21	.458	720
9		0.19	.436	
10		0.17	.412	
11		0.17	.412	
12		0.16	.400	
Total		-	5.007	5065
Average		-	.455	724

a) From outside of port to sampling point.

Pitot tube "S" TYPE

Manometer _____

Thermometer _____

Data Recorder RSA / GF

Date 2-24-72

Stack Inside Dimensions 57" I.D.

Stack Area, A_s = 17.72 sq. ft.

Barometric Pressure, P_b = 30.3 "Hg

Stack Gage Pressure = -0.75 "H_2O

Stack Abs. Pressure, P_s = $\frac{-.06}{13.6}$ "H_2O + P_b = 30.24 "Hg

Stack Gas Temp., T_s = 724 °F + 460 = 1184 °R

Molecular Weight of Stack Gas, M_s = 29

$$V_s = 174 \sqrt{\Delta p}\ Cp \sqrt{T_s \times \frac{29.92}{P_s} \times \frac{29}{M_s}}\ \text{ft/min.}$$

$$V_s = 174 \times .455 \times .85 \sqrt{1184 \times \frac{29.92}{30.24} \times \frac{29}{29}} = 2303$$

Q, Volume = 2303 ft/min. x 17.72 sq. ft. = 40,809 cfm

Q_w, Standard Volume at 70°F and 29.92 "Hg (Wet Basis) =

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 40{,}809 \times \frac{30.24}{1184} = 18{,}448$$

$Q_s = Q_w \times (100-W)/100$ = _____

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PARTICULATE SOURCE SAMPLING CALCULATIONS

TEST NO. _____

DATE _____

LOCATION _____

_____

$$V_{m_s} = 17.71\ V_m \times \frac{(P_b + \frac{\Delta H}{13.6})}{(460 + T_m)}$$

V_c, Condensate Volume, $(V_f - V_i)$ = _____ ml. (From Sample Train)

Equiv. Cond. Vapor Vol., $V_{w_c} = 0.0474 \times V_c = 0.0474 \times$ _____ = _____ scf at 70°F.

Total Gas Volume, $V_t = V_{m_s} + V_{w_c}$ = _____ + _____ = _____ scf

Net Sample Wt., M_n = _____ gms.

Concentration, $C = \frac{M_n \times 15.43}{V_t}$ = _____ grains/scf at 70°F and 29.9" Hg, stack conditions

Emission Rate = C _____ x Qw _____ x 0.00857 = _____ lbs/hr. of Particulate

GAS VELOCITY AND VOLUME DATA

Test No. 2

Location DEFLUOR. OUTLET BORDEN'S

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1		1.90	1.378	90
2		2.00	1.414	90
3		2.00	1.414	90
4		2.00	1.414	90
5		2.00	1.414	90
6		2.10	1.449	95
7		2.50	1.581	95
8		2.60	1.612	95
9		2.70	1.643	95
10		2.70	1.643	95
11		2.90	1.703	95
12		2.50	1.581	95
Total		-	18.246	1115
Average		-	1.521	93

a) From outside of port to sampling point.

Pitot tube "S" TYPE

Manometer _____

Thermometer _____

Data Recorder LAE & JFG

Date 2-24-72

Stack Inside Dimensions 40.5" ϕ

Stack Area, A_s = 8.95 sq. ft.

Barometric Pressure, P_b = 30.3 "Hg

Stack Gage Pressure = -7.75 "H_2O

Stack Abs. Pressure, P_s = $\frac{-7.75}{13.6}$ "H_2O + P_b = 29.73 "Hg

Stack Gas Temp., T_s = 93 °F + 460 = 553 °R

Molecular Weight of Stack Gas, M_s ≈ 29

$$V_s = 174 \sqrt{\Delta p}\ Cp \sqrt{T_s \times \frac{29.92}{P_s} \times \frac{29}{M_s}}\ \text{ft/min.}$$

$$V_s = 174 \times 1.521 \times .85 \sqrt{553 \times \frac{29.92}{29.73} \times \frac{29}{29}} = 5307$$

Q, Volume = 5307 ft/min. x 8.95 sq. ft. = 47,498 cfm

Q_w, Standard Volume at 70°F and 29.92 "Hg (Wet Basis) =

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 47{,}498 \times \frac{29.73}{553} = 45{,}198$$

$Q_s = Q_w \times (100-W)/100$ = _____

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GAS VELOCITY AND VOLUME DATA

Test No. 3

Location DEFLUOR, INLET BORDEN'S

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1		.31 → .20	.500	760
2		0.27	.520	770
3		0.28	.529	760
4		0.27	.520	765
5		0.28	.529	765
6		0.27	.520	760
7		0.20	.447	755
8		0.17	.412	755
9		0.18	.424	750
10		0.19	.436	750
11		0.17	.412	750
12		0.19	.436	755
				757
Total		-	5.685	9852
Average		-	.474	758

a) From outside of port to sampling point.

Pitot tube "S" TYPE

Manometer _____

Thermometer _____

Data Recorder RSA ; GF

Date 2-25-72

Stack Inside Dimensions 57" I.D.

Stack Area, A_s = 17.72 sq. ft.

Barometric Pressure, P_b = 30.3 "Hg

Stack Gage Pressure = −0.70 "H_2O

Stack Abs. Pressure, P_s = $\frac{-0.70}{13.6}$ "H_2O + P_b = 30.25 "Hg

Stack Gas Temp., T_s = 758 °F + 460 = 1218 °R

Molecular Weight of Stack Gas, M_s = 29

$$V_s = 174 \sqrt{\Delta p}\ Cp \sqrt{T_s \times \frac{29.92}{P_s} \times \frac{29}{M_s}}\ \text{ft/min.}$$

$$V_s = 174 \times .474 \times .85 \sqrt{1218 \times \frac{29.92}{30.25} \times \frac{29}{29}} = 2433$$

Q, Volume = 2433 ft/min. x 17.72 sq. ft. = 43,113 cfm

Q_w, Standard Volume at 70°F and 29.92 "Hg (Wet Basis) =

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 43{,}113 \times \frac{30.25}{1218} = 18{,}952$$

$Q_s = Q_w \times (100-W)/100$ = _____

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GAS VELOCITY AND VOLUME DATA

Test No. 3

Location DEFLUOR - OUTLET BORDEN'S

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1		1.5	1.225	90
2		1.5	1.225	90
3		1.7	1.303	90
4		1.7	1.303	90
5		2.0	1.414	90
6		2.2	1.483	90
7		2.5	1.581	90
8		2.7	1.643	90
9		2.7	1.643	90
10		2.7	1.643	90
11		2.5	1.581	90
12		2.4	1.549	90
Total		-	17.593	1080
Average		-	1.466	90

Stack Inside Dimensions 40.5" ϕ

Stack Area, A_s = 8.95 sq. ft.

Barometric Pressure, P_b = 30.0 "Hg

Stack Gage Pressure = -7.75 "H_2O

Stack Abs. Pressure, P_s = $\frac{-7.75 \text{ "}H_2O}{13.6}$ + P_b = 29.43 "Hg

Stack Gas Temp., T_s = 90 °F + 460 = 550 °R

Molecular Weight of Stack Gas, M_s = 29

$$V_s = 174 \sqrt{\Delta p}\ Cp \sqrt{T_s \times \frac{29.92}{P_s} \times \frac{29}{M_s}} \text{ ft/min.}$$

$$V_s = 174 \times 1.466 \times .85 \sqrt{550 \times \frac{29.92}{29.43} \times \frac{29}{29}} = 5127 \text{ FPM}$$

Q, Volume = 5127 ft/min. x 8.95 sq. ft. = 45,887 cfm

Q_w, Standard Volume at 70°F and 29.92 "Hg (Wet Basis) =

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 45{,}887 \times \frac{29.43}{550} = 43{,}460$$

$Q_s = Q_w \times (100-W)/100$ = _____

a) From outside of port to sampling point.

Pitot tube "S" TYPE

Manometer _____

Thermometer _____

Data Recorder LAE & JFG

Date _____

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COMBUSTION GAS ANALYSIS

Plant BORDEN CHEM CO. Comments:

Location PLANT CITY DEFLUORINATION

Date FEB. 24+25, 1972

Operator R. GERSTLE

Test No. Time	%(CO_2)	%(O_2)	%(CO)
1 INLET 1:00 PM	4.0	14.5	< 0.2
1 OUTLET	2.8	16.0	< 0.2
2 INLET 6:30	3.0	15.3	< 0.2
2 OUTLET	2.2	15.8	< 0.2
2-25-72 3 INLET 9:50 AM	3.2	15.3	< 0.2
3 OUTLET	1.8	16.0	< 0.2

NOTE: Analyses are on a dry basis when performed by Orsat.

$$\% \text{ EXCESS AIR} = \frac{100(\%O_2 - 0.5\%CO)}{0.264(\%N_2) - (\%O_2 - 0.5\%CO)}$$

$$\%N_2 = 100 - (\%O_2 + \%CO_2 + \%CO)$$

APPENDIX C

TEST LOG

February 24, 1972 Partly Cloudy 60-75°F

A.M.

7:45 Arrive at plant and set up equipment at defluorination process.

8:30 Make preliminary pitot and temperature traverse. Inlet site is only at 700°F - checked with thermocouple and dial thermometer. Less gas flow measured at inlet when compared to outlet.

9:30-10:30 Make moisture runs.

11:55 Start fluoride test 1 on this process. Use 1/2" stainless steel probe at inlet site.

P.M.

12:00 Scrubber water samples taken. Inlet scrubber water is taken in lagoon at pump suction, temp.=80°F. Discharge is taken in pipe leading to pond.

12:35 Inlet sampling train can't maintain flow due to plugged nozzle. Change from 3/8 to 1/4" nozzle. Wash out 3/8" nozzle into sample container.

1:00 Orsat Sample.

1:45 Inlet nozzle and/or probe is plugged on inlet train again. Replaced nozzle, but still plugged. Stop sampling after 58 minutes of sample time.

2:00 Complete outlet test.

2:15 Take scrubber water samples.

2:30- 3:00 State of Florida sampling at outlet site.

4:20 Start test no. 2 at outlet.

4:35 Start test no. 2 at inlet - use 12 points at 8 minutes each since train cannot contain a 2 hour sample.

4:45 Scrubber water samples.

5:00 Inlet train plugged again. Changed to new nozzle and probe; continued for another hour.

6:00 Opacity <10%.

6:20 Complete outlet sample and discontinue inlet sampling.

6:25 Scrubber water sample 91°F at inlet to scrubber
104°F at discharge of scrubber

6:30 Orsat analyses

NOTE: Outlet train filter was greenish-yellow in color.

8:00 Leave plant.

February 25, 1972 Partly Cloudy 60-75°F

A.M.

7:45 Arrive at plant.

9:00 Start Run 3, inlet train to run 8 minutes at each of 12 points.

9:20 Scrubber water sample. Water inlet 85°F pH ≈ 6.5
Water outlet 100°F pH ≈ 3.2

9:50 Orsat analyses.

NOTE: Visible fume is passing through first three impingers and filter on inlet train and is apparently reacting with silica gel. Silica gel very dark at completion of test.

10:25 Scrubber water sample.

10:30 Opacity = 10%.

Inlet probe requires tapping with screwdriver to prevent plugging.

10:45 Complete inlet sample.

11:00 Complete outlet sample.

11:00-12:30 Clean up trains and pack all equipment.

12:30 Leave plant.

APPENDIX D

PROJECT PARTICIPANTS

Project Participants and Titles

PEDCo-ENVIRONMENTAL SPECIALISTS, INC.

Richard W. Gerstle, P.E., Engineer in charge of sampling

Larry A. Elfers, Chemist

Robert S. Amick, Engineer

Gene Forte, Technician

Joseph Geiger, Technician

EPA

J. Rom - In charge of sampling

L. Evans - In charge of process operations liaison

APPENDIX E

RECOMMENDATIONS

Recommendations

The sampling train used during these tests was apparently not capable of absorbing high concentrations of fluorides. This was evident at the inlet sampling site on the defluorination process where the silica gel in the fourth impinger became very dark in color and was apparently affected by fluorides passing into this impinger. We recommend a strong reducing agent such as sodium arsenite and/or a strong basic solution be used in the impingers whenever high concentrations of fluorides and free fluorine are suspected. As used in these tests, the collection efficiency of the sampling train is probably less than 95%. Further studies of sampling fluorides in percentage quantities appears necessary.