TEST NUMBER 72-CI-16

INTERNATIONAL MINERALS AND CHEMICALS
SUPER PHOSPHORIC ACID
BARTOW, FLORIDA

February 28-March 1, 1972

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

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Prepared by

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By

PEDCo-Environmental Specialists, Inc.
Cincinnati, Ohio

Contract No. 68-02-0237, Task 2

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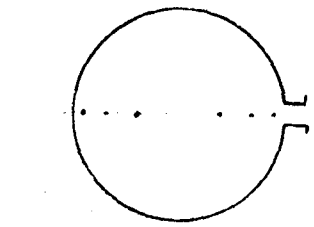
I. INTRODUCTION

Stack emission tests were conducted, and related process samples were taken during the period February 28 to March 1, 1972, at the International Mineral and Chemical Company's superphosphoric acid plant in Bartow, Florida.

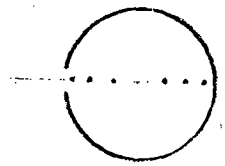
According to the terms of PEDCo's contract with EPA, only stack gas measurements, selected feed and product samples, and scrubber water samples were to be taken by PEDCo. Stack gas samples were taken at points designated by EPA. All process data and operating procedures were obtained by EPA personnel. Sample analyses and emission calculations were also to be performed by EPA staff.

Three tests were made to determine total fluoride emissions before and after the scrubber serving the superphosphoric acid plant. In this process, fumes from the plant's acid recycle tank, and the vent serving the product storage tank and barometric seal tank are directed into a combination venturi scrubber and packed bed scrubber in series before entering the atmosphere. Samples were taken simultaneously in the two lines entering the scrubber system, and in the single duct leaving the scrubber. Figure 1 shows the equipment layout and the locations of the sampling sites.



Detail of Outlet
Sampling Site
Point E

Detail of Inlet
Sampling Site from
Recycle Acid Tank
Point C_1



Detail of Inlet
Sampling Site from
Barometric Seal Tank
Point C_2

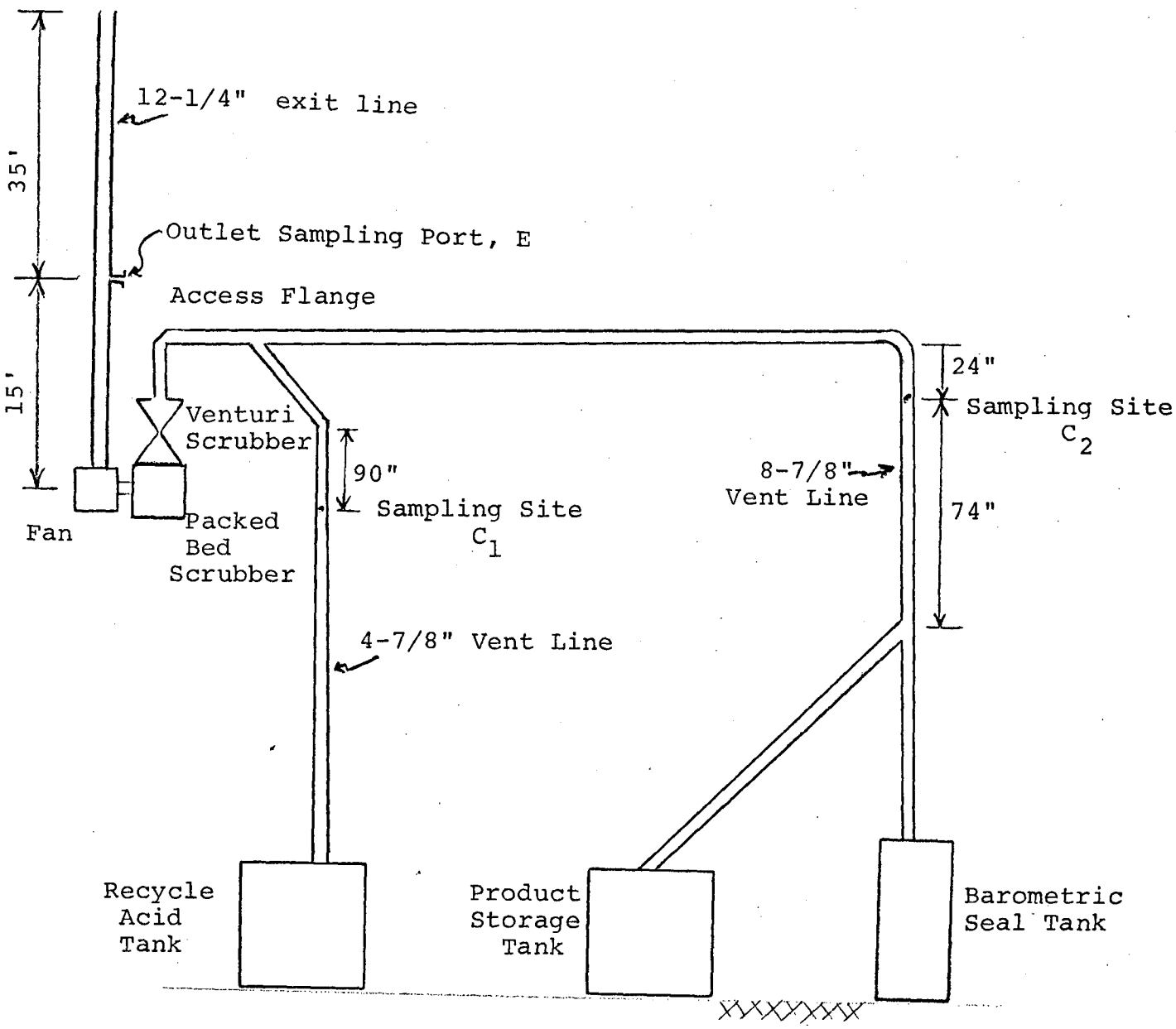


FIGURE 1 DUCTWORK AND SAMPLING SITES AT IMC SUPERPHOSPHORIC ACID PLANT

Three sets of samples were taken to determine total fluoride content of the gas streams. Moisture, carbon dioxide, and oxygen contents of the gas streams were also measured; velocity, temperature and total gas flow were determined for each test. Samples of feed, product, and recycle acid were taken during each run, as well as scrubber water samples. Each stack gas sample extended over a two hour period.

II. SUMMARY OF RESULTS

During the first two runs, the plant was operating under normal process conditions. However, during the third test some puffing of gases was noticed at the inlet ducts and the flow rates were slightly lower indicating that the scrubber could have been partially plugged up.

Tests on the vent leading to the scrubber from the recycle acid tank were characterized by extremely high fluoride concentrations. This high concentration of what was apparently silicon tetrafluoride caused plugging problems in the sampling train. In addition, reactions between HF, SiF_4, and H_2O in the impinger depleted the water in the impingers, formed a white precipitate, and caused a reduced fluoride collection efficiency for this train.

A fume was exiting from the sample train pump. For this reason fluoride concentrations reported for the recycle tank inlet to the scrubber are probably lower than the true values.

Total measured vent gas flows were greater on the scrubber outlet as compared to the two inlet lines. This is partly due to the leaks around the scrubber which caused ambient air to leak into the scrubber and connecting duct work.

A complete summary of stack gas conditions and emission levels for each test run are given in Tables 1 - 3.

Table 1
Summary of Results
Inlet - Recycle Tank

Run Number	1	2	3
Date	2/29/72	2/29/72	3/1/72
Stack pressure, inches Hg	30.2	30.2	30.2
Stack gas moisture, % volume	15.8	8	9.7
Average stack gas temperature, °F.	206	225	207
Stack gas flow rate @ S.T.P.*, SCFM	165	146	138
Vol. Gas Sampled @ S.T.P.*, SCF	37.9	24.7	16.2
Fluoride, water soluble, mg	115000	30200	171000
Fluoride, total, mg	115033.4	30210.5	171099
Fluoride, water soluble, gr/SCF	46.7	18.9	162.1
Fluoride, total, gr/SCF	46.7	18.9	162.2
Fluoride, water soluble, gr/CF stk. cond.	31.3	13.4	118.6
Fluoride, total, gr/CF stk. cond.	31.3	13.4	118.7
Fluoride, water soluble, lb/hour	66.1	23.6	192.3
Fluoride, total, lb/hour	66.1	23.6	192.4
Fluoride, water soluble, lb/ton P_2O_5 Fed.	2.9	1.1	8.7
Fluoride, total, lb/ton P_2O_5 Fed.	2.9	1.1	8.7

* Dry, 70°F., 29.92 inches Hg.

Table 2
Summary of Results
Inlet - Seal Tank

Run No.	1	2	3
Date	2/29/72	2/29/72	3/1/72
Stack pressure, inches Hg	30.2	30.2	30.2
Stack gas moisture, % volume	2.7	2.5	2.0
Average stack gas temperature, °F.	161	170	154
Stack gas flow rate @ S.T.P.*, SCFM	319	357	288
Vol. gas sampled @ S.T.P.*, SCF	74.4	77.0	62.9
Fluoride, water soluble, mg	3900	2100	5400
Fluoride, total, mg	3921	2103	5416
Fluoride, water soluble, gr/SCF	0.81	0.42	1.32
Fluoride, total, gr/SCF	0.81	0.42	1.33
Fluoride, water soluble, gr/CF stk. cond.	0.67	0.34	1.12
Fluoride, total, gr/CF stk. cond.	0.68	0.35	1.12
Fluoride, water soluble, lb/hour	2.2	1.3	3.3
Fluoride, total, lb/hour	2.2	1.3	3.3
Fluoride, water soluble, lb/ton P_2O_5 Fed.	0.10	0.06	0.15
Fluoride, total, lb/ton P_2O_5 Fed.	0.10	0.06	0.15

*Dry, 70°F., 29.92 inches Hg.

Table 3
Summary of Results
Outlet

Run No.	1	2	3
Date	2/29/72	2/29/72	3/1/72
Stack pressure, inches Hg	30.2	30.3	30.2
Stack gas moisture, % volume	3	3	2.3
Average stack gas temperature, °F.	87	94	90
Stack gas flow rate @ S.T.P.*, SCFM	812	779	586
Vol. gas sampled @ S.T.P.* , SCF	92.5	90.8	71.2
Fluoride, water soluble, mg	309	471	404
Fluoride, total, mg	309	472	405.7
Fluoride, water soluble, gr/SCF	0.05	0.08	0.09
Fluoride, total, gr/SCF	0.05	0.08	0.09
Fluoride, water soluble, gr/CF stk. cond.	0.05	0.07	0.08
Fluoride, total, gr/CF stk. cond.	0.05	0.07	0.08
Fluoride, water soluble, lb/hour	0.36	0.53	0.44
Fluoride, total, lb/hour	0.36	0.53	0.44
Fluoride, water soluble, lb/ton P_2O_5 Fed.	0.02	0.02	0.02
Fluoride, total, lb/ton P_2O_5 Fed.	0.02	0.02	0.02
Scrubber efficiency, %	99.5	97.9	99.8

*Dry, 70°F., 29.92 inches Hg.

III. 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.

Due to the high fluoride content of the gases from the acid recycle tank, the train used here was further modified during the last two runs by adding another straight tip impinger before the filter and adding 50 ml. of water to this impinger.

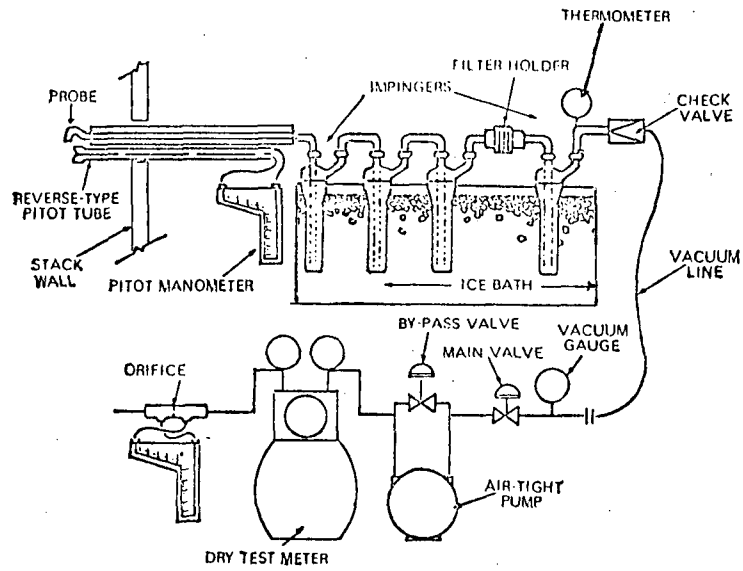


FIGURE 2. SAMPLING TRAIN USED TO DETERMINE FLUORIDE CONCENTRATIONS

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 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 from the recycle tank where a 60 minute sampling period was used because of heavy fluoride concentrations. This period was extended over a two hour period by running the train in 15 minute on-off cycles. At each point the velocity head, stack gas temperature, final impinger temperature, meter temperatures, meter reading, and pump suction pressure drop were 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. Much of the white precipitate in the inlet train on the recycle tank line could not be removed from the inside of the impinger stems.

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.

IV. 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.

P_2O_5 analysis of the stack effluent was done by the Molybdovanadophosphate Colorimetric Method.

For more details of exact methods used, see Appendix, Part C.

V. 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

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

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

QSTPD - 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

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

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

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

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

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

FMOIST = Assumed moisture fraction

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

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

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

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

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

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

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

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

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

Fluoride Emissions:

MG = Milligrams of fluoride from lab analysis

Grains/SCF = $(0.01543) \times (MG) \div VSTPD$

Grains/CF, Stack Cond. = $(17.71) \times (PS) \times (FDA) \times (Grains/SCF) \div (TS)$

Lbs/hour = $(Grains/SCF) \times (0.00857) \times (QSTPD)$

P_2O_5 Fed = Tons/hour, determined from plant data

Lbs/ton P_2O_5 Fed = $(lbs/hour) \div (Tons/hour\ P_2O_5\ Fed)$

EMISSION DATA
I.M.C. SUPER ACID
OUTLET

	1	2	3
1) Run Number	2/29/72	2/29/72	3/1/72
2) Date	12:12	16:00	8:57
3) Time Began	14:12	18:00	10:57
4) Time End	30.2	30.3	30.2
5) Barometric Pressure, In Hg	1.69	1.61	0.89
6) Meter Orifice Pressure Drop, in H_2O	99.1	98.28	75.15
7) Vol Dry Gas, Meter Cond. Cubic Feet	115.5	123.5	106
8) Average Gas Meter Temperature, Deg F	92.488	90.756	71.183
9) Vol Dry Gas, S.T.P., Cubic Feet	59.8	59	35
10) Total H_2O Collected, Ml	2.83	2.8	1.66
11) Vol H_2O Vapor Collected, S.T.P., Cu.Ft.	3	3	2.3
12) Stack Gas Moisture, Percent Volume	3.5	4	4
13) Assumed Stack Gas Moisture, Pct Vol	0.1	0.1	0.1
14) Percent CO_2	20.8	20.8	20.8
15) Percent O_2	0.1	0.1	0.1
16) Percent CO	79	79	79
17) Percent N_2	7860	7860	7860
18) Percent Excess Air	28.85	28.85	28.85
19) Molecular Weight of Stack Gas, Dry	28.53	28.52	28.6
20) Molecular Weight of Stack Gas, Stk Cond.	0.98	0.98	0.99
21) Stack Gas Specific Gravity	0.309	0.298	0.222
22) Avg. Square Root (Vel Head), in H_2O	87	94	90
23) Average Stack Gas Temperature, Deg F	7.236	7.017	5.214
24) Avg. Square Root (Stk Temp x Vel Head)	0.83	0.83	0.83
25) Pitot Correction Factor	30.2	30.3	30.2
26) Stack Pressure, in Hg, Absolute	1052.1	1020.3	757.1
27) Stack Gas Vel, Stack Cond, F.P.M.	0.82	0.82	0.82
28) Stack Area, Sq. Feet	0.82	0.82	0.82
29) Effective Stack Area, Square Feet	812	779	586
30) Stack Gas Flow Rate, S.T.P., SCFMD	120	120	120
31) Net Time of Test, Minutes	0.375	0.375	0.375
32) Sampling Nozzle Diameter, Inches	101.3	103.9	108.2
33) Percent Isokinetic	309	471	404
34) Fluoride - Water Soluble, MG	309	472	405.7
35) Fluoride - Total, MG	0.0514	0.0799	0.0874
36) Fluoride - Water Soluble, GR/SCF	0.0514	0.0801	0.0878
37) Fluoride - Total, GR/SCF	0.0485	0.0743	0.0825
38) Fluoride - Water Sol., GR/CF,STK CND.	0.0485	0.0745	0.0828
39) Fluoride - Total, GR/CF,STK CND.	0.3579	0.5332	0.4391
40) Fluoride - Water Soluble, LB/HOUR	0.3579	0.5344	0.4400
41) Fluoride - Total, LB/HOUR	0.0158	0.0238	0.0190
43) Fluoride - Water Sol., LB/TON P_2O_5 FED	0.0158	0.0239	0.0190
44) Fluoride - Total, LB/TON P_2O_5 FED			

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

EMISSION DATA
I.M.C. SUPER ACID
INLET - SEAL TANK

	1	2	3
1) Run Number	2/29/72	2/29/72	3/1/72
2) Date	11:30	15:55	9:05
3) Time Began	13:30	17:55	11:05
4) Time End	30.2	30.2	30.2
5) Barometric Pressure, In Hg	1	1.25	0.85
6) Meter Orifice Pressure Drop, in H_2O	76.879	81.146	65.014
7) Vol Dry Gas, Meter Cond. Cubic Feet	94.5	105.5	94
8) Average Gas Meter Temperature, Deg F	74.35	76.997	62.909
9) Vol Dry Gas, S.T.P., Cubic Feet	43	41.8	26.8
10) Total H_2O Collected, Ml	2.04	1.98	1.27
11) Vol H_2O Vapor Collected, S.T.P., Cu.Ft.	2.7	2.5	2
12) Stack Gas Moisture, Percent Volume	3.5	3.5	3.5
13) Assumed Stack Gas Moisture, Pct Vol	0.1	0.1	0.1
14) Percent CO_2	21	21	21
15) Percent O_2	0.1	0.1	0.1
16) Percent CO	78.8	78.8	78.8
17) Percent N_2	193981	193981	193981
18) Percent Excess Air	28.86	28.86	28.86
19) Molecular Weight of Stack Gas, Dry	28.57	28.58	28.64
20) Molecular Weight of Stack Gas, Stk Cond.	0.99	0.99	0.99
21) Stack Gas Specific Gravity	0.246	0.277	0.218
22) Avg. Square Root (Vel Head), in H_2O	161	170	154
23) Average Stack Gas Temperature, Deg F	6.136	6.942	5.437
24) Avg. Square Root (Stk Temp x Vel Head)	0.83	0.83	0.83
25) Pitot Correction Factor	30.2	30.2	30.2
26) Stack Pressure, in Hg, Absolute	891.6	1008.3	788.9
27) Stack Gas Vel, Stack Cond, F.P.M.	0.43	0.43	0.43
28) Stack Area, Sq. Feet	0.43	0.43	0.43
29) Effective Stack Area, Square Feet	319	357	288
30) Stack Gas Flow Rate, S.T.P., SCFMD	120	120	120
31) Net Time of Test, Minutes	0.375	0.375	0.375
32) Sampling Nozzle Diameter, Inches	108.8	100.9	102.1
33) Percent Isokinetic	3900	2100	5400
34) Fluoride - Water Soluble, MG	3921	2103	5415.6
35) Fluoride - Total, MG	0.8078	0.42	1.3219
36) Fluoride - Water Soluble, GR/SCF	0.8121	0.4206	1.3257
37) Fluoride - Total, GR/SCF	0.6723	0.3451	1.1206
38) Fluoride - Water Sol., GR/CF,STK CND.	0.6759	0.3456	1.1238
39) Fluoride - Total, GR/CF,STK CND.	2.2085	1.2834	3.2602
40) Fluoride - Water Soluble, LB/HOUR	2.2204	1.2852	3.2696
41) Fluoride - Total, LB/HOUR	0.0977	0.0573	0.1469
43) Fluoride - Water Sol., LB/TON P_2O_5 FED	0.0982	0.0574	0.1473
44) Fluoride - Total, LB/TON P_2O_5 FED			

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

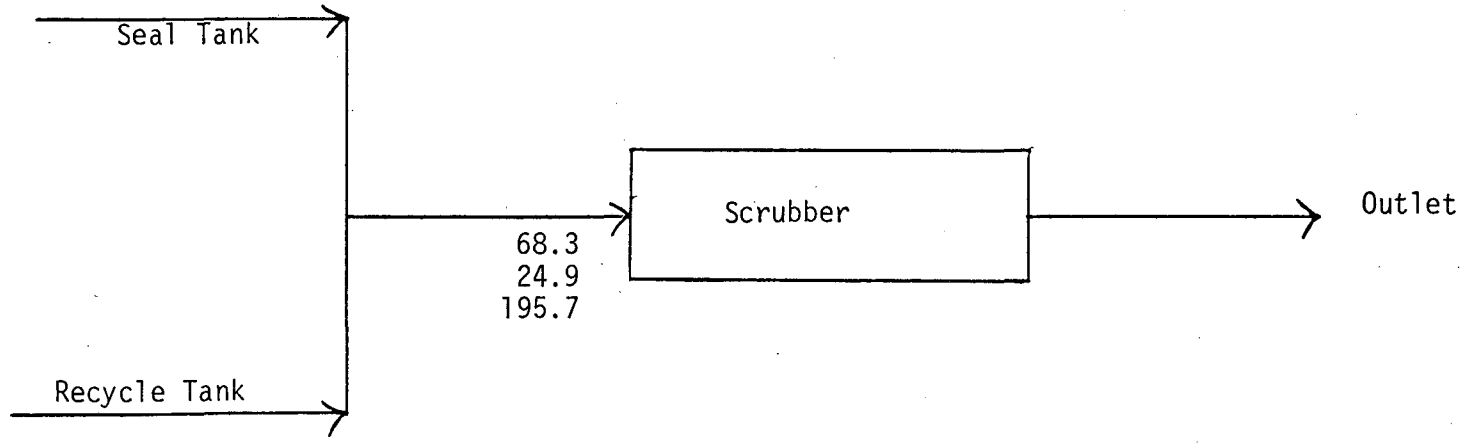
EMISSION DATA
I.M.C. SUPER ACID
INLET - RECYCLE TANK

	1	2	3
1) Run Number	2/29/72	2/29/72	3/1/72
2) Date	12:00	16:10	9:00
3) Time Began	13:45	18:10	11:00
4) Time End	30.2	30.2	30.2
5) Barometric Pressure, In Hg	0.64	0.45	0.43
6) Meter Orifice Pressure Drop, in H_2O	38.745	25.67	16.65
7) Vol Dry Gas, Meter Cond. Cubic Feet	87.5	97.5	89
8) Average Gas Meter Temperature, Deg F	37.917	24.659	16.241
9) Vol Dry Gas, S.T.P., Cubic Feet	150.6	45.1	36.7
10) Total H_2O Collected, Ml	7.14	2.14	1.74
11) Vol H_2O Vapor Collected, S.T.P., Cu.Ft.	15.8	8	9.7
12) Stack Gas Moisture, Percent Volume	13.9	13.9	13.9
13) Assumed Stack Gas Moisture, Pct Vol	1	1	1
14) Percent CO_2	20	20	20
15) Percent O_2	0.1	0.1	0.1
16) Percent CO	78.9	78.9	78.9
17) Percent N_2	1923	1923	1923
18) Percent Excess Air	28.96	28.96	28.96
19) Molecular Weight of Stack Gas, Dry	27.22	28.09	27.9
20) Molecular Weight of Stack Gas, Stk Cond.	0.94	0.97	0.96
21) Stack Gas Specific Gravity	0.494	0.412	0.391
22) Avg. Square Root (Vel Head), in H_2O	206	225	207
23) Average Stack Gas Temperature, Deg F	12.753	10.782	10.092
24) Avg. Square Root (Stk Temp x Vel Head)	0.83	0.83	0.83
25) Pitot Correction Factor	30.2	30.2	30.2
26) Stack Pressure, in Hg, Absolute	1898.1	1579.9	1483.7
27) Stack Gas Vel, Stack Cond, F.P.M.	0.13	0.13	0.13
28) Stack Area, Sq. Feet	0.13	0.18	0.13
29) Effective Stack Area, Square Feet	165	146	138
30) Stack Gas Flow Rate, S.T.P., SCFMD	80	60	60
31) Net Time of Test, Minutes	0.25	0.25	0.25
32) Sampling Nozzle Diameter, Inches	109	108.9	74.4
33) Percent Isokinetic	115000	30200	171000
34) Fluoride - Water Soluble, MG	115033.4	30210.5	171099
35) Fluoride - Total, MG	46.7078	18.8604	162.1434
36) Fluoride - Water Soluble, GR/SCF	46.7214	18.8669	162.2373
37) Fluoride - Total, GR/SCF	31.3398	13.4539	118.5943
38) Fluoride - Water Sol., GR/CF,STK CND.	31.3489	13.4586	118.6618
39) Fluoride - Total, GR/CF,STK CND.	66.133	23.6302	192.3198
40) Fluoride - Water Soluble, LB/HOUR	66.1522	23.6384	192.4312
41) Fluoride - Total, LB/HOUR	2.9262	1.0549	8.6631
43) Fluoride - Water Sol., LB/TON P_2O_5 FED	2.9271	1.0553	8.6681
44) Fluoride - Total, LB/TON P_2O_5 FED			

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

I.M.C. Super Acid
Scrubber Efficiency

Run 1	Flow:	319 (DSCFM)
	Total Fluoride:	2.2 (#/HR)
2		357
		1.3
3		288
		3.3



Run 1	Flow:	165 (DSCFM)	Efficiency: 99.5	Flow:	812 (DSCFM)
	Total Fluoride:	66.1(#/HR)		Total Fluoride:	0.36 (#/HR)
2		146	97.9		779
		23.6			0.53
3		138	99.8		586
		192.4			0.44

APPENDIX B

Field Data

This section contains all field data collected during these tests. Data sheets are arranged in the following order:

Preliminary Pitot Traverse - Inlet on Recycle Tank Line

Preliminary Pitot Traverse - Inlet on Barometric Seal Tank Line

Preliminary Pitot Traverse - Scrubber Outlet

Moisture Run-Meter Data - Inlet on Recycle Tank Line

Moisture Run-Meter Data - Inlet on Barometric Seal Tank Line

Moisture Run-Meter Data - Scrubber Outlet

Meter Data Sheet, Line from Recycle tank-Scrubber Inlet Test 1

Meter Data Sheet, Line from Barometric Seal-Scrubber Inlet Test 1

Meter Data Sheet, Vent from Scrubber Outlet Test 1

Meter Data Sheet, Line from Recycle tank-Scrubber Inlet Test 2

Meter Data Sheet, Line from Barometric Seal-Scrubber Inlet Test 2

Meter Data Sheet, Vent from Scrubber Outlet Test 2

Meter Data Sheet, Line from Recycle tank-Scrubber Inlet Test 3

Meter Data Sheet, Line from Barometric Seal-Scrubber Inlet Test 3

Meter Data Sheet, Vent from Scrubber Outlet Test 3

Orsat Analyses

GAS VELOCITY AND VOLUME DATA

Test No. PRELIM.

Location IMC SCRUBBER INLET RECYCLE TANK

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1	0.2	0.19	0.436	180
2	0.7	.12	.346	
3	1.5	.15	.387	
4	3.5	.16	.400	
5	4.2	.18	.424	
6	4.7	.10	.316	
Total		-	2.309	
Average		-	0.385	180

a) From outside of port to sampling point.

Pitot tube 5

Manometer

Thermometer

Data Recorder R.A.

Date 2-29-72

Stack Inside Dimensions 4 7/8" I.D.

Stack Area, A_s = .1299 sq. ft.

Barometric Pressure, P_b = 30.2 "Hg

Stack Gage Pressure = -.55 "H_2O

Stack Abs. Pressure, P_s = $-.55 \frac{\text{"H}_2\text{O}}{13.6} + P_b$ = 30.16 "Hg

Stack Gas Temp., T_s = 170 °F + 460 = 630 °R

Molecular Weight of Stack Gas, M_s = 29

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

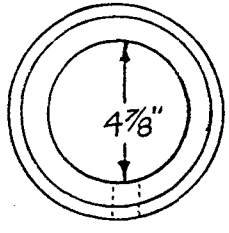
$$V_s = 174(.385)\ .85 \sqrt{630 \times \frac{29.92}{30.16} \times \frac{29}{29}} = 1423$$

Q, Volume = 1423 ft/min. x .1299 sq. ft. = 184 cfm

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

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 184 \times \frac{30.16}{630} = 156$$

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



1/4" WALL THICKNESS
3/4" BUILD-UP

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GAS VELOCITY AND VOLUME DATA

Test No. PRELIM

Location IMC
SCRUBBER INLET
BAR. SEAL

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1	0.3	.11	0.332	160
2	1.0	.09	.300	
3	1.7	.14	.374	
4	3.9	.06	.245	
5	6.0	.07	.265	
6	7.2	.05	.224	
7	7.9	.05	.224	
8	8.5	.03	.173	
Total		-	2.137	
Average		-	0.267	160

a) From outside of port to sampling point.

Pitot tube S
Manometer 0-1"
Thermometer

Data Recorder G.F.

Date 2-29-72

Stack Inside Dimensions 8 7/8" I.D.

Stack Area, A_s = .4301 sq. ft.

Barometric Pressure, P_b = 30.2 "Hg

Stack Gage Pressure = -2.0 "H_2O

Stack Abs. Pressure, P_s = $\frac{-2.0}{13.6}$ "H_2O + P_b = 30.06 "Hg

Stack Gas Temp., T_s = 160 °F + 460 = 620 °R

Molecular Weight of Stack Gas, M_s = 29

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

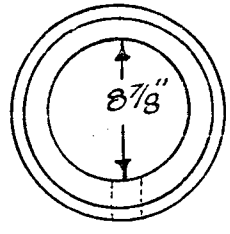
$$V_s = 174(.267)\ .85\sqrt{620 \times \frac{29.92}{30.06} \times \frac{29}{29}} = 981$$

Q, Volume = 981 ft/min. x .4301 sq. ft. = 422 cfm

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

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 422 \times \frac{30.06}{620} = 362$$

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



VERTICAL
1/4" WALL THICKNESS
3/4" BUILD-UP

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GAS VELOCITY AND VOLUME DATA

Test No. PRE. TRAVERSE

Location IMC SUPER PHOS. SCRUBBER OUTLET

VELOCITY TRAVERSE DATA

Point	Position Inches[a]	Reading, Δp "H_2O	$\sqrt{\Delta p}$	T_s °F
1	0.24	0.08	0.283	85
2	0.82	0.10	.316	
3	1.45	0.10	.316	
4	2.15	0.11	.332	
5	3.10	0.11	.332	
6	4.35	0.115	.339	
7	7.90	0.11	.332	
8	9.2	0.11	.332	
9	10.0	0.095	.308	
10	10.8	0.09	.300	
11	11.1	0.09	.300	
12	11.9	0.07	.265	
Total		-	3.755	
Average		-	0.313	85

a) From outside of port to sampling point.

Pitot tube S-TYPE
Manometer 0-1" H_2O
Thermometer DIAL

Data Recorder L. ELFERS

Date 2-29-72

Stack Inside Dimensions 12¼" ∅

Stack Area, A_s = .8185 sq. ft.

Barometric Pressure, P_b = 30.2 "Hg

Stack Gage Pressure = 0 "H_2O

Stack Abs. Pressure, P_s = $0 \frac{\text{"H}_2\text{O}}{13.6} + P_b$ = 30.2 "Hg

Stack Gas Temp., T_s = 80 °F + 460 = 540 °R

Molecular Weight of Stack Gas, M_s = 29

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

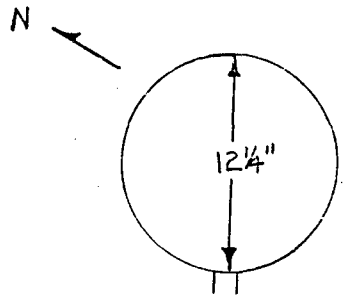
$$V_s = 174(.313) \cdot 85 \sqrt{540 \times \frac{29.92}{30.2} \times \frac{29}{29}} = 1066.6$$

Q, Volume = 1066.6 ft/min. x .8185 sq. ft. = 373 cfm

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

$$Q \times \frac{530}{T_s} \times \frac{P_s}{29.92} = 17.7 \times 873 \times \frac{30.2}{540} = 864$$

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



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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC

Run Number MOISTURE

Location RECYCLE - INLET SCRUBBER

Date 2-29-72 Time 10:30 A.M.

Operator R.S.A. & G.E.

Sample Train Number 3

Meter Number 4

ΔH@ 1.40

Filter No. -

Barometric Pressure, in. Hg 30.2

Assumed Moisture, % —

Assumed Meter Temp., °F —

Stack Gage Pressure — "H_2O

Probe Tip Diameter, in. —

Condensate Collected, ml. 36.5

'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						
3" IN	10	38.20	86	80			3.5			170
	10	43.41	87	82			4.0			170
	10	48.81	86	82			4.0			170
Total	30	10.61	259	244						
Avg.			86	81						

Leakage Rate @ 15 "Hg = 0.017 cfm

$$V_{ms} = 10.61 \times \frac{30.2}{29.9} \times \frac{530}{544} = 10.48 \text{ SCF}$$

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number MOISTURE
Location SCRUBBER INLET - BAR SEAL
Date 2-29-72 Time 9:45 A.M.
Operator R.S.A & G.F.
Sample Box Number 1
Meter Box Number 3
ΔH@ 1.52 @ 15"

Filter No. -
Barometric Pressure, in. Hg 30.2
Assumed Moisture, % -
Assumed Meter Temp., °F -
Stack Gage Pressure - "H_2O
Probe Tip Diameter, in. -
Condensate Collected, ml. 12.9
'C' Correction Factor -

Point	Time Min.	Dry Gas Meter Volume ft^3	Dry Gas Meter Inlet Temp. °F	Dry Gas Meter Outlet Temp. °F	Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Box Temp. °F	Impinger or Condenser Temp., °F	Stack Temp. °F
1	10	136.187	75	75			4			160
3" IN	10	144.22	94	78			5			160
1	10	153.53	98	82			5			160
Total	30	17.34	267	235						
Avg.			89	83.7						160

Leakage Rate @ 15 "Hg = 0 CFM

$$V_{m_S} = 17.34 \times \frac{30.2}{29.9} \times \frac{530}{544} = 17.05 \text{ SCF}$$

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC

Run Number MOISTURE

Location SUPER PHOS. OUTLET

Date 2-29-72 Time 10:00 A.M.

Operator L.E.

Sample Box Number 2

Meter Box Number 2

ΔH@ 1.39 @ .75 CFM

Filter No. -

Barometric Pressure, in. Hg 30.2

Assumed Moisture, % -

Assumed Meter Temp., °F -

Stack Gage Pressure - "H_2O

Probe Tip Diameter, in. -

Condensate Collected, ml. 16.9

'C' Correction Factor -

Point	Time Min.	Dry Gas Meter			Velocity Head Δp "H_2O	Orifice ΔH "H_2O	Pump Vacuum "Hg	Box Temp. °F	Impinger or Condenser Temp., °F	Stack Temp. °F
		Volume ft^3	Inlet Temp. °F	Outlet Temp. °F						
6" IN	10	127.330	110	86			20		57	80
	10	139.30	122	86					57	80
		151.025								
Total	20	23.70								
Avg.			116	86					57	80

Leakage Rate @ 15 "Hg = 0 CFM

$V_{m_s} = 23.70 \times \frac{530}{560} \times 1 = 22.4\ FT^3$

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number 1
Location INLET - RECYCLE TANK
Date 2-29-72 Time 12:00 - 1:45
Operator RSA & GF
Sample Train Number 3
Meter Number 4
ΔH@ 1.40 @ 0.75 cfm

Filter No. -
Barometric Pressure, in. Hg 30.2
Assumed Moisture, % 13.9
Assumed Meter Temp., °F 90°
Stack Gage Pressure -0.55 "H_2O
Probe Tip Diameter, in. .375-.250
Condensate Collected, ml. 150.6
'C' Correction Factor 0.69

DIST	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 Condenser Temp., °F	Stack Gas Temp., °F T_s
0.3	1	20 *	48.895	86	86	0.27	0.72	14	-	69	180
1.2	2	20	57.900	90	84	0.20	0.53	16	-	70	210
3.7	3	20	67.710	96	86	0.25	0.65	11	-	68	220
4.5	4	20 **	77.890	87	85	0.26	0.67	22-5"	-	69	215
			87.640								
	Total	80	38.745	359	341		2.57	68.0	-	276	825
	Avg.			90	85		0.64	13.6	-	69	206

Leakage Rate @ 15 "Hg = 0 cfm

* STOPPED @ 4 MINUTES TO CHANGE NOZZLE FROM 3/8" TO 1/4"
ALSO CHANGED FILTER - COMPLETELY CLOGGED

** CHANGED FILTER AGAIN

$V_{ms} = 38.745 \times \frac{530}{548} \times \frac{30.2}{29.92} = 37.82$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number 1
Location INLET - BAR. SEAL
Date 2-29-72 Time 11:30 - 1:30
Operator RSA & GF
Sample Train Number 1
Meter Number 3
ΔH@ 1.5 @ 0.75 CFM

Filter No. -
Barometric Pressure, in. Hg 30.2
Assumed Moisture, % 3.5
Assumed Meter Temp., °F 90
Stack Gage Pressure 0 "H_2O
Probe Tip Diameter, in. .375
Condensate Collected, ml. 43
'C' Correction Factor 0.90

DIST.	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 Condenser Temp., °F	Stack Gas Temp., °F T_s
0.4	1	20	153.649	96	85	0.08	1.30	5	-	67	165
1.3	2	20	168.190	104	88	0.07	1.15	4	-	69	167
2.6	3	20	182.570	104	88	0.08	1.30	4	-	69	175
6.3	4	20	196.630	108	83	0.05	0.80	4	-	69	155
7.6	5	20	208.400	108	85	0.05	0.80	4	-	70	150
8.9	6	20	219.990	104	83	0.04	0.66	4	-	72	155
			230.528								
	Total	120	76.879	624	512		6.01	25	—	416	967
	Avg.			104	85		1.00	4	—	69	161

Leakage Rate @ 15 "Hg = 0 cfm

$V_{ms} = 76.879 \times \frac{530}{555} \times \frac{30.2}{29.92} = 74.10$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC

Run Number 1

Location OUTLET - SUPER PHOSPHORIC ACID

Date 2-29-72 Time 12:12 - 2:12 P.M.

Operator L. Elfers

Sample Train Number 2

Meter Number 2

ΔH@ 1.39 @ 0.75 CFM

Filter No. —

Barometric Pressure, in. Hg 30.2

Assumed Moisture, % 3.5

Assumed Meter Temp., °F 110

Stack Gage Pressure +0.03 "H_2O

Probe Tip Diameter, in. .375

Condensate Collected, ml. 59.8

'C' Correction Factor 0.82

DIST.	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 Condenser Temp., °F	Stack Gas Temp., °F T_s
0.55	1	20	151.170	108	89	0.06	1.10	7.0	-	57	80
1.8	2	20	164.100	124	92	0.10	1.75	10.5	-	56	85
3.6	3	20	180.900	131	96	0.10	1.75	11.0	-	57	85
8.6	4	20	198.000	142	102	0.12	2.05	12.0	-	56	90
10.5	5	20	215.190	143	106	0.10	1.75	13.0	-	56	90
11.7	6	20	232.800	143	106	0.10	1.75	13.0	-	58	90
			250.270								
	Total	120	99.100	791	591		10.15	66.5	-	340	520
	Avg.			132	99		1.69	11.0	-	57	87

Leakage Rate @ 15 "Hg = 0 cfm

$V_{m_s} = 99.100 \times \frac{530}{576} \times \frac{30.2}{29.92} = 92.04$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number 2
Location INLET - BAR. SEAL
Date 29 FEB 72 Time 3:55 P.M.
Operator G.F. & R.S.A.
Sample Train Number 1
Meter Number 3
ΔH@ 1.52 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.2
Assumed Moisture, % 3.5
Assumed Meter Temp., °F 90
Stack Gage Pressure 0 "H_2O
Probe Tip Diameter, in. .375
Condensate Collected, ml. 41.8
'C' Correction Factor 0.90

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	20	230.711	100	83	0.09	1.45	5	—	62	160
2	20	245.100	110	86	0.08	1.30	8	—	63	160
3	20	258.230	116	100	0.07	1.15	7	—	65	180
4	20	271.090	118	104	0.07	1.15	8	—	65	180
5	20	284.450	120	106	0.07	1.15	8	—	67	170
6	20	297.890	118	104	0.08	1.30	8	—	67	170
		311.857								
Total	120	81.146	682	583		7.50	44	—	389	1020
Avg.			114	97		1.25	7.3	-	65	170

Leakage Rate @ 15 "Hg = 0 cfm

$V_{ms} = 81.146 \times \frac{530}{566} \times \frac{30.2}{29.92} = 76.70$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number 2
Location INLET - RECYCLE TANK
Date 2-29-72 Time 4:10 PM - 6:10 P.M.
Operator R.S.A.
Sample Train Number 3
Meter Number 4
ΔH@ 1.40 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.2
Assumed Moisture, % 13.9
Assumed Meter Temp., °F 90
Stack Gage Pressure -0.55 "H_2O
Probe Tip Diameter, in. .250
Condensate Collected, ml. 45.1
'C' Correction Factor 0.69

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 Condenser Temp., °F	Stack Gas Temp., °F T_s
1	15	93.090	100	100	0.15	0.40	4	—	69	225
		99.080	99	99	0.15	0.40	4	—	70	225
2	15	99.080	98	98	0.17	0.44	4	—	70	225
		104.930	100	100	0.17	0.44	4	—	72	227
3	15 *	104.930	100	100	0.17	0.44	22-4*	—	73	225
		111.030	94	94	0.17	0.44		—	74	225
4	15	111.030	97	93	0.19	0.52	5	—	74	225
		118.760	99	92	0.19	0.52	5	—	74	225
Total	60	25.670	787	776		3.60	52.0	—	576	1802
Avg.			98	97		0.45	6.5	—	72	225

Leakage Rate @ 15 "Hg = 0.04 cfm

* CHANGED FILTER

$V_{ms} = 25.670 \times \frac{530}{558} \times \frac{30.2}{29.92} = 24.61$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number 2
Location OUTLET - SUPER PHOSPHORIC ACID
Date 2-29-72 Time 4:00-6:00 P.M.
Operator L. ELFERS
Sample Train Number 2
Meter Number 2
ΔH@ 1.39 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.3
Assumed Moisture, % 4
Assumed Meter Temp., °F 110
Stack Gage Pressure +.03 "H_2O
Probe Tip Diameter, in. .375
Condensate Collected, ml. 59.0
'C' Correction Factor .82

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	20	250.880	124	96	0.06	1.10	6.5	—	58	95
2	20	264.200	140	102	0.09	1.70	14.0	—	59	95
3	20	281.000	148	108	0.11	2.00	15.0	—	60	95
4	20	299.300	150	108	0.12	2.05	17.5	—	60	95
5	20	317.300	140	114	0.08	1.40	15.0	—	62	95
6	20	333.400	140	114	0.08	1.40	15.0	—	62	90
		349.160								
Total	120	98.280	842	642		9.65	83.0	—	361	565
Avg.			140	107		1.61	13.8	—	60	94

Leakage Rate @ 15 "Hg = 0.0 cfm

$V_{ms} = 98.280 \times \frac{530}{584} \times \frac{30.3}{29.92} = 90.33$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number 3
Location INLET - BAR. SEAL
Date 1 MAR 72 Time 9:05-11:05 A.M.
Operator G.F.
Sample Train Number 1
Meter Number 3
ΔH@ 1.52 @ 0.75 CFM

Filter No. –
Barometric Pressure, in. Hg 30.2
Assumed Moisture, % 3.5
Assumed Meter Temp., °F 95
Stack Gage Pressure -1.5 "H_2O
Probe Tip Diameter, in. .375
Condensate Collected, ml. 26.8
'C' Correction Factor 0.90

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	20	312.071	85	79	0.08	1.30	5	–	70	130
2	20	324.830	98	83	0.06	0.97	4	–	72	160
3	20	337.770	102	88	0.05	0.77	4	–	67	163
4	20	348.490	106	92	0.05	0.77	4	–	68	160
5	20	359.150	105	93	0.04	0.64	3	–	69	155
6	20	369.790	106	95	0.02	0.63	3	–	69	155
		377.085								
Total	120	65.014	602	530		5.08	23	–	415	923
Avg.			100	88		0.85	4	–	69	154

Leakage Rate @ 15 "Hg = 0 cfm

$V_{ms} = 65.014 \times \frac{530}{554} \times \frac{30.2}{29.92} = 62.78$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number 3
Location INLET - RECYCLE TANK
Date 2-30-72 Time 9:00 - 11:00 A.M.
Operator R.S.A.
Sample Train Number 3
Meter Number 4
ΔH@ 1.40 @ 0.75 cfm

Filter No., —
Barometric Pressure, in. Hg 30.2
Assumed Moisture, % 13.9
Assumed Meter Temp., °F 100
Stack Gage Pressure 0 "H_2O
Probe Tip Diameter, in. 0.250
Condensate Collected, ml. —
'C' Correction Factor 0.71

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	15	126,460	80	80	0.10	0.26	7	—	69	210
		129,670	80	80	0.10	0.26	7	—	69	205
2	15 *	129,670	88	88	0.15	0.40	5-25	—	70	205
		133,170	88	88	0.15	0.40	—	—	70	205
3	15	133,170	90	88	0.17	0.46	8	—	69	205
		138,230	90	88	0.17	0.46	8	—	69	205
4	15	138,230	96	98	0.20	0.58	11	—	69	212
		143,110	96	98	0.20	0.58	11	—	69	217
Total	60	16,650	708	708		3.40	82	—	554	1659
Avg.			89	89		.43	10	—	69	207

Leakage Rate @ 15 "Hg = 0.05 cfm

* CLEANED PROBE & CHANGED TO CLEAN NOZZLE 18 MINUTES INTO TEST

$V_{ms} = 16.650 \times \frac{530}{549} \times \frac{30.2}{29.92} = 16.22$ SCF

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PARTICULATE FIELD SAMPLING METER DATA

Plant IMC
Run Number 3
Location OUTLET - SUPER PHOSPHORIC ACID
Date 3-1-72 Time 8:57 - 10:57 A.M.
Operator L. ELFERS & J. GEIGER
Sample Train Number 2
Meter Number 2
ΔH@ 1.39 @ 0.75 CFM

Filter No. —
Barometric Pressure, in. Hg 30.2
Assumed Moisture, % 4
Assumed Meter Temp., °F 110
Stack Gage Pressure +0.02 "H_2O
Probe Tip Diameter, in. .375
Condensate Collected, ml. 35.0
'C' Correction Factor 0.82

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	20	349.380	99	89	0.05	0.90	6.0	—	58	90
2	20	361.280	115	98	0.06	1.05	9.5	—	56	88
3	20	374.840	114	98	0.03	0.55	6.5	—	60	89
4	20	385.090	118	96	0.05	0.90	9.0	—	62	90
5	20	397.680	125	98	0.06	1.05	11.5	—	66	90
6	20	411.730	122	98	0.05	0.90	10.5	—	68	90
		424.530							70	90
Total	120	75.150	693	577		5.35	53.0	—	440	627
Avg.			116	96		.89	8.8	—	63	90

Leakage Rate @ 15 "Hg = 0.0 cfm

$$V_{ms} = 75.150 \times \frac{530}{566} \times \frac{30.2}{29.92} = 71.03 \text{ SCF}$$

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COMBUSTION GAS ANALYSIS

Plant IMC Comments:

Location BARTOW FLA. SUPER PHOSPHORIC ACID

Date MAR. 1, 1972

Operator RG

Test No.	Time	%(CO_2)	%(O_2)	%(CO)	
1	10:00	< 0.1	20.8	< 0.1	OUTLET
1	10:10	< 0.1	21.0	< 0.1	INLET, BAROMETRIC SEAL
1	10:15	≈ 1.0*	20.0	< 0.1	INLET RECYCLE TANK

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

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

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

* Probably due to absorption of fluorides in CO_2 solution (KOH). Reading was erratic.

APPENDIX C

Standard Analytical Procedures

ENVIRONMENTAL PROTECTION AGENCY

Research Triangle Park, North Carolina 27711

Reply to Attn of:

Date: 12-21-72

Subject: Summary of Fluoride Analysis

To: R. Neulicht, EMB, IRL

This memorandum is in response to your request for a brief summary of our SPADNS-Zirconium Lake procedure for determination of fluoride in stack emission samples.

Samples received in our laboratory are filtered through fluoride free paper filters to yield water soluble and water insoluble portions. The water insoluble particulate collected on the filter is rinsed throughly to be sure that all water soluble fluoride is rinsed through. The water soluble fraction is distilled from sulfuric acid to a maximum temperature of 180°C. If chloride is suspected in the sample Ag_2So_4 is added to the still. SPADNS solution is added to an aliquot of the distillate and the absorbance is read at 570 nm. The concentration of the sample is determined from a calibration curve prepared from standard fluoride solutions. It is very important that the temperature of the samples be the same as that of the standards when absorbances are recorded.

The water insoluble fraction of the sample is evaporated to dryness in the presence of a slurry of CAO, and then fused with NAOH. The fusate is dissolved with distilled water, neutralized with dilute H_2So_4, distilled and analyzed as described for the soluble portion.

Paper filters containing particulate are cut into small pieces, suspended in a slurry of CAO, evaporated to dryness and ashed prior to the alkali fusion and distillation.

If you have any questions about this procedure, let me know.

Howard Crist

Howard L. Crist
Chief, Source Sample Analysis Section
SSFAB, QAEML

cc: R. E. Lee

Phosphorus Pentoxide Determination

Colorimetric Molybdovanadophosphate Method

An aliquot of sample is hydrolyzed in the presence of HCl and HNO_3 acids by boiling almost to dryness.

The sample is cooled to room temperature, transferred to a 250 ml. volumetric flask and diluted to volume with distilled water. A 20 ml. aliquot is transferred to a 100 ml. volumetric flask, 20 ml. of molybdovanadate reagent is added and the flask is diluted to volume.

The absorbance of the yellow color is determined after ten minutes at 400 nm. The concentration of phosphorus pentoxide is determined from a calibration curve prepared with standard solutions.

APPENDIX D

Test Log

February 28, 1972

A.M.

9:00-10:00 At request of I.M.C. and C.F. Industries all members of sampling team attended meeting to review safety rules at super phosphoric acid plant. Attendees were PEDCo-Environmental: R. Gerstle, L. Elfers, R. Amick, J. Geiger, G. Forte. EPA: J. Rom. I.M.C./C.F. Industries: Bill Harwood, Bob Riddle, Bob Hearon, Richard Gonzales, Pat Peterson, J. Cox, Gene Lewis.

10:00-11:00 Plant is shutdown today for weekly cleanout. Therefore look over sampling sites and make requests for electrical outlets, sampling platform changes, etc. and make physical measurements of sites.

12:00 Leave plant.

February 29, 1972

A.M.

7:50 Arrive at plant and begin set up. Two trains on inlet-one on recycle tank and one on combined barometric seal tank and product storage tank. One train on single outlet stack after scrubber.

9:00 Make Pitot traverses at all sites. Fumes very bad at all sites due to lack of wind.

10:00-10:30 Make moisture runs at all three sites. NOTE: Inlet train on recycle tank vent became coated with white material after only a few minutes, but still able to run for 30 minutes @ 0.3 cfm.

11:30 Begin inlet run on barometric seal line.

11:45 Orsat

P.M.

12:00 Begin first test run on recycle tank vent. Stopped after four minutes to change from 3/8 to 1/4" nozzle and change filter. Filter had brownish color.

12:12 Begin outlet run.
NOTE: Process somewhat upset during this run due to hole in barometric condenser seal line. This was repaired at 1:00 and increased vacuum in evaporator. Sampling train on recycle tank vent is emitting a white visible highly irritating fume - apparently a fluoride. Impingers are heavily coated with white gelatinous material which has consumed most of the water in the train. Glass in train is heavily etched.

1:00	Scrubber inlet water sample pH = 1.0, Temp. 75°F. Bill Harwood getting product and feed samples.
1:15	Opacity <10%
1:30-2:15	Complete first series of tests.
2:15	I.M.C. started tests using their equipment. Their train on recycle tank vent also plugged up. (This was the first time they had sampled inlet.)
2:30-4:00	Clean-up trains. Inlet train on recycle tank is very difficult to clean and white material cannot be completely removed. Use copious amounts of water to wash out fluorides. Silica gel bleached white. Decide to make second run with this train over a one hour period (on fifteen minutes-off fifteen minutes) and use four straight tip impingers with 150cc, 150cc, 50cc, and Occ of water before filter and then silica gel impinger. Use 1/4" nozzle for entire run.
4:00	Start run No. 2 at all locations. This run routine except for plugging problems on inlet-recycle train. This train again completely coated with white precipitate and is not collecting all fluorides as evidenced by fume leaving train's meter.

5:00 Take scrubber water, and product and feed samples. Opacity = 10-20% somewhat heavier than this morning.

6:15 Complete test work and begin train cleanup.

7:30 Leave plant

March 1, 1972

A.M.

7:45 Arrive at plant and begin setting up equipment. Notice that inlet ducts are puffing out gases, i.e. ducts are under slight positive pressure and flow is somewhat less than yesterday. Appears that scrubber is partially plugged up.

9:00 Begin sampling. Use same set-up as second run yesterday.

9:15 Operator uncovers inlet plate to scrubber and pokes around inside venturi section to loosen cake buildup. Uncovered duct for 3-5 minutes. This appeared to increase vent gas flows for a while.

9:18 Inlet train at recycle is plugged-washed out probe and nozzle.

10:00 Orsat

10:30	Scrubber water and process samples taken. Scrubber outlet water temperature = 84°F
11:15	Complete sampling. Inlet train on recycle line is again completely filled with white material and difficult to clean out. Absorption efficiency of this type of train under these conditions of high F^- concentration is very questionable but is certainly well under 90% after the first 5 or ten minutes of sampling. In addition much of the precipitate in train cannot be removed.
11:15-1:00	Clean up trains and pack equipment. Elfers in lab dividing samples: 1/2 to I MC 1/2 to EPA.
1:00	Leave plant and go to Farmland Industries.

APPENDIX E

Project Participants

Project Participants

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

J. Reynolds - In charge of process operations liaison

APPENDIX F

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 from the recycle tank line where visible emissions were emitted from the dry gas meter and the silica gel became very white 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. In addition, more liquid should be used in the train and sampling volumes should be decreased to avoid saturation. 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 appear necessary.