Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

Background Report Reference

AP-42 Section Number: 11.17

Background Chapter: 4

Reference Number: 33

Title: Emission Testing report of Woodville Lime and Chemical Company

PEDCO Environmental

PEDCO Environmental

July 1974

Reference 16
Incorrect
See page 1 correction

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513/771-4330

EMISSION TESTING REPORT

EPA REPORT 74-LIM-3-A

WOODVILLE LIME AND CHEMICAL CO.
WOODVILLE, OHIO

FINAL

NOT USED.
LABELED AS
PROCESS RATES "INCORRECT"
~~AS~~ CORRECT RATES NOT
PROVIDED

Prepared by:

William G. DeWees
Richard W. Gerstle, P.E.

PEDCo-Environmental Specialists
Suite 13, Atkinson Square
Cincinnati, Ohio 45246

Contract No. 68-02-0237
Task Order No. 26

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II. INTRODUCTION

Under the Clean Air Act of 1970, as amended, the Environmental Protection Agency (EPA) is charged with the establishment of performance standards for stationary sources which may contribute significantly to air pollution. A performance standard is based on the best emission reduction systems which have been shown to be technically and economically feasible.

In order to set realistic performance standards, accurate data on pollutant emissions must be gathered from the stationary source category under consideration.

Woodville Lime and Chemical Company in Woodville, Ohio, was designated as a well-controlled stationary source in the lime producing industry and was thereby selected by EPA for an emission testing program. The tests were conducted during the period of May 20 to 21, 1974. The process under investigation in this test series was the No. 1 lime kiln at the Woodville plant. Emissions from the lime kiln are controlled by a cyclone in series with an electrostatic precipitator. During the test period difficulties encountered with process operation and above-normal production rates resulted in nontypical emissions; the test program was therefore rescheduled for a later date (July 8, 1974).

Results obtained in preliminary testing on May 20 and in one complete test on May 21 are presented here. The complete

test run included measurements of filterable particulates, total particulate, oxides of nitrogen, and sulfur dioxide in effluent from the exit stack of the lime kiln. In addition, moisture content and dry molecular weight of the exit gas were determined, and opacity of visible emissions was recorded by two trained observers and also with a continuous opacity transmissometer.

III. SUMMARY OF RESULTS

A summary of data on particulate emissions from the No. 1 lime kiln ESP exit stack is presented in Table 1. The preliminary test (A), which was conducted on May 20, 1974, covered only 40 of the 48 traverse points; the second test (No. 1), conducted on May 21, 1974, covered only 44 of the 48 traverse points. In addition, the plant was operating at an above-normal production rate, which caused overloading of the ESP emission control device. Therefore, the emissions data presented in this report are considered to be questionable and nonrepresentative of a well-controlled lime producing process.

The EPA Process Engineer decided to conduct several tests on the effluent gas stream from the ESP even though the process rate exceeded normal operational parameters. This decision was based on the need for information with which to determine correlation of emissions concentrations and visible opacity observations. EPA had transported to the plant site a continuous monitoring transmissometer for opacity measurements; the emission measurements therefore were performed for purposes of correlation with readings from this instrument, even though emission rates were known to be above normal for this plant.

The filterable particulate, as measured by the probe and filter catch, averaged 30.35 pounds per hour at a concentration of

Table 1. SUMMARY OF PARTICULATE RESULTS

LIME KILN

Run Number	A	1	Average
Date	5/20/74	5/21/74	
Volume of Gas Sampled, DSCF[a]	56.155	121.814	
Average Stack Temperature, °F	675	686	681
Percent Moisture by Volume	12.17	10.65	11.41
Stack Volumetric Flow Rate, DSCFM[b]	26994	27142	27068
Stack Volumetric Flow Rate, ACFM[c]	66504	66504	66504
Percent Isokinetic	99.3	98.2	
Feed Rate, ton/hr		[illegible]	
Particulates - probe, bypass, and filter catch			
mg	277.2	1463.4	
gr/DSCF	0.0762	0.1854	0.131
gr/ACF	0.0310	0.0757	0.0533
lb/hr	17.6	43.1	30.35
lb/ton		[illegible]	
Particulates - total			
mg	635.2	1586.8	
gr/DSCF	0.1746	0.2010	0.188
gr/ACF	0.0710	0.0820	0.0765
lb/hr	40.4	46.8	43.6
lb/ton		[illegible]	

[a] Dry standard cubic feet at 70°F, 29.92 in Hg.
[b] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.
[c] Actual cubic feet per minute.

0.131 grains per DSCF. Total particulate emissions averaged 43.6 pounds per hour at a concentration of 0.188 grains per DSCF. Results of the second test yielded higher concentrations of filterable particulate than were obtained in the first test, probably because of discontinuities in process operation and production rates.

Emissions of oxides of nitrogen and sulfur dioxide were determined only during the second test. A summary of oxides of nitrogen data is presented in Table 2. These data show average emissions of 481 ppm by volume and 93.2 pounds per hour.

The method for sampling of sulfur dioxide was intended to measure emissions in the 1000 ppm range. Analysis of the samples obtained, however, showed sulfur dioxide concentrations much lower than those expected, about 20 ppm; sample volume was therefore inadequate to yield measurable results. This low concentration was attributable to the neutralization of the sulfur dioxide by the alkaline dust produced in the process.

Determinations of visual opacity of emissions from the lime kiln stack were performed independently by two PEDCo personnel using Federal Register Method 9. Opacity was also measured by the Lear Siegler continuous transmissometer. Data on visible emissions are summarized in Table 3. The average opacity was 14 percent for all readings during the test periods. A 20 percent opacity level was exceeded about 8.5 percent of the test time. This high visible opacity was another indication of emissions much higher than those expected.

Table 2. SUMMARY OF NITROGEN OXIDES EMISSIONS FROM LIME KILN

Test no.	2	3	Average column
Date:	5/21/74	5/21/74	
Time, 24 hr	1249	1339	
Flow rate, DSCFM	27142	27142	27142
Sample volume, ml	1025.46	1145.04	
Milligrams of NO_2	0.979	1.009	
Concentration, ppm	500.7	462.2	481.5
Emissions, lb/hr	96.94	89.48	93.21

Run No. 2

Date 5/21/74

Table 3. Summary of Visual Opacity Readings

		Obs. 1	Obs. 2	Obs. 1	Lear Siegler 2	Obs. 1	Obs.
Interval of Observations[1]	Start	1158	1158		1530		
	End	1441	1458		1550		
Duration of Observation (min)[2]		163	180		20		
Total No. of Readings[3]		653	720		80		
No. of Readings Unobservable		-	-		-		
No. of Readings @ 0% Opacity		0	4		0		
5%		0	118		0		
10%		189	201		42		
15%		388	270		24		
20%		54	64		14		
25%		21	22		0		
30%		1	15		0		
35%		0	18		0		
40%		0	6		0		
45%		0	2		0		
50%		0	0		0		
Percent Readings Unobservable		-	-		-		
Percent Readings @ 0% Opacity		0	0.6		0		
5%		0	16.4		0		
10%		28.9	27.9		52.5		
15%		59.4	37.5		30.0		
20%		8.3	8.9		17.5		
Percent Readings Exceeding 20%		3.4	8.8		0		

[1] 24-hour clock start and end times

[2] Excluding the time that readings were not recorded for period of observation.

[3] Readings recorded at 15-second intervals unless otherwise noted.

Observer 1 - W. DeWees

Observer 2 - R. Amick

The testing series was terminated by OAP personnel before the desired number of tests were run because the lime kiln was running at a high production rate, and visible emissions were exceeding the average 5 percent opacity level that was normal for the No. 1 lime kiln exit stack.

IV. PROCESS DESCRIPTION

Limestone consisting primarily of calcium carbonate or combinations of calcium and magnesium carbonate with varying amounts of impurities is quarried at the Woodville Plant. The limestone is calcined or burned to form lime, commonly divided into two basic products--quicklime and hydrated lime. Calcination expels carbon dioxide from the raw limestone, leaving calcium oxide (quicklime). With the addition of water, calcium hydroxide (hydrated lime) is formed.

The basic processes in production are: (1) quarrying the limestone raw material, (2) preparing the limestone for kilns by crushing and sizing, (3) calcining the limestone, and (4) optionally processing the quicklime further by additional crushing and sizing followed by hydration. The majority of lime is produced in rotary kilns which can be fired by coal, oil, or gas. Rotary kilns have the advantage of producing high production per man-hour and a more uniform product. However, they do require higher capital investment and unit fuel costs than most vertical kilns.

The Woodville Lime and Chemical plant has two rotary kilns each equipped with a Buell electrostatic precipitator. The kilns are almost identical. The feed for both is a dolomitic stone, quarried on the site and fed in sizes ranging from 1 inch to 2 1/4 inches at a rate of about 700 tons per day. There is no

preheater. Normally the kiln is fueled with a mixture of 95 percent Number 6 fuel oil and 5 percent natural gas. Both kilns have two heat transfer sections, each 20 feet long. The product, about 350 tons per day, is cooled in a Neims cooler before storage. There is no product crushing, but undersize material is separated and returned to the kiln. The majority of the product is used in the steel industry, mostly in basic oxygen furnaces; none of the product is hydrated.

The electrostatic precipitator on kiln Number 1 was put in operation in July 1971. In this kiln the main process fan is located before the ESP, with a cyclone before the fan to reduce fan blade erosion. The precipitator on kiln Number 2 was put in operation in December 1973. The main process fan is after the ESP and there is no cyclone.

In both systems the inlet gas to the precipitators is cooled to about 600°F with a combination of water injection and/or tempering air. Each precipitator has 28,800 square feet of collecting surface area, which includes one cell and two fields; design gas velocity is 1.5 feet per second and treatment time, 10.0 seconds.

At present the dust collected from the precipitators is disposed of in the quarry. It is expected that in the future the dust will be granulated and used as a component of dry mix fertilizers that are blended in another part of the complex.

V. LOCATION OF SAMPLING POINTS

Figure 1 shows the sampling ports and sampling points used in the No. 1 lime kiln exit stack. The sampling ports were located in a 63.5-inch inside-diameter vertical stack, 4 feet (0.75 diameter) from the stack exit, and 12 feet (2.26 diameters) from the nearest downstream disturbance. In order to meet the sampling requirements of Methods 1 and 5 of the Federal Register, Vol. 36, No. 247, it was necessary to install a stack extension on the ESP exhaust outlet. Forty-eight traverse points (24 along each of two perpendicular diameters) were used as described in the Federal Register Method 1. Additional sampling points in the existing stack at a lower site were used for some of the gas sampling.

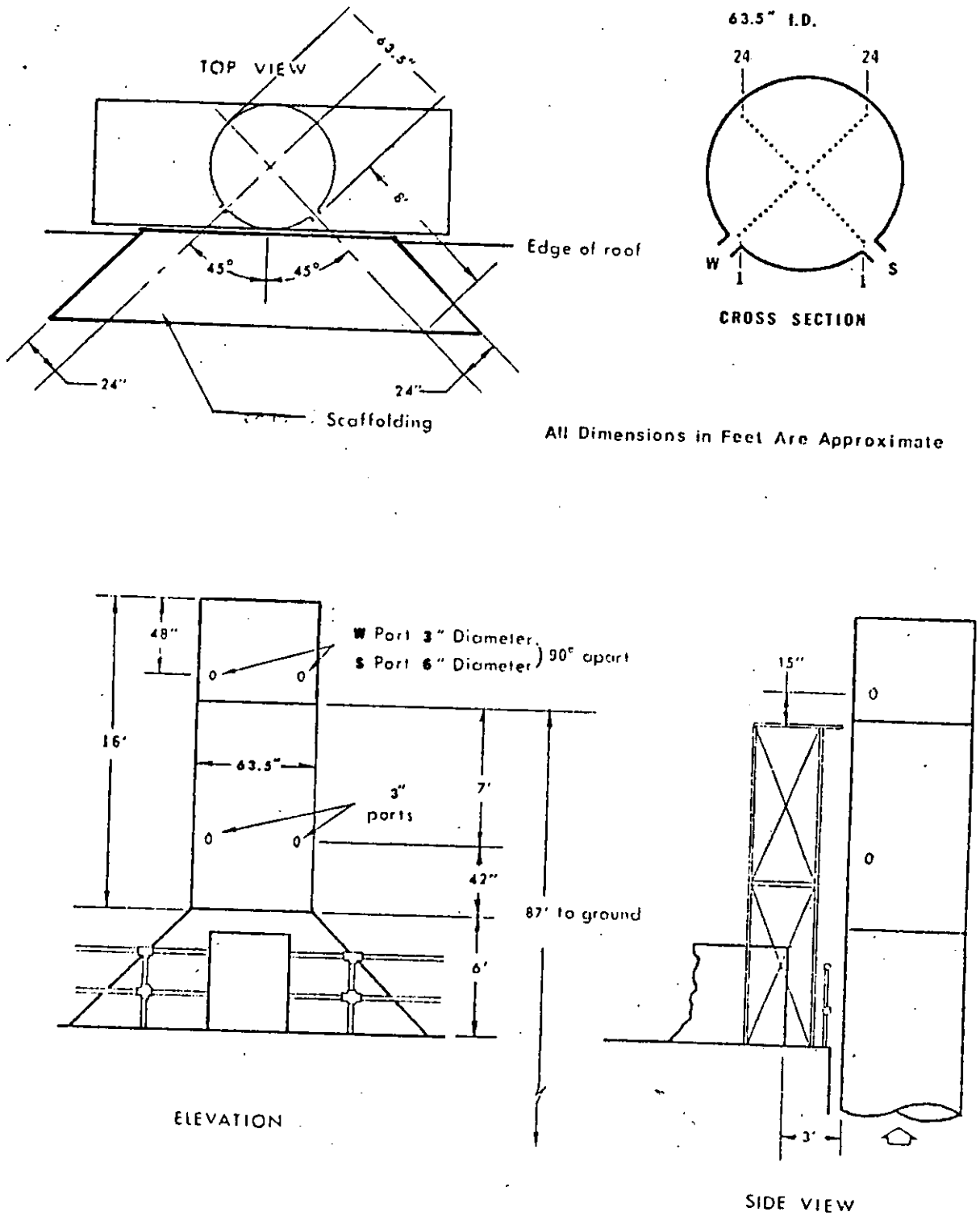

Figure 1. Test Site-No. 1 Kiln Precipitator Outlet.

VI. PROCESS OPERATION

The EPA project engineer arrived at the plant at 3:00 p.m. on Monday, May 20. At this time the plant was running at 5 to 10 percent over the normal production rate. Because the Pfizer Chemical Company lime plant in Perrysburg, Ohio, had just gone on strike, production at the Woodville plant had been increased to the absolute maximum in anticipation of increased demand. Neither stack was clear (about 20% opacity), and the ESP voltage and amps were reading low. It was assumed that the higher opacity was due to the increased production rate, which caused the process to emit greater concentrations of dust. The kiln feed rate was calculated by multiplying the factor of [redacted] times the total indicated tonnage recorded from the control room stone totalizer meter (see reference letter in Appendix D).

On the morning of May 21, kiln No. 1 was processing an average of [redacted] tons of stone per hour. The ESP voltage and amp readings were still low, and opacity readings still high (about 15%, with some as high as 30%). A water spray was added to the feed end of the kiln to increase the conductivity of the gas stream in the ESP, but no effect on collection performance was noticed. Plant officials believed that increasing the

production capacity may have resulted in "heavy combustibles" (oil) passing into the ESP. This oil possibly combined with dust to build up a coating on the wires and plates. This coating would eventually be removed by the rappers but this process might require several weeks. Further testing was postponed until the time when the plant and the ESP resumed normal operation. The operating variables are summarized in Table 4.

Table 4. SUMMARY OF OPERATING VARIABLES

Test No.	1
Stone feed rate,(tons/hr)	[illegible]
Oil rate,(gal/hr)	388
Gas to oil ratio,(BTU Basis)	-
Mid kiln temp.,(°F)	1490-1530
Feed end temp.,(°F)	1040-1100
Before ESP temp.,(°F)	690-740
Stack temp.,(°F)	675-710
Electrostatic Precipitator Data	
A Field	
Primary current,(amps)	35-46
Primary voltage,(volts)	210-245
Precipitator current,(amps)	0.17-0.21
B Field	
Primary current,(amps)	22-39
Primary voltage,(volts)	200-245
Precipitator current,(amps)	0.12-0.21

NOTE: No operational data were collected during the preliminary run on May 20, 1974.

VII. SAMPLING AND ANALYTICAL PROCEDURES

Sampling procedures were designated by EPA. Analyses of collected samples were performed by PEDCo. Appendix G presents detailed sampling and analytical procedures.

Velocity and Gas Temperature

Gas velocities were measured with a calibrated type S pitot tube and inclined draft gage. Velocities were measured at each sampling point across the stack diameter to determine an average value according to procedures described in the Federal Register[1] - Method 2. Temperatures were measured with the use of a thermocouple.

Molecular Weight

A 4-hour integrated sample of the stack gases was collected during test 1 by pumping the gas into a Tedlar plastic bag at the rate of approximately 0.005 CFM. This bag sample was then analyzed with an Orsat analyzer for CO_2, O_2, and CO as described in the Federal Register, Method 3.

Particulates

Method 5 as described in Federal Register,[2] was used to measure particulate matter. A rigid train consisting of a heated glass-lined probe, a 3" glass fiber filter, and a series of Greenburg-Smith impingers, as shown in Figure 2, was employed in all particulate tests.

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1) Federal Register, Vol. 36, No. 247, December 23, 1971.
2) Federal Register, Vol. 36, No. 159, August 17, 1971.

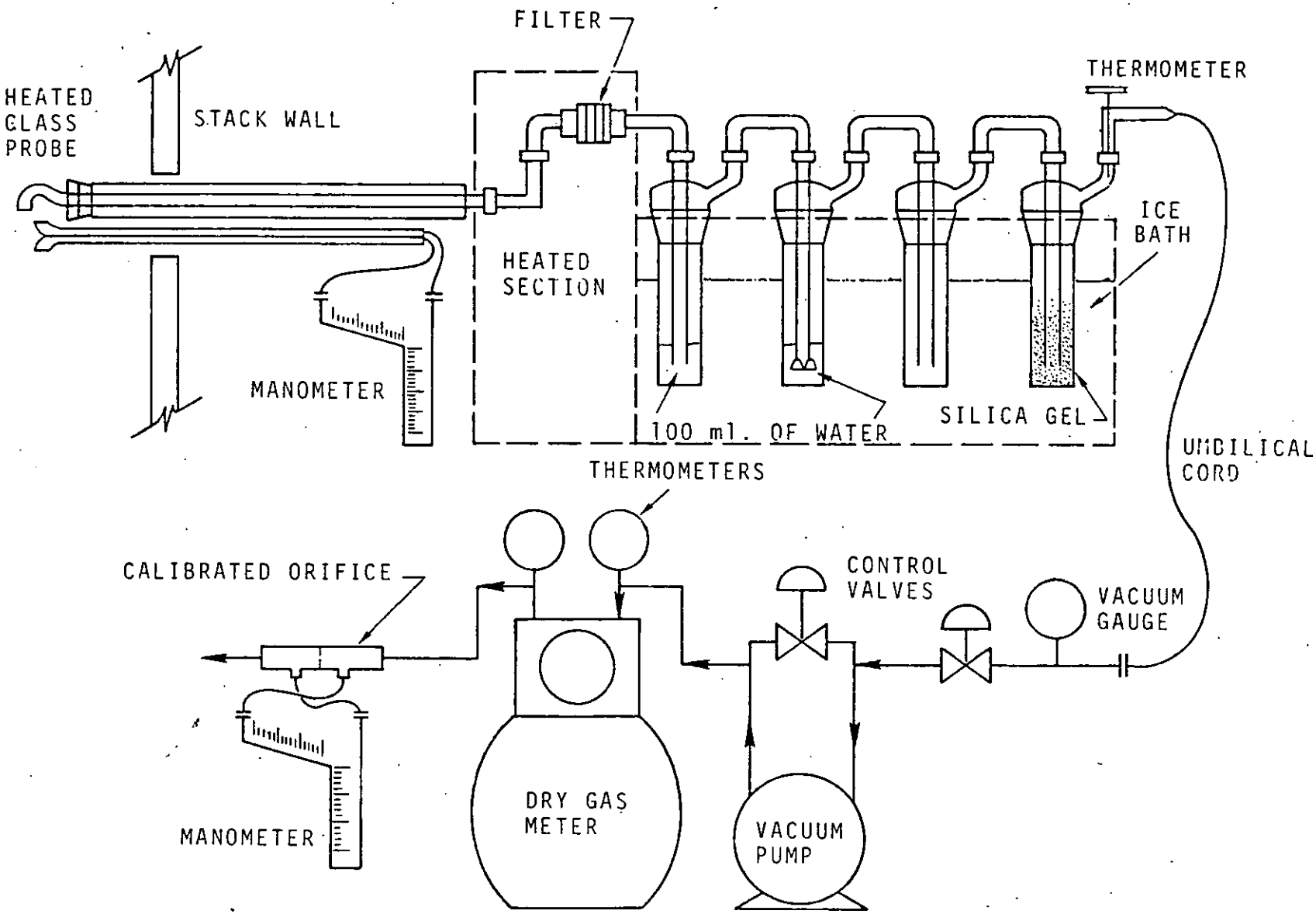

Figure 2. Particulate Sample Train

Sampling was conducted under isokinetic conditions by monitoring the velocity with a pitot tube and adjusting the sampling rate accordingly. Because of the heavy dust loading during a 4-hour test, two filter changes were required during Test 1. After 131 minutes of testing on Test 1 the high temperature and high vacuum pulled a hole in the polyvinyl vacuum line in the meter box. The hole was detected immediately because of the vacuum that was required to sample. The test was terminated at this point.

Sample recovery consisted of triple-rinsing the nozzle, probe, cyclone by-pass, and front half of the filter holder with acetone into a glass container. The back half of the filter holder, impingers, and connecting tubes were first rinsed with distilled water, then placed in a glass container along with the impinger contents. These components were then triple-rinsed with acetone and the washings placed in another glass container. The filter was placed in a separate container. Blank samples of water and acetone were also taken.

NO_x

Nitrogen oxides were collected in evacuated 2-liter flasks containing 25 ml of a dilute sulfuric acid/hydrogen peroxide absorbing solution. The sampling and analytical procedure was as described in Method 7 of the Federal Register[1] except that the final flask vacuum was read immediately after sampling.

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1) Federal Register, Vol. 36, No. 247, December 23, 1971.

The samples were analyzed by the PDSA method. Two samples were lost in the lab by breakage.

$\underline{SO_2}$

Sulfur dioxide was determined by passing a measured volume of flue gas through a set of midget impingers at a rate of approximately 0.025 cubic foot per minute. The first impinger contained 15 ml of 80 percent isopropanol; the second and third impingers contained 15 ml each of hydrogen peroxide in water solution. The hydrogen peroxide solution was titrated with barium chloride using a Thorin indicator to determine sulfur dioxide (SO_2). Because the concentration was so low, less than 1 ml of titrant was required and an accurate measurement was not possible.

APPENDIX A

PARTICULATE RESULTS AND EXAMPLE CALCULATIONS

Summary of Particulate Results

Run No.		A	1
Test Date		5/20/74	5/21/74
Sampling Time, 24 hour clock		1630 - 1745	1055 - 1339
Sampling Location		kiln outlet	kiln outlet
D_n	Sampling Nozzle Diameter, in.	0.375	0.375
T_t	Net Time of Test, Min.	60	131
P_b	Barometric Pressure, in. Hg Absolute	29.62	29.52
P_m	Average Orifice Pressure Drop, in. H_2O	2.6	2.79
V_m	Volume of Dry Gas Sampled at Meter Conditions, DCF	56.690	131.663
T_m	Average Gas Meter Temperature, °F	73	109
$V_{m_{std}}$	Volume of Dry Gas Sampled at Standard Conditions[a], DSCF	56.155	121.814
V_w	Total H_2O Collected in Impingers and Silica Gel, ml	164.2	306.3
$V_{w_{gas}}$	Volume of Water Vapor Collected at Standard Conditions[b], SCF	7.783	14.519
% M	% Moisture in Stack Gas, by Volume	12.17	10.65
M_d	Mole Fraction of Dry Gas	.8783	.8935
% CO_2	Volume % Dry	27.4	27.4
% O_2	Volume % Dry	6.6	6.6
% CO	Volume % Dry	0	0
% N_2	Volume % Dry	66.0	66.0
% EA	Percent Excess Air		
MW_d	Molecular Weight of Stack Gas, Dry Basis	32.65	32.65

Run No.		A	1
MW	Molecular Weight of Stack Gas, Wet Basis	30.87	31.09
C_p	Pitot Tube Coefficient	.83	.83
T_s	Average Stack Temperature, °F	675	686
N_p	Net Sampling Points	40	44
P_{st}	Static Pressure of Stack Gas, in. Hg	.026	.026
P_s	Stack Gas Pressure, in. Hg Absolute	29.65	29.55
V_s	Stack Gas Velocity at Stack Conditions, fpm	3017	3014
A_s	Stack Area, ft^2	21.992	21.992
Q_s	Dry Stack Gas Volumetric Flow Rate at Standard Conditions,[c] DSCFM	26994	27142
Q_a	Stack Gas Volumetric Flow Rate at Stack Conditions, ACFM	66504	66504
% I	Percent Isokinetic	99.3	98.2
% O	Percent Opacity	-	14
T_c	Unit Production Rate - tons/hr.	-	[illegible]
m_f	Particulate - Probe, Cyclone, and Filter, mg	277.2	1463.4
m_t	Particulate - Total, mg	635.2	1586.8
I_c	% Impinger Catch	56	8
C_{an}	Particulate - Probe, Cyclone, and Filter, gr/SCF	.076	.185
C_{ao}	Particulate - Total, gr/SCF	.175	.201

Run No.		A	1
C_{at}	Particulate - Probe, Cyclone, and Filter, gr/ACF	.031	.076
C_{au}	Particulate - Total, gr/ACF	.071	.082
C_{aw}	Particulate - Probe, Cyclone, and Filter, lb/hr.	17.6	43.1
C_{ax}	Particulate - Total, lb/hr.	40.4	46.8
P_{tf}	Particulate - Probe, Cyclone and Filter, lb/ton	-	[redacted]
P_{tt}	Particulate - Total, lb/ton	-	[redacted]

[a] Dry standard cubic feet at 70°F, 29.92 in. Hg.

[b] Standard conditions at 70°F, 29.92 in. Hg.

[c] Dry standard cubic feet per minute at 70°F, 29.92 in. Hg.

EXAMPLE CALCULATIONS USING TEST 1 DATA

1. Volume of dry gas sampled at standard conditions - 70°F, 29.92" Hg. ft^3.

$$V_{m_{std}} = \frac{17.71 \times V_m \left(P_B + \frac{P_m}{13.6}\right)}{(T_m + 460)} = \frac{(17.71)(131.663)(29.52 + \frac{2.79}{13.6})}{(109 + 460)}$$

$$= 121.814$$

2. Volume of water vapor at 70°F & 29.92" Hg, $Ft.^3$

$$V_{w_{gas}} = 0.0474 \times V_w = Ft.^3 = (.0474)(306.3) = 14.519 \text{ Std } ft^3$$

3. % moisture in stack gas

$$\%M = \frac{100 \times V_{w_{gas}}}{V_{m_{std}} + V_{w_{gas}}} = \frac{(100 \times 14.519)}{(121.814) + (14.519)} = 10.65\%$$

4. Mole fraction of dry gas

$$M_d = \frac{100 - \%M}{100} = \frac{(100) - (10.65)}{100} = 0.8935$$

5. Average molecular weight of dry stack gas

$$M\,W_d = (\%CO_2 \times \frac{44}{100}) + (\%O_2 \times \frac{32}{100}) + (\%N_2 \times \frac{28}{100})$$

$$= (27.4 \times .44) + (6.6 \times .32) + (66 \times .28) = 32.65$$

6. Molecular weight of stack gas

$$M\,W = M\,W_d \times M_d + 18\,(1 - M_d)$$

$$= (32.65)(.8935) + (18)(.1065) = 31.09$$

7. Stack velocity @ stack conditions, fpm

$$V_s = 5128.8 C_p \times \sqrt{\Delta P \times (T_s + 460)} \left[\frac{1}{P_s \times M\,W}\right]^{1/2} =$$

$$= (5128.8)(.83)\sqrt{(.403)(686 + 460)} \quad \frac{1}{(29.55)(31.09)}^{1/2} = 3014$$

8. Stack gas volume @ standard conditions, SCFM

$$Q_s = \frac{17.71 \times V_s \times A_s \times M_d \times P_s}{(T_s + 460)} = \text{SCFM} = \frac{(17.71)(3014)(21.992)(.8935)(29.55)}{(686 + 460)}$$

$$= 27116$$

9. Per cent isokinetic

$$\%I = \frac{1032 \times (T_s + 460) \times V_{m_{std}}}{V_s \times T_t \times P_s \times M_d \times (D_n)^2} = \frac{(1032)(686 + 460)(121.813)}{(3014)(131)(29.55)(.8935)(.375)^2}$$

$$= 98\%$$

10. Particulate - probe, cyclone, & filter, gr/SCF

$$C_{an} = 0.01543 \times \frac{M_f}{V_{m\ std}} = \frac{(.0154)(1463.4)}{121.813} = 0.185 \text{ gr/DSCF}$$

11. Particulate total, gr/SCF

$$C_{ao} = 0.01543 \times \frac{M_t}{V_{m_{std}}} = \frac{(.01543)(1586.8)}{(121.813)} = .201$$

12. Particulate - probe, cyclone & filter, gr/CF at stack conditions

$$C_{at} = \frac{17.71 \times C_{an} \times P_s \times M_d}{(T_s + 460)} = \frac{(17.71)(.185)(29.55)(.8935)}{(686 + 460)} = .0755$$

13. Particulate - total, gr/CF @ stack conditions

$$C_{au} = \frac{17.71 \times C_{ao} \times P_s \times M_d}{(T_s + 460)} = \frac{(17.71)(.201)(29.55)(.8935)}{(686 + 460)} = .082$$

14. Particulate - probe, cyclone, & filter, lb/hr.

$$C_{aw} = 0.00857 \times C_{an} \times Q_s = (.00857)(0.185)(27116) = 43.0$$

15. Particulate - total, lb/hr.

$$C_{ax} = 0.00857 \times C_{ao} \times Q_s = (.00857)(0.201)(27116) = 46.7$$

FIELD DATA

PLANT	WOODVILLE LIME&CHEM, WOODVILLE,OH	DATE	05-20-74
SAMPLING LOCATION	LIME KILN OUTLET	RUN NUMBER	A
SAMPLE TYPE	PARTICULATE	PROBE LENGTH AND TYPE	6' GLASS LINED HTD
OPERATOR	O'CONNOR, MIKE	NOZZLE I.D.	.3750
AMBIENT TEMP.(DEG.F)	74	ASSUMED MOISTURE	18
BAR.PRESS.(IN.HG)	29.62	SAMPLE BOX NUMBER	2
STATIC PRESS(IN.H2O)	.35	METER BOX NUMBER	FM3
FILTER NUMBER(S)	100100	METER HEAD DIFF.	1.36
STACK INSIDE DIM(IN)	63.500	C FACTOR	.63
PITOT TUBE COEFF	.83	PROBE HEATER SETTING	.80
		HEATER BOX SETTING	250
READ AND RECORD DATA EVERY	1.5 MINUTES	REFERENCE PRESS DIFF.	.29

TRAVERSE POINT NO.	SAMPLE TIME (MIN.)	CLOCK TIME (24-HR CLOCK)	GAS METER READING (CU.FT.)	VELOCITY HEAD (IN.H2O)	ORIFICE PRESSURE DIFFERENTIAL (IN.H2O) DESIRED	ORIFICE PRESSURE DIFFERENTIAL (IN.H2O) ACTUAL	STACK TEMP (DEG.F)	DRY GAS METER TEMP (DEG.F) INLET	DRY GAS METER TEMP (DEG.F) OUTLET	PUMP VACUUM (IN.HG)	SAMPLE BOX TEMP (DEG.F)	IMPINGER TEMP (DEG.F)
INIT	0	1630	858.831									
W-1	001.5		860.100	.280	1.80	1.80	675	70	74	5.0	240	62
W-2	003.0	1633	861.465	.330	2.15	2.15	675	70	74	5.0	235	60
W-3	004.5		862.840	.350	2.22	2.22	675	70	74	5.0	220	60
W-4	006.0	1636	864.040	.380	2.40	2.40	675	70	74	6.0	220	60
W-5	007.5		865.390	.400	2.58	2.58	675	70	74	7.0	225	62
W-6	009.0	1639	866.730	.420	2.68	2.68	675	71	74	7.0	225	63
W-7	010.5		868.290	.440	2.80	2.80	675	72	74	8.5	210	65
W-8	012.0	1642	869.760	.480	3.05	3.05	675	72	74	9.0	210	66
W-9	013.5		871.385	.500	3.15	3.15	675	73	74	9.5	230	67
W-10	015.0	1645	872.930	.490	3.10	3.10	675	74	74	9.5	240	68
W-11	016.5		874.500	.490	3.10	3.10	675	75	74	9.5	240	69
W-12	018.0	1648	876.050	.480	3.05	3.05	675	75	75	9.5	240	69
W-13	017.5		877.610	.490	3.10	3.10	675	76	75	9.7	250	70
W-14	021.0	1651	879.120	.460	2.91	2.91	675	76	75	9.1	260	70
W-15	022.5		880.650	.440	2.80	2.80	675	76	75	8.8	230	70
W-16	024.0	1654	882.070	.390	2.50	2.50	675	75	75	8.5	245	72
W-17	025.5		883.370	.350	2.22	2.22	675	74	74	8.5	235	72
W-18	027.0	1657	884.640	.340	2.17	2.17	675	73	74	8.5	230	70
W-19	028.5		885.980	.310	2.00	2.00	675	72	74	9.0	240	70
W-20	030.0	1700	887.112	.250	1.60	1.60	675	72	73	8.5	235	69
S-1	031.5		888.150	.300	1.92	1.92	675	70	72	8.5	260	58
S-2	033.0	1718	889.480	.330	2.15	2.15	675	70	72	10.0	270	55
S-3	034.5		890.810	.380	2.40	2.40	675	70	72	11.5	270	55
S-4	036.0	1721	892.050	.390	2.50	2.50		71	72	12.0	270	55
S-5	037.5		893.480	.370	2.31	2.31	675	72	72	13.0	250	56
S-6	039.0	1724	894.860	.410	2.61	2.61	675	73	72	14.0	270	57
S-7	040.5		896.380	.460	2.91	2.91	675	73	72	16.0	270	59

PLANT WOODVILLE LIME&CHEM, WOODVILLE,OH

SAMPLING LOCATION LIME KILN OUTLET

DATE 05-20-74

RUN NUMBER A

TRAVERSE POINT NO.	SAMPLE TIME (MIN.)	CLOCK TIME (24-HR CLOCK)	GAS METER READING (CU.FT.)	VELOCITY HEAD (IN.H2O)	ORIFICE PRESSURE DIFFERENTIAL (IN.H2O) DESIRED	ORIFICE PRESSURE DIFFERENTIAL (IN.H2O) ACTUAL	STACK TEMP (DEG.F)	DRY GAS METER TEMP (DEG.F) INLET	DRY GAS METER TEMP (DEG.F) OUTLET	PUMP VACUUM (IN.HG)	SAMPLE BOX TEMP (DEG.F)	IMPINGER TEMP (DEG.F)
S-8	042.0	1727	897.850	.460	2.91	2.91	675	73	72	18.0	235	60
S-9	043.5		899.440	.500	3.15	3.15	675	73	72	9.5	255	61
S-10	045.0	1730	930.820	.510	3.20	3.20	675	74	72	9.8	265	63
S-11	046.5		902.590	.500	3.15	3.15	675	74	72	9.8	230	65
S-12	048.0	1733	904.685	.520	3.25	3.25	675	75	72	10.0	245	66
S-13	049.5		905.635	.490	3.10	3.10	675	75	72	9.5	250	68
S-14	051.0	1736	907.175	.490	3.10	3.10	675	75	72	10.0	230	68
S-15	052.5		908.740	.480	3.05	3.05	675	75	72	10.2	245	69
S-16	054.0	1739	910.245	.440	2.80	2.80	675	75	73	10.0	255	72
S-17	055.5		911.720	.400	2.58	2.58	675	75	73	9.8	230	73
S-18	057.0	1742	913.075	.380	2.40	2.40	675	75	72	9.5	250	73
S-19	058.5		914.370	.280	1.80	1.80	675	74	72	8.5	265	73
S-20	060.0	1745	915.521	.230	1.48	1.48	675	73	72	8.0	255	73
TOTALS	60.0		56.690									
AVERAGE					2.60	2.60	675	73	73	9.9	249	65

PLANT WOODVILLE LIME&CHEM, WOODVILLE,OH

SAMPLING LOCATION LIME KILN OUTLET

DATE 05-20-74

RUN NUMBER A

DRY MOLECULAR WEIGHT DETERMINATION

GAS	VOL. PERCENT DRY BASIS
CO2	27.400
O2	6.600
CO	.000
N2	66.000
TOTAL	100.000

DRY MOLECULAR WEIGHT,LB/LB-MOLE 32.65

MOISTURE CONTENT DETERMINATION

IMPINGER MOISTURE,ML	139.0
SILICA MOISTURE,ML	25.2
TOTAL MOISTURE,ML	164.2
WATER VAPOR COLLECTED, STD. CU. FT.	7.783
GAS METER VOL.,CU.FT.	
GROSS TOTAL	56.690
LESS LEAKAGE CORR	.000
NET TOTAL	56.690
DRY GAS VOL. THROUGH METER,STD. CU. FT	56.155
MOISTURE CONTENT, VOL. FRACTION	.1217

STACK GAS VELOCITY AND VOLUME DETERMINATION

STACK AREA,SQ. FT.	21.992
PITOT TUBE COEFFICIENT	.83
STACK ABS.PRESS.,IN.HG	29.65
STACK GAS TEMPERATURE,DEG.F	675
STACK GAS MOL. WT.,WET BASIS	30.87
SQRT(VEL HD X STACK TEMP ABS)	21.5
STACK GAS VELOCITY, ACT. FPS	50.4
STACK GAS VOLUME,STD CFM, WET BASIS	30735.0
DRY BASIS	26993.7

ISOKINETIC VARIATION

PERCENT OF ISOKINETIC SAMPLING 99.3

EMISSION DATA

SAMPLE	WEIGHT MG.	STD. CONC. GR./SCF	ACT. CONC. GR./ACF	EMISSION RATE LB./HR.	EMISSION FACT. LB/TON.	THROUGHPUT TON/HR.
PART FILTERABLE	277.2000	.07617	.03095	17.625	.000	0.0000
PARTICULATE TOTAL	635.2000	.17456	.07093	40.389	.000	0.0000

FIELD DATA

PLANT	WOODVILLE LIME&CHEM, WOODVILLE,OH	DATE	05/21/74
SAMPLING LOCATION	NO.1 KILN OUTLET	RUN NUMBER	1
SAMPLE TYPE	PARTICULATE	PROBE LENGTH AND TYPE	7' GLASS LINED HTD
OPERATOR	O'CONNOR,MIKE	NOZZLE I.D.	.3750
AMBIENT TEMP.(DEG.F)	90	ASSUMED MOISTURE	12
BAR.PRESS.(IN.HG)	29.52	SAMPLE BOX NUMBER	1
STATIC PRESS(IN.H2O)	.35	METER BOX NUMBER	FM3
FILTER NUMBER(S)	100101,2,4,5	METER HEAD DIFF.	1.36
STACK INSIDE DIM(IN)	63.500	C FACTOR	.69
PITOT TUBE COEFF	.83	PROBE HEATER SETTING	80
		HEATER BOX SETTING	250
READ AND RECORD DATA EVERY 3.0 MINUTES		REFERENCE PRESS DIFF.	.27

TRAVERSE POINT NO.	SAMPLE TIME (MIN.)	CLOCK TIME (24-HR CLOCK)	GAS METER READING (CU.FT.)	VELOCITY HEAD (IN.H2O)	ORIFICE PRESSURE DIFFERENTIAL (IN.H2O) DESIRED	ORIFICE PRESSURE DIFFERENTIAL (IN.H2O) ACTUAL	STACK TEMP (DEG.F)	DRY GAS METER TEMP (DEG.F) INLET	DRY GAS METER TEMP (DEG.F) OUTLET	PUMP VACUUM (IN.HG)	SAMPLE BOX TEMP (DEG.F)	IMPINGER TEMP (DEG.F)
INIT	0	1055	915.687									
W-1	003.0	1058	917.835	.200	1.40	1.40	695	94	96	7.5	245	80
W-2	006.0	1101	920.270	.240	1.68	1.68	695	93	96	5.0	225	77
W-3	009.0	1104	922.720	.270	1.85	1.85	695	94	96	5.0	220	76
W-4	012.0	1107	925.230	.280	1.91	1.91	698	95	96	5.2	240	79
W-5	015.0	1110	927.840	.300	2.05	2.05	698	96	96	5.8	260	80
W-6	018.0	1113	930.520	.310	2.11	2.11	698	96	96	6.0	275	80
W-7	021.0	1116	933.230	.325	2.21	2.21	698	97	96	6.5	250	82
W-8	024.0	1119	936.115	.360	2.48	2.48	698	99	96	7.0	290	83
W-9	027.0	1122	939.075	.390	2.61	2.61	698	100	96	7.5	205	85
W-10	030.0	1125	942.090	.410	2.79	2.79	698	102	97	8.0	240	88
W-11	033.0	1128	945.080	.440	3.00	3.00	695	104	98	10.0	225	89
W-12	036.0	1131	948.350	.520	3.50	3.50	695	107	98	15.0	205	90
W-13	039.0	1134	951.690	.550	3.70	3.30	695	120	99	20.0	220	95
W-14	042.0	1142	954.810	.550	3.70	3.70	695	107	100	9.0	250	92
W-15	045.0	1145	958.195	.520	3.50	3.50	695	109	101	9.8	260	92
W-16	048.0	1148	961.475	.490	3.33	3.33	695	112	102	10.0	240	93
W-17	051.0	1151	964.640	.470	3.18	3.18	695	114	102	10.8	215	95
W-18	054.0	1154	967.850	.440	3.00	3.00	695	115	103	12.0	255	100
W-19	057.0	1157	970.810	.410	2.79	2.79	695	116	103	12.5	210	101
W-20	060.0	1200	973.845	.390	2.61	2.61	695	116	104	12.8	250	101
W-21	063.0	1203	976.640	.340	2.33	2.33	691	117	105	12.0	215	103
W-22	066.0	1206	979.560	.370	2.51	2.51	691	118	105	13.1	225	105
W-23	069.0	1209	982.435	.350	2.40	2.40	690	120	106	13.1	245	106
W-24	072.0	1212	985.217	.320	2.19	2.19	690	121	107	12.5	215	107
S-1	075.0	1233	987.850	.280	1.91	1.91	680	112	110	5.2	275	83
S-2	078.0	1236	991.275	.590	3.95	3.95	680	113	110	10.5	260	85
S-3	081.0	1239	994.610	.220	1.52	1.52	680	114	110	5.0	260	86

PLANT WOODVILLE LIME&CHEM, WOODVILLE,OH DATE 05/21/74

SAMPLING LOCATION NO.1 KILN OUTLET RUN NUMBER 1

TRAVERSE POINT NO.	SAMPLE TIME (MIN.)	CLOCK TIME (24-HR CLOCK)	GAS METER READING (CU.FT.)	VELOCITY HEAD (IN.H2O)	ORIFICE PRESSURE DIFFERENTIAL (IN.H2O) DESIRED	ORIFICE PRESSURE DIFFERENTIAL (IN.H2O) ACTUAL	STACK TEMP (DEG.F)	DRY GAS METER TEMP (DEG.F) INLET	DRY GAS METER TEMP (DEG.F) OUTLET	PUMP VACUUM (IN.HG)	SAMPLE BOX TEMP (DEG.F)	IMPINGER TEMP (DEG.F)
S-4	084.0	1242	997.485	.270	1.84	1.84	680	116	111	5.5	250	86
S-5	087.0	1255	999.730	.430	2.93	2.93	675	113	112	7.5	225	89
S-6	090.0	1258	2.695	.390	2.61	2.61	675	113	112	7.2	245	82
S-7	093.0	1301	5.880	.440	3.00	3.00	675	114	112	7.8	250	84
S-8	096.0	1304	8.970	.400	2.71	2.71	675	113	112	7.8	250	85
S-9	099.0	1307	12.210	.460	3.15	3.15	675	114	112	8.5	225	86
S-10	102.0	1310	15.640	.540	3.68	3.68	675	115	113	10.5	240	87
S-11	105.0	1313	19.245	.580	3.92	3.92	675	117	113	11.8	260	91
S-12	108.0	1316	22.730	.520	3.50	3.50	675	121	113	10.8	240	95
S-13	111.0	1319	26.150	.500	3.40	3.40	675	123	114	10.8	220	97
S-14	114.0	1322	29.580	.500	3.40	3.40	675	124	114	10.8	240	95
S-15	117.0	1325	32.810	.420	2.90	2.90	675	123	114	9.0	255	94
S-16	120.0	1328	35.975	.450	3.05	3.05	675	122	114	9.2	215	93
S-17	123.0	1331	39.150	.420	2.90	2.90	675	122	114	9.2	220	91
S-18	126.0	1334	42.320	.440	3.00	3.00	675	121	114	9.5	240	92
S-19	129.0	1337	45.830	.565	3.82	3.82	675	121	114	13.2	230	93
S-20	131.0	1339	47.350	.440	3.00	3.00	675	121	114	13.2	220	94
TOTALS	131.0		131.663									
AVERAGE					2.80	2.79	686	112	106	9.5	239	90

PLANT WOODVILLE LIME&CHEM. WOODVILLE,OH
SAMPLING LOCATION NO.1 KILN OUTLET

DATE 05/21/74
RUN NUMBER 1

DRY MOLECULAR WEIGHT DETERMINATION

GAS	VOL. PERCENT DRY BASIS
CO2	27.400
O2	6.600
CO	.000
N2	66.000
TOTAL	100.000

DRY MOLECULAR WEIGHT,LB/LB-MOLE 32.65

MOISTURE CONTENT DETERMINATION

IMPINGER MOISTURE,ML	260.0
SILICA MOISTURE,ML	46.3
TOTAL MOISTURE,ML	306.3
WATER VAPOR COLLECTED, STD. CU. FT.	14.519
GAS METER VOL.,CU.FT.	
GROSS TOTAL	131.663
LESS LEAKAGE CORR	.000
NET TOTAL	131.663
DRY GAS VOL. THROUGH METER,STD. CU. FT	121.814
MOISTURE CONTENT, VOL. FRACTION	.1065

STACK GAS VELOCITY AND VOLUME DETERMINATION

STACK AREA,SQ. FT.	21.992
PITOT TUBE COEFFICIENT	.83
STACK ABS.PRESS.,IN.HG	29.55
STACK GAS TEMPERATURE,DEG.F	686
STACK GAS MOL. WT.,WET BASIS	31.09
SQRT(VEL HD X STACK TEMP ABS)	21.5
STACK GAS VELOCITY, ACT. FPS	50.4
STACK GAS VOLUME,STD CFM,	
WET BASIS	30376.6
DRY BASIS	27141.6

ISOKINETIC VARIATION

PERCENT OF ISOKINETIC SAMPLING 98.2

EMISSION DATA

SAMPLE	WEIGHT MG.	STD. CONC. GR./SCF	ACT. CONC. GR./ACF	EMISSION RATE LB./HR.	EMISSION FACT. LB/TON.	THROUGHPUT TON/HR.
PART FILTERABLE	1463.4000	.18539	.07565	43.130	.000	0.0000
PARTICULATE TOTAL	1586.8000	.20102	.08203	46.767	.000	0.0000

// XEQ ES001

APPENDIX B

GASEOUS RESULTS AND EXAMPLE CALCULATIONS

NO_2 CALCULATIONS

Test No. 2

1. Sample Volume

$$V_s = (17.71)(V_o - 25ml)\left(\frac{P_f}{T_f} - \frac{P_i}{T_i}\right)$$

where: V_s = Sample volume at std. cond., dry basis, ml.
V_o = Volume of flask and valve, ml.
P_f = Final absolute pressure of flask, in.Hg.
P_i = Initial absolute pressure of flask, in. Hg.
T_f = Final absolute temperature of flask, °R.
T_i = Initial absolute temperature of flask, °R.

$$V_s = (17.71)(2070 - 25ml)\left(\frac{27.22}{550} - \frac{11.52}{544}\right)$$

$$V_s = 1025.5 \text{ ml.}$$

2. PPM NO_2

$$C = \frac{(.5245)(M)}{V_s} \times 10^6$$

where: C = Concentration of NO_2, PPM. (dry basis)
M = Mass of NO_2 in gas sample, mg.
V_s = Gas sample volume @ 70°F and 29.92" Hg.

$$C = \frac{(.5245)(.979)}{1025.5} \times 10^6$$

$$C = 500.7 \text{ PPM}$$

3. LBS/HR NO_2

$$ER = (PPM)(Q_s)\left(60\,\frac{min}{hr}\right) \times \left(\frac{M.W.\,(lbs/lb\text{-}mole)}{387\ ft^3/lb\text{-}mole}\right) \times 10^{-6}$$

where: ER = Emission Rate in lbs/hr.

PPM= Parts per million NO_2 (dry basis)

MW = Molecular weight of NO_2, 46.01

Q_s = Dry standard cubic feet per minute

$$ER = (7.133)(PPM)(Q_s) \times 10^{-6}$$

$$ER = (7.133)(\ 500.7)(\ 27142\ \ ) \times 10^{-6}$$

ER = 96.94 LBS/HR

TEST NO.NO-2 DATE 05-21-74 LOCATION LIME KILN OUTLET 1

TYPE OF OPERATION LIME KILN PRECIPITATOR OUTLET

SAMPLING FLASK NO. 20 FLASK VOLUME 2070.0 ML

VOLUME OF REAGENT 25.0 ML TYPE OF REAGENT NOX

INITIAL FLASK VACUUM,	LEG 1	10.20	
	LEG 2	7.80	
	TOTAL	18.00	PI=PB-TOTAL LEG1+LEG2= 11.52

FINAL FLASK VACUUM,	LEG 1	1.70	
	LEG 2	0.60	
	TOTAL	2.30	PF=PB-TOTAL LEG1+LEG2= 27.22

INITIAL FLASK TEMPERATURE, TI= 84. F+460= 544.R
FINAL FLASK TEMPERATURE, TF= 90. F+460= 550.R

BAROMETRIC PRESSURE,PB= 29.520 IN. HG

MILLIGRAMS OF NO2 0.979

CLOCK TIME 1249 DRY STACK VOL. FLOW RATE 27142.00 DSCFM

OUTPUT CALCULATIONS

VS= 1025.46 ML
C= 500.73 PPM NO2
ER= 96.94 LBS/HR NO2

TEST NO.NO-3 DATE 05-21-74 LOCATION LIME KILN OUTLET 1

TYPE OF OPERATION LIME KILN PRECIPITATOR OUTLET

SAMPLING FLASK NO. 17 FLASK VOLUME 2057.0 ML

VOLUME OF REAGENT 25.0 ML TYPE OF REAGENT NOX

INITIAL FLASK VACUUM,	LEG 1	11.10	
	LEG 2	8.80	
	TOTAL	19.90	PI=PB-TOTAL LEG1+LEG2= 9.62

FINAL FLASK VACUUM,	LEG 1	1.70	
	LEG 2	0.40	
	TOTAL	2.09	PF=PB-TOTAL LEG1+LEG2= 27.42

INITIAL FLASK TEMPERATURE, TI= 87. F+460= 547.R
FINAL FLASK TEMPERATURE, TF= 95. F+460= 555.R

BAROMETRIC PRESSURE,PB= 29.520 IN. HG

MILLIGRAMS OF NO2 1.009

CLOCK TIME 01339 DRY STACK VOL. FLOW RATE 27142.00 DSCFM

OUTPUT CALCULATIONS

VS= 1145.04 ML
C= 462.18 PPM NO2
ER= 89.48 LBS/HR NO2

SO_2 Symbols

Vm_{std} = Volume of gas sample through the dry gas meter (standard conditions), cu. ft.

V_m = Volume of gas sample through the dry gas meter (meter conditions), cu. ft.

T_{std} = Absolute temperature at standard conditions, 530° R.

T_m = Average dry gas meter temperature, °R.

P_{bar} = Barometric pressure at the orifice meter, inches Hg.

P_{std} = Absolute pressure at standard conditions, 29.92 inches Hg.

V_t = Volume of barium percholorate titrant used for the sample, ml.

V_{tb} = Volume of barium percholorate titrant used for the blank, ml.

N = Normality of barium percholorate titrant, g.-et./l.

V_{soln} = Total solution volume of sulfur dioxide, 50 ml.

V_a = Volume of sample aliquot titrated, ml.

Cso_2 = Concentration of sulfur dioxide at standard conditions, dry basis, lb./cu. ft.

$7.05X10^{-5}$ = Conversion factor, including the number of grams per gram equivalent of sulfur dioxide (32 g./g.-eq.), 453.6 g./lb., and 1,000 ml./l., lb.-l./g.-ml.

Qs_{std} = Stack gas flow rate at standard conditions dry cu. ft./min.

SO_2 Calculations

$$Vmstd = Vm \frac{(Tstd)}{(Tm)} \frac{(Pbar)}{(Pstd)}$$

$$Vmstd = \frac{(\quad)}{(\quad)} \frac{(\quad)}{(\quad)} \frac{(\quad)}{} =$$

$$PPMSO_2 = \frac{(Vt-Vth)}{(64)} \frac{(N)}{(28.316)} \frac{(Vsoln)}{(Va)} \frac{(24.5)}{(Vmstd)} \frac{(10^6)}{}$$

$$PPMSO_2 = \frac{(\quad)}{(64)} \frac{(\quad)}{(28.316)} \frac{(\quad)}{(\quad)} \frac{(24.5)}{(\quad)} \frac{(10^6)}{}$$

$PPMSO_2$ = ppm by volume

$$CSO_2 = \frac{(7.05x10^{-5})}{(\quad)} \frac{(Vt-Vtb)}{(\quad} \frac{(N)}{} \frac{(Vsoln)}{}$$

CSO_2 = lb/std cu.ft.

Emission rate = (CSO_2) (Qsstd) (60)

Emission rate = ( ) ( ) = lb./hr.

APPENDIX D

OPERATIONAL RESULTS

Please [illegible] make copies and return to me Gene R.

WOODVILLE LIME AND CHEMICAL COMPANY

Office of the Vice President

Phone 849-4311
WOODVILLE, OHIO

August 23, 1974

EPA
Mutual Plaza
Room 926
Research Triangle Park, N. C. 27711

Attn: Mr. Gene Riley

Dear Sir:

Herewith enclosed please find copies of your research data sheets, with the stone rate recalculated to a more reasonable figure. This information was placed in your column for Gas Totalizer, which I have relabled as ~~Corrected~~ Stone Rate T/hr. The factor that I used was 0.7291666. This factor times the total indicated tonnage gives us a reasonable figure to calculate the amount of lime produced.

As I indicated our oil totalizer gives us a very good indication of the total amount of oil used, but as a whole I tend to discount the hour by hour figures.

incorrect factor

Yours very truly,

George Judd
Chief Chemist

D-3

Company Woodville Lime and Chemical | Location Woodville, Ohio

Facility Rotary Lime Kiln with ESP | Unit No.

Operators

Date May 21, 1974

Data Set No. | Page

Gas totalizer
gas rate

	Units	8:00	10:00	11:33	12:00	1:00	2:00		
Stone Totalizer			932385	939409	940776	945070	949171		
Stone Rate	tons/hr			41.90	42.15	42.94	41.01		
Oil Totalizer	gals	247852	248536	249098	249264	249634	249997		
Oil Rate	gals/hr	388							
Firing Zone Temp *	°F		2600	2625	2650	2650	2600		
Mid Kiln Temp	°F	1530	1510	1510	1490	1490	1500		
Feed End Temp	°F	1100	1090	1070	1070	1040	1040		
Before ESP	°F	740	720	710	~~670~~ 710	690	700		
After ESP (stack)	°F	710	680	690	690	680	675		
A Field									
Primary Current	amps	35-42		46	46	46			
Primary Voltage	volts	210-220		240	240	245			
Precipitator Current	amps	.17		.20	.20	.21			
B Field									
Primary Current	amps	22-28		39	39	39			
Primary Voltage	volts	200-215		240	240	245			
Precipitator Current	amps	.12		.21	.21	.21			
Mode of operation		auto		manual	manual	manual			
Correct stone Rate	tons/hr			30.55	30.73	31.31	29.90		

At 9:05 (?) went down, ID fan needed cleaning, 20 min

*

APPENDIX E

FIELD DATA

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT Woodville Lime
DATE 5-20-74
SAMPLING LOCATION No. 1 Kiln, ESP stack
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE A) 63 5/8"
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE, (DISTANCE B) 1/8"
STACK I.D., (DISTANCE A - DISTANCE B) 63 1/2"
NEAREST UPSTREAM DISTURBANCE 12'-2" or 146" = 2.30 dia
NEAREST DOWNSTREAM DISTURBANCE 48" = 0.76 dia
CALCULATOR

SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	1.1	63.5	~~.70~~ 1.0	1/8"	1 1/8
2	3.2		2.03		2 1/8
3	5.5		3.49		3 5/8
4	7.9		5.02		5 1/8
5	10.5		6.67		6 3/4
6	13.2		8.38		8 1/2
7	16.1		10.2		10 3/8
8	19.4		12.3		12 1/2
9	23.0		14.6		14 3/4 ? 3/4
10	27.2		17.3		17 1/2
11	32.3		20.5		20 5/8
12	39.8		25.3		25 1/2
13	60.2		38.2		38 3/8
14	67.7		43.0		43 1/8
15	72.8		46.2		46 3/8
16	77.0		48.9		49
17	80.6		51.2		51 3/8
18	83.9		53.3		53 1/2
19	86.8		55.1		55 1/4
20	89.5		56.8		56 7/8
21	92.1		58.5		58 5/8
22	94.5		60.0		60 1/8
23	96.8		61.5		61 5/8
24	98.9	63.5	~~62.8~~ 62.5	1/8"	62 5/8

4 (Dur) 232
4/72

	PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
1.	WOODVILLE LIME & CHEM WOODVILLE Ohio	05/20/74	LIME KILN OUTLET	PARTICULATE

	RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS (IN.HG)	STATIC PRESS. (IN.H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT
2.	A	O'CONNOR MIKE	74	29.62	.35	100100	63.5 x .	.8

	PROBE LENGTH AND TYPE	NOZZLE I. D. INCHES	H_2O (%)	SAMPLE BOX NO.	METER BOX NO.	METER ΔH @	C FACTOR	PROBE HEAT SET	BOX HEAT SET.	REF. ΔP	RECORD DATA MINS.
3.	6' GLASS LINED HEATED	0.375	18	2	FM-3	1.36	.63	.80	250	.29	15

EMISSION TESTING FIELD DATA

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in.H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in.H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in.H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in.Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1630	858.831									
W-1	1.5		860.100	.28	1.80	1.80	675	70	74	5.	240	62
2	3.	1633	861.465	.33	2.15	2.15		70	74	5.	235	60
3	4.5		862.840	.35	2.22	2.22		70	74	5.	220	60
4	6.	1636	864.040	.38	2.40	2.40		70	74	6.	220	60
5	7.5		865.390	.40	2.58	2.58		70	74	7.	225	62
6	9.	1639	866.730	.42	2.68	2.68		71	74	7.	225	63
7	10.5		868.290	.44	2.80	2.80		72	74	8.5	210	65
8	12.	1642	869.760	.48	3.05	3.05		72	74	9.	210	66
9	13.5		871.385	.50	3.15	3.15		73	74	9.5	230	67
10	15.	1645	872.930	.49	3.10	3.10		74	74	9.5	240	68
11	16.5		874.500	.49	3.10	3.10		75	74	9.5	240	69
12	18.	1648	876.050	.48	3.05	3.05		75	75	9.5	240	69
13	17.5		877.610	.49	3.10	3.10		76	75	9.5	250	70
14	21.	1651	879.120	.46	2.91	2.91		76	75	9.5	260	70
15	22.5		880.650	.44	2.80	2.80		76	75	8.5	230	70
16	24.	1654	882.070	.39	2.50	2.50		75	75	8.5	245	72
17	255		883.370	.35	2.22	2.22		74	74	8.5	235	72
18	27.	1657	884.640	.34	2.17	2.17		73	74	8.5	230	70
19	28.5		885.980	.31	2.00	2.00		72	74	9.0	240	70
20	30	1700	887.112	.25	1.60	1.60	675	72	73	8.5	235	69

LEAKAGE @ 15 "Hg = 0 CFM

GAS METER COR. 1.11

PEDCo - ENVIRONMENTAL

SUITE 8 • ATKINSON SQUARE

	PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
1.		[illegible]		

	RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS (IN.HG)	STATIC PRESS. (IN.H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PT TUB.
2.	A							

	PROBE LENGTH AND TYPE	NOZZLE I. D. INCHES	H_2O (%)	SAMPLE BOX NO.	METER BOX NO.	METER ΔH @	C FACTOR	PROBE HEAT SET	BOX HEAT SET.	REF. ΔP	RECORD DATA MINS.
3.											

EMISSION TESTING FIELD DATA

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in.H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in.H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in.H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in.Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1715										
S-1	31.5		888.150	.30	1.92	1.92	675	70	72	8.5	260	58
2	33.	1718	889.480	.33	2.15	2.15		70	72	10.	270	55
3	34.5		890.810	.38	2.40	2.40		70	72	11.5	270	55
4	36.	1721	892.050	.39	2.50	2.50		71	72	12.	270	55
5	37.5		893.480	.37	2.31	2.31		72	72	13.	250	56
6	39.	1724	894.860	.41	2.61	2.61		73	72	14.	270	57
7	40.5		896.380	.46	2.91	2.91		73	72	16.	270	59
8	42.	1727	897.850	.46	2.91	2.91		73	72	18.	235	60
9	43.5		899.440	.50	3.15	3.15		73	72	9.5	255	61
10	45.	1730	900.870	.51	3.20	3.20		74	72	9.8	265	63
11	46.5		902.590	.50	3.15	3.15		74	72	9.8	230	65
12	48.	1733	904.685	.52	3.25	3.25		75	72	10	245	66
13	49.5		905.635	.49	3.10	3.10		75	72	9.5	250	68
14	51.	1736	907.175	.49	3.10	3.10		75	72	10	230	68
15	52.5		908.740	.48	3.05	3.05		75	72	10.2	245	69
16	54.	1739	910.245	.44	2.80	2.80		75	73	10	255	72
17	55.5		911.720	.40	2.58	2.58		75	73	9.8	230	73
18	57.	1742	913.075	.38	2.40	2.40		75	72	9.5	250	73
19	58.5		914.370	.28	1.80	1.80		74	72	8.5	265	73
20	60.	1745	915.521	.23	1.48	1.48	675	73	72	8.0	255	73

LEAKAGE @ ____ "Hg = ____ CFM

GAS METER COR. ____

PEDCo - ENVIRONMENTAL

SUITE 8 • ATKINSON SQUARE

8

	PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
1.	WOODVILLE LIME + CHEM WOODVILLE OHIO	05/21/74	NO. 1 KILN OUTLET	PARTICULATE

	RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS (IN.HG)	STATIC PRESS. (IN.H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT
2.	1	O'CONNOR - MIKE B	90	29.52	.35	100101, 2 4,5 ~~100102~~	63.5 X	.8

	PROBE LENGTH AND TYPE	NOZZLE I. D. INCHES	H_2O (%)	SAMPLE BOX NO.	METER BOX NO.	METER ΔH@	C FACTOR	PROBE HEAT SET	BOX HEAT SET.	REF. ΔP	RECORD DATA MINS.
3.	7' GLASS LINED - HEATED	0.375	12	1	FM3	1.36	.69	80	250	.27	3

EMISSION TESTING FIELD DATA

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in.H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in.H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in.H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in.Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1055	915.687									
W-1	03.	1058	917.835	.20	1.40	1.40	695	94	96	7.5	245	80
2	06.	1101	920.270	.24	1.68	1.68	695	93	96	5.	225	77
3	09.	1104	922.720	.27	1.85	1.85	695	94	96	5.	220	76
4	12.	1107	925.230	.28	1.91	1.91	698	95	96	5.2	240	79
5	15.	1110	927.840	.30	2.05	2.05	698	96	96	5.8	260	80
6	18.	1113	930.520	.31	2.11	2.11	698	96	96	6.0	275	80
7	21.	1116	933.230	.325	2.21	2.21	698	97	96	6.5	250	82
8	24.	1119	936.115	.36	2.48	2.48	698	99	96	7.0	290	83
9	27.	1122	939.075	.39	2.61	2.61	698	100	96	7.5	205	85
10	30.	1125	942.090	.41	2.79	2.79	698	102	97	8.0	240	88
11	33.	1128	945.080	.44	3.00	3.00	695	104	98	10.0	225	89
12	36.	1131	948.350	.52	3.50	3.50	695	107	98	15.0	205	90
13	39.	1134	951.690	.55	3.70	3.30	695	110	99	20.	220	95 (7)
14	42.	1142 ~~19~~	954.810	.55	3.70	3.70	695	107	100	9.	250	92 (6)
15	45.	1145 ~~18~~	958.195	.52	3.50	3.50	695	109	101	9.8	260	92
16	48.	1148 ~~45~~	961.475	.49	3.33	3.33	695	112	102	10.	240	93
17	51.	1151	964.640	.47	3.18	3.18	695	114	102	10.8	215	95
18	54.	1154	967.850	.44	3.00	3.00	695	115	103	12.0	255	100
19	57.	1157	970.810	.41	2.79	2.79	695	116	103	12.5	210	101
20	60.	1200	973.845	.39	2.61	2.61	695	116	104	12.8	250	101
21	63.	1203	976.640	.34	2.33	2.33	691	117	105	12.0	215	103
22	66.	1206	979.560	.37	2.51	2.51	691	118	105	13.1	225	105
23	69.	1209	982.435	.35	2.40	2.40	690	120	106	13.1	245	106
24	72.	1212	985.217	.32	2.19	2.19	690	121	107	12.5	215	107 (8)

LEAKAGE @ ____ "Hg = ____ CFM

GAS METER COR. 1.11

PEDCo - ENVIRONMENTAL

SUITE 8 • ATKINSON SQUARE

	PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
1.		05/21/1984		

	RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS (IN.HG)	STATIC PRESS. (IN.H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	P. TUB
2.	1					100105 - 100104		

	PROBE LENGTH AND TYPE	NOZZLE I. D. INCHES	H_2O (%)	SAMPLE BOX NO.	METER BOX NO.	METER ΔH @	C FACTOR	PROBE HEAT SET	BOX HEAT SET.	REF. ΔP	RECORD DATA MINS.
3.											

EMISSION TESTING FIELD DATA

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in.H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in.H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in.H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in.Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATU- °F
	0											
5-1	75.	1233	987.850	.28	1.91	1.91	680	112	110	5.2	275	83
2	78.	1236	991.275	.59	3.95	3.95	680	113	110	10.5	260	85 (1)
3	81.	1239	994.610	.22	1.52	1.52	680	114	110	5.0	260	86 (1)
4	84.	1242	997.485	.27	1.84	1.84	680	116	111	5.5	250	86 (2)
5	87.	1255	999.730	.43	2.93	2.93	675	113	112	7.5	225	89
6	90.	1258	1002.695	.39	2.61	2.61	675	113	112	7.2	245	82
7	93.	1301	1005.880	.44	3.00	3.00	675	114	112	7.8	250	84
8	96.	1304	1008.970	.40	2.71	2.71	675	113	112	7.8	250	85
9	99.	1307	1012.210	.46	3.15	3.15	675	114	112	8.5	225	86
10	102.	1310	1015.640	.54	3.68	3.68	675	115	113	10.5	240	87
11	05.	1313	1019.245	.58	3.92	3.92	675	117	113	11.8	260	91
12	08.	1316	1022.730	.52	3.50	3.50	675	121	113	10.8	240	95
13	11.	1319	1026.150	.50	3.40	3.40	675	123	114	10.8	220	97
14	14.	1322	1029.580	.50	3.40	3.40	675	124	114	10.8	240	95
15	17.	1325	1032.810	.42	2.90	2.90	675	123	114	9.0	255	94
16	20.	1328	1035.975	.45	3.05	3.05	675	122	114	9.2	215	93
17	23.	1331	1039.150	.42	2.90	2.90	675	122	114	9.2	220	91
18	26.	1334	1042.320	.44	3.00	3.00	675	121	114	9.5	240	92
19	29.	1337	1045.830	.565	3.82	3.82	675	121	114	13.2	230	93 (7)
20	131.	1339	1047.350	.44	3.00	3.00	675	121	114	13.2	220	94

LEAKAGE @ ____ "Hg = ____ CFM

GAS METER COR. ___.___

PEDCo - ENVIRONMENTA

SUITE 8 • ATKINSON SQUARE

NO_x GAS SAMPLING-EVACUATED FLASK

COMPUTER INPUT DATA

Prepared By GLP

Project No. 3082-Y

TEST NO.	DATE	LOCATION
N01-1	5-21-74	LIME KILN UNIT 1

1 5 13 37

TYPE OF OPERATION	SAMPLING FLASK NO.	FLASK VOLUME (ml)
LIME KILN PRECIPITATOR OUTLET	4	2032

38 68 76 80

FLASK VACUUM-in. Hg.				FLASK TEMP. °F		BARO-METRIC PRES-SURE	CLOCK TIME	DSCFM
INITIAL		FINAL		IN-ITIAL	FINAL			
LEG 1	LEG 2	LEG 1	LEG 2					
14.20	12.10	11.50	13.0	180	186		11:36	

1 5 9 13 17 21 25 30 off 11:48 38 45

REAGENT		Mg NO_x IN SAMPLE	TEST BY
VOL. (ml)	TYPE		
250	NOX	~~Results~~ Sample lost	GLP

46 52 59 66 75

PEDCo-ENVIRONMENTAL
SUITE 13 · ATKINSON SQUARE
CINCINNATI, OHIO 45246

NO_x GAS SAMPLING-EVACUATED FLASK

COMPUTER INPUT DATA

73-344

Prepared By GLP

Project No. 3082-K

TEST NO.	DATE	LOCATION
N01-2	5-12/1-74	LIME KILN OUTLET

1 5 13 37

TYPE OF OPERATION	SAMPLING FLASK NO.	FLASK VOLUME (ml)
LIME KILN PRECIPITATOR OUTLET	20	2070

38 68 76 80

FLASK VACUUM-in. Hg.				FLASK TEMP. °F		BARO-METRIC PRES-SURE	CLOCK TIME	DSCFM
INITIAL		FINAL		IN-ITIAL	FINAL			
LEG 1	LEG 2	LEG 1	LEG 2					
10.20	7.80	1.70	1.60	84	90	29.52	1249	27.42

1 5 9 13 17 21 25 30 38 45

REAGENT		Mg NO_x IN SAMPLE	TEST BY
VOL. (ml)	TYPE		
250	~~H2O2~~ NOX	979	GPL

46 52 59 66 75

PEDCo-ENVIRONMENTAL
SUITE 13 · ATKINSON SQUARE
CINCINNATI, OHIO 45246

NO_x GAS SAMPLING-EVACUATED FLASK

COMPUTER INPUT DATA

Prepared By GLD

Project No. 3082-Y

TEST NO.	DATE	LOCATION
M01-3	5-21-74	LIME KILN OUTLET

1 5 13 37

TYPE OF OPERATION	SAMPLING FLASK NO.	FLASK VOLUME (ml)
LIME KILN PRECIPITATOR OUTLET	17	20510

38 68 76 80

FLASK VACUUM-in. Hg.				FLASK TEMP. °F		BARO-METRIC PRES-SURE	CLOCK TIME	DSCFM
INITIAL		FINAL		IN-TIAL	FINAL			
LEG 1	LEG 2	LEG 1	LEG 2					
110	80	170	40	87	95	29.52	1339	27.42

1 5 9 13 17 21 25 30 38 45

REAGENT		Mg NO_x IN SAMPLE	TEST BY
VOL. (ml)	TYPE		
25	NOX	1009	GLD

46 52 59 66 75

PEDCo-ENVIRONMENTAL
SUITE 13 · ATKINSON SQUARE
CINCINNATI, OHIO 45246

105 62/30

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CINCINNATI, OHIO 45246
513/771-4330

GAS SAMPLING FIELD DATA

Material Sampled For SO2

Date 5/21/74

Plant Woodville Lime Co. Location Lime Kiln #1

Barometric Pressure _____ " Mercury

Ambient Temperature, °F 86 Stack Temperature, °F 700

Test No. SO2-1

Power-Stat Setting _____

Filter Used: — Yes ✓ No

Operator GLP

Time	Meter, ft³	Flow Rate cfm	Meter Temp., °F in	Meter Temp., °F out
1058	921.185	.05	82	83
1315	927.928	.05	100	90

Impinger Contents

No. 1 - 15 ml. Isoprop.

No. 2 - 15 ml. H2O2 3%

No. 3 - 15 ml. H2O2 3%

No. 4 - Silicagel

No. 5 - _____

PEDCO

APPENDIX F

LABORATORY REPORT

ANALYTICAL DATA

1. Plant Hoodville Lime Date 5/21/74
2. Sampling location Lime Kiln NO 1 ESP Outlet Run No. 1
3. Sample Type PARTICULATE Sample Box No. _____
4. Clean-up Man A' O'Connor

IMPINGERS			MOISTURE SILICA GEL			
Final Volume	460	ML	Final Wt.	246.3 g.	_____ g.	_____ g.
Initial Volume	200	ML	Initial Wt.	200 g.	_____ g.	_____ g.
Net Volume	260	ML	Net Wt.	46.3 g.	_____ g.	_____ g.
			TOTAL MOISTURE	306.3 g.		

LABORATORY RESULTS

	1	2	3	4	5	6	7
GROSS	99.8624	2.5338			97.8611	96.8831	100.1353
TARE	99.2578	1.6738			97.8025	96.8229	100.1211
BLANK	.0012	N/A			.0023	.0068	.0007

FRONT HALF

Acetone wash of nozzle, probe, cyclone (bypass), flask, front half of filter holder. Container WV1 1. 603.4 mg

Filter Number _____ _____ Container _____ 2. 860.0 mg

Water wash of nozzle, probe, cyclone (bypass), flask, front half of filter holder. Container _____ Water 3. _____ mg

Container _____ Ether-Chloroform Extraction 4. _____ mg

FRONT HALF SUBTOTAL 1463.4 mg

BACK HALF

Impinger contents and water wash of impingers, connectors, and back half of filter holder. Container WV-2 Impinger Water 5. 56.3 mg

Container WV-3 Ether-Chloroform Extraction 6. 53.4 mg

Acetone wash of impingers, connectors, and back half of filter holder Container WV-4 7. 13.7 mg

BACK HALF SUBTOTAL 123.4 mg

TOTAL WEIGHT 1586.8 mg

ANALYTICAL DATA

1. Plant Woodville Lime Date 5/20/74
2. Sampling location Lime kiln #1 ESP Outlet Run No. A
3. Sample Type Particulate Sample Box No. 2
4. Clean-up Man A. O'Connor

IMPINGERS			MOISTURE SILICA GEL			
Final Volume	339	ML	Final Wt.	225.2 g.	____ g.	____ g.
Initial Volume	200	ML	Initial Wt.	200 g.	____ g.	____ g.
Net Volume	139	ML	Net Wt.	25.2 g.	____ g.	____ g.
			TOTAL MOISTURE	164.2 g.		

LABORATORY RESULTS

	1	2	3	4	5	6	7
GROSS	98.7767	.5156			96.5365	96.1898	97.1590
TAPE	98.5904	.4239			96.4931	95.8797	97.1474
BLANK	.0008	N/A			.0017	.0046	.0008

FRONT HALF

Acetone wash of nozzle, probe, cyclone (bypass), flask, front half of filter holder. Container WA-2 1. 185.5 mg

Filter Number ____ ____ Container ____ 2. 91.7 mg

Water wash of nozzle, probe, cyclone (bypass), flask, front half of filter holder. Container ____ Water 3. ____ mg

Container ____ Ether-Chloroform Extraction 4. ____ mg

FRONT HALF SUBTOTAL 277.2 mg

BACK HALF

Impinger contents and water wash of impingers, connectors, and back half of filter holder. Container WA-3 Impinger Water 5. 41.7 mg

Container WA-4 Ether-Chloroform Extraction 6. 305.5 mg

Small type oil

Acetone wash of impingers, connectors, and back half of filter holder Container WA-5 7. 10.8 mg

BACK HALF SUBTOTAL 358.0 mg

TOTAL WEIGHT 635.2 mg

CASCADE® L1-C2462 Wooduille PN -3082-Y BSM 5-23-74 PRINTED IN U.S.A.

NOx

	Vol	aliquot	O.D.	ug/ml	total ug NOx
Wooduille #17	34ml	5ml	0.33	40	1009 ug
Wooduille #20	40ml	5ml	0.27	33	979 ug
Wooduille #4	— Lost — dropped flask in lab —				

SO2

		Vol	aliquot	ml $BaCl_2$ used	g SO_2
A	Run 1 5/21/74	67.5	10.0	0	0
B	Run 1 5/21/74	67.5	10.0	0	0

aliquot at end point before titrant used

APPENDIX G

SAMPLING AND ANALYTICAL METHODS

DETERMINATION OF PARTICULATE EMISSIONS

The following method was used in this test program. Sampling procedures followed those described in the Federal Register.[1]

SAMPLING APPARATUS

The particulate sampling train used in these tests met design specifications established by the Federal EPA and was assembled by PEDCo personnel. It consisted of:

Nozzle - Stainless steel (316) with sharp, tapered leading edge and accurately measured round opening.

Probe - Pyrex glass with a heating system capable of maintaining a minimum gas temperature of 250°F at the exit end during sampling.

Pitot Tube - Calibrated type S attached to probe to monitor stack gas velocity.

Filter Holder - Pryex glass with heating system capable of maintaining minimum temperature of 225°F.

Draft Gage - An inclined manometer made by Dwyer with a readability of 0.01 inches H_2O in the 0-1 inch range was used.

Impingers - Four impingers connected in series with glass ball joints. The first, third, and fourth impingers were of the Greenburg-Smith design, modified by replacing the tip with a 1/2 inch I.D. glass tube extending to 1/2 inch from the bottom of the flask. The second impinger was of the Greenburg-Smith design with a standard tip.

Thermometer - Dial type with long stem.

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[1] Federal Register, Vol. 36, No. 247, Part II, December 23, 1971.

Metering System - Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5°F, dry gas meter with 2% accuracy, and related equipment, to maintain an isokinetic sampling rate and to determine sample volume. The dry gas meter is made by Rockwell and the fiber vane pump is made by Gast.

Barometer - Bourden tube type to measure atmospheric pressures to ± 0.1 inches Hg.

SAMPLING PROCEDURE

After selecting the sampling site and the minimum number of traverse points, the stack pressure, temperature, moisture, and range of velocity head was measured according to procedures described in Method 1 of the Federal Register (December 23, 1971).

Approximately 200 grams of silica gel were weighed in a sealed impinger prior to each test. Glass fiber filters* (3" diameter) were desiccated for at least 24 hours and weighed to the nearest 0.1 milligram on an analytical balance. One-hundred ml of distilled water was placed in each of the first two impingers; the third impinger was initially empty; and the impinger containing the silica gel was placed next in series. The train was set up without the probe as shown in Figure A-1. The sampling train was leak checked at the sampling site by plugging the inlet to the filter holder and pulling a 15 inch Hg vacuum. Leakage rates of less than 0.02 cfm at a vacuum of 15 in. Hg were recorded in all cases. The probe assembly was then attached, and crushed ice placed around the impingers. More ice was added during the run to keep the temperature of the gases leaving the last impinger at approximately 70°F.

* MSA 1106 BH

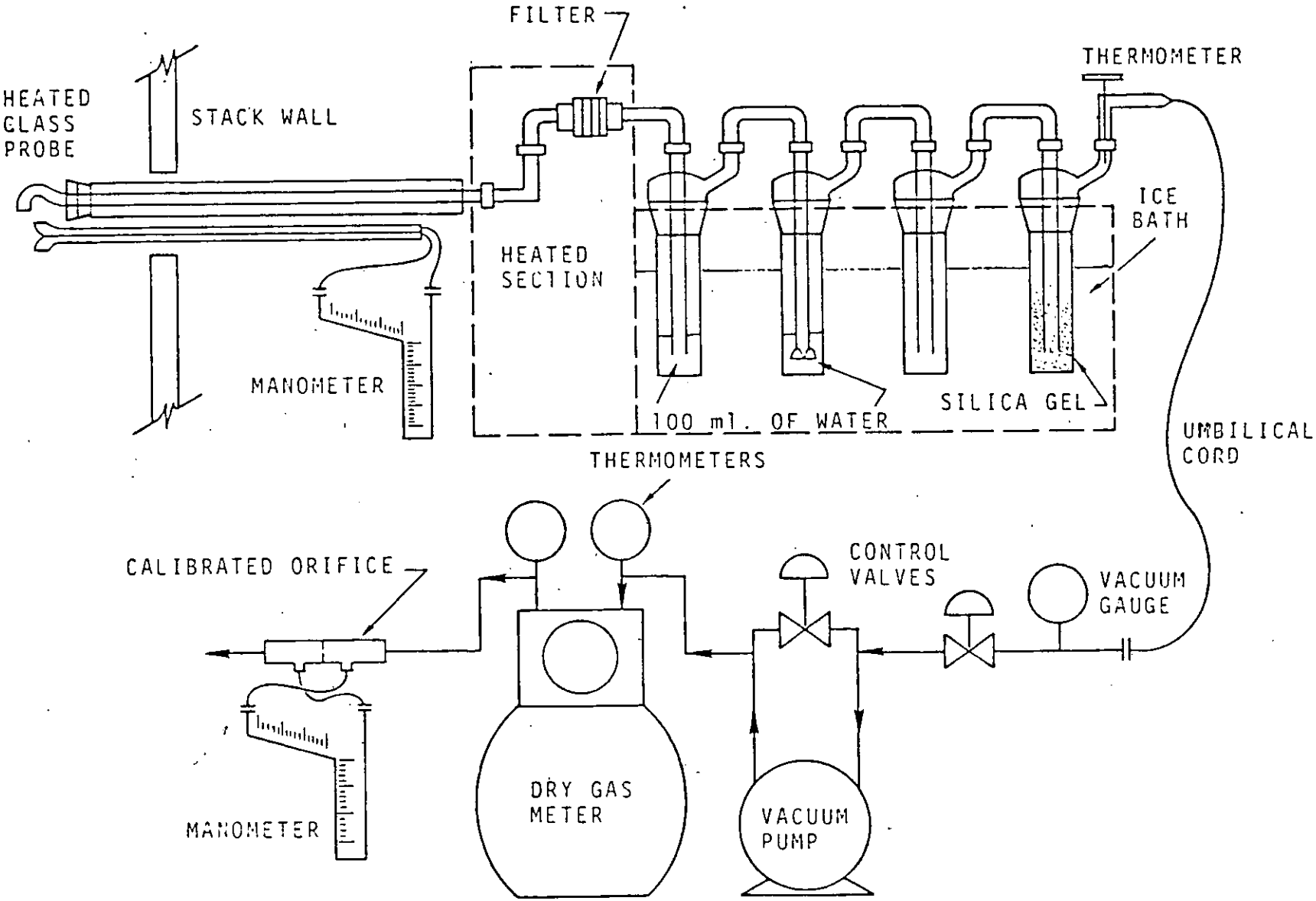

Figure A-1. Particulate sampling train.

During sampling, stack gas and sampling train data were recorded at each sampling point and when significant changes in stack flow conditions occurred. Isokinetic sampling rates were set throughout the sampling period with the aid of a nomograph.

After the completion of the sampling throught the west port the filter was changed due to a particulate buildup on it. The velocity pressure readings were erratic at times resulting in the sample train being shut-off at one point to clean the pitot tube.

After 131 minutes of sampling on Test 1 the velocity pressure increased. The sample train was unable to pull enough flow to maintain an isokinetic rate. The pump was immediately shut-off. The filter was again changed. The leak check that always follows a sample train component change pulled a check in the bypass vacuum line. Because of the time required to fix the lime the test was concluded thirteen minutes short of a complete test.

SAMPLE RECOVERY PROCEDURE

The sampling train was moved carefully from the test site to the cleanup area. Samples of the acetone and water used in the sample recovery were taken for use as blanks. The sample fractions were recovered as follows:

Container No. 1 - The filter was removed from its holder and placed in a petri dish and sealed.

Container No. 2 - Loose particulate and acetone washings from all sample-exposed surfaces prior to the filter were placed in a glass jar and sealed. Particulate was removed from the probe with the aid of a brush and acetone rinsing.

Container No. 3 - The condensate from the first three Greenburg-Smith impingers was measured within ± 1 ml and placed into a glass jar. Water rinsings from the back half of the filter holder, all connectors, and the first three Greenburg-Smith impingers were placed in this container and the container sealed.

Container No. 4 - Acetone rinsings from the back half of the filter holder, support, all connectors, and the first three Greenburg-Smith impingers were placed in this container and sealed.

Container No. 5 - A minimum of 300 ml of acetone was taken for the blank analysis.

Container No. 6 - A minimum of 300 ml of distilled water was taken for a blank.

The silica gel from the fourth impinger was weighed and recorded. The used silica gel was discarded.

ANALYTICAL PROCEDURES

The following procedures were used and follow the methods described in the Federal Register of August 17, 1971.[1]

Container No. 1 - The filter and any loose particulate matter from this sample container were placed into a tared glass weighing dish, desiccated to a constant weight and weighed to the nearest 0.1 mg.

Container No. 2 - The acetone washings were transferred to a tared beaker and evaporated to dryness at ambient temperature and pressure; desiccated to a constant weight; and weighed to the nearest 0.1 mg.

Container No. 3 - Organic matter from the impinger solution was extracted with three 25 ml. portions each of ethyl ether and chloroform. The extracts were combined into a tared beaker, and evaporated until no solvent remained at about 70°F. The sample was then

[1] Federal Register, Vol. 36, No. 159, Part II, August 17, 1971.

desiccated to a constant weight and weighed to the nearest 0.1 mg. The remaining water was evaporated by boiling in a tared beaker, and the residue weighed.

Container No. 4 - The acetone washings from the back half of the filter holder, connectors and first three Greenburg-Smith impingers were transferred to a tared beaker; evaporated to dryness at ambient temperature and pressure; desiccated to a constant weight; and weighed to the nearest 0.1 mg.

Container No. 5 - The acetone blank was transferred to a tared beaker, and evaporated to dryness at ambient temperature and pressure. The blank was then desiccated to a constant weight and weighed to the nearest 0.1 mg.

Container No. 6 - The water blank was evaporated by boiling in a tared beaker, desiccated to a constant weight, and weighed to the nearest 0.1 mg. Blank corrections were made in proportion to the amount of reagent used.

DETERMINATION OF NITROGEN OXIDES IN STACK GAS:

PHENOLDISULFONIC ACID METHOD

INTRODUCTION

The following method was used to determine total oxides of nitrogen. Samples were collected in evacuated flasks containing a dilute sulfuric acid-hydrogen peroxide absorbing solution, and the nitrogen oxides, except nitrous oxides were measured spectrophotometrically at 410 nm.

REAGENTS

The following reagents were used in this sampling program:

(All chemicals were ACS analytical-reagent grade.)

Water - Distilled - deionized water.

Hydrogen Peroxide (3%)- 10 ml. of 30 percent H_2O_2 was diluted to 100 ml in a 100 ml volumetric flask with water.

Absorbing Reagent - 2.8 ml of concentrated H_2SO_4 was diluted to one liter with distilled water. After mixing well, 6 ml of 3 percent hydrogen peroxide were added. The solution is prepared fresh every two or three days.

Sodium Hydroxide (1 N) - 40 gm of NaOH were dissolved in distilled water and diluted to one liter.

Ammonium Hydroxide (concentrated)

Sulfuric Acid (fuming) - (15-18% SO_3)

Phenoldisulfonic Acid Solution - 25 grams of pure white phenol were dissolved in 150 ml of concentrated H_2SO_4 on a steam bath. After the solution cooled, 75 ml fuming sulfuric acid were added. It was then heated to 100°C for two hours. The reagent was stored in a dark stoppered reagent bottle.

Potassium Nitrate Solution (standard) - 0.5495 grams of KNO_3 were dissolved in one liter of water in a volumetric flask. 100 ml of this solution was diluted to one liter in a volumetric flask. One ml of the final solution was equivalent to 0.025 mg NO_2.

SAMPLING APPARATUS

Flasks - Two-liter, Pyrex, round-bottom flask were encased in a simple container with a sleeve and accompanying stopcock valve as shown in Figure A-2.

Vacuum System - The vacuum system consisted of a vacuum pump, capable of producing a vacuum of 3 inches Hg absolute pressure, connected to a 0-36" Hg u-tube manometer.

Thermometer - Dial thermometer, range 25 to 125°F. 5-inch stem.

Probe - Pyrex glass, heated, with a filter to remove particulate matter.

Variable Transformer - Rated at 12 amps, 0 to 140 volts.

Spectrophotometer - A Bausch & Lomb Spectronic 70, capable of measuring optical density at 410 nm in 0.5 inch absorbance cells was used.

SAMPLING PROCEDURES

25 ml of absorbing solution were pipetted into a sample flask. The flask valve stopper was inserted into the flask with the valve in the "closed" position. The sampling train was assembled as shown in Figure A-2 with all valves closed. The probe was placed at the sampling point. The probe valve and the pump-manometer valve were turned to their "open" positions and the probe purged. The probe valve was then closed and the flask valve opened to its "evacuate" position. The flask was evacuated to at least 3 in. Hg absolute pressure. The manometer reading was taken by turning the pump-manometer valve to the "manometer" position. The pump was turned off and the system was checked for leaks by observing any drop in the mercury level.

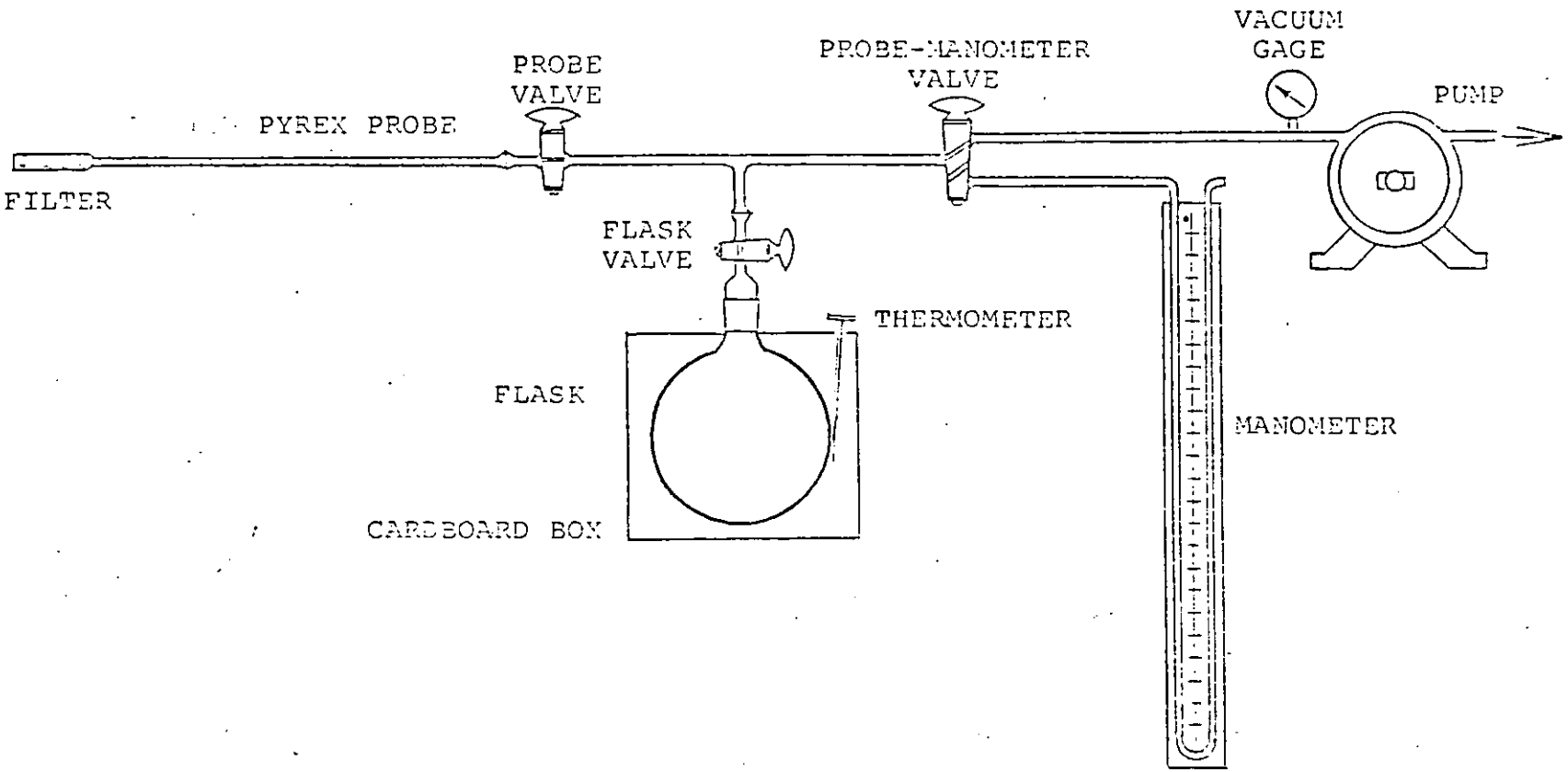

Figure A-2 Nitrogen Oxides Sampling Train

The initial flask pressure, volume, temperature, and barometric pressure were recorded on the data sheet. The probe valve was slowly turned to the "sample" position until a slight drop in the manometer mercury level was observed. The sample was allowed to enter the flask for about 3 to 4 minutes. The probe valve was then closed when there was approximately a one inch mercury vacuum left in the flask. The final flask pressure and temperature were then recorded. The flask valve was closed and the flask contents were shaken for five minutes.

Sample Recovery

The samples were allowed to remain in the flasks for at least 24 hours. The sample was then transferred to a 250 ml beaker using a small amount of water.

Analysis

The sample was evaporated to dryness in an oven and then cooled. Two ml of phenoldisulfonic acid solution were added to the dried residue and triturated thoroughly with a glass rod. One ml of water and 4 drops of concentrated sulfuric acid were then added. The solution was heated on a steam bath for three minutes with occasional stirring. After cooling, 20 ml of water were added and mixed well by stirring. Concentrated ammonium hydroxide was added dropwise with constant stirring until alkaline to litmus paper. The solution was transferred to a 100 ml volumetric flask and the beaker washed three times with 4 to 5 ml portions of water. The solution was diluted to the mark and mixed thoroughly. The absorbance of each sample was measured at 410 nm using the blank solution as a zero. A half inch absor-

bance cell was used.

CALIBRATION PROCEDURES

Flask Volume - The flask and flask valve were assembled and filled with water to the stopcock. The volume of water was measured to ± 1 ml. The flasks were numbered and the volume recorded on each.

Spectrophotometer - Aliquots of 0.0 to 16.0 ml of potassium nitrate solution (standard) was added to a series of beakers, and 25 ml of absorbing solution added to each. Sodium hydroxide (1N) was added dropwise until alkaline to litmus paper (about 25 to 35 drops). These solutions were transferred to 100 ml volumetric flasks and the absorbance read at 410 nm. The calibration curve was checked prior to each set of samples.

DETERMINATION OF SULFUR DIOXIDE EMISSIONS IN STACK GASES

This method was used to measure sulfur dioxide in stack gases and follows Method 6 of the Federal Register[1], with modifications as noted below.

SAMPLING APPARATUS

Nozzle - Stainless Steel (316) with sharp, tapered leading edge.

Probe - Pyrex glass with a heating system capable of maintaining a minimum gas temperature of 225 F at the exit end during sampling and prevent condensation form occurring.

Pitot Tube - Type S, attached to probe to monitor stack gas velocity.

Filter Holder - Pyrex glass

Impingers - Four as shown in Figure A-2. The first and third are of the Greenburg-Smith design with standard tip. The second and fourth were modified by replacing the standard tip with a 1/2 - inch ID glass tube extending to within one-half inch of the bottom of the impinger flask.

Metering System - Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5°F, dry gas meter with 2% accuracy, and related equipment, to maintain an isokinetic sampling rate and to determine sample volume.

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1. Federal Register, Vol. 36, No. 247 - December 23, 1971.

Barometer - Bourden tube type to measure atmospheric pressure to ± 0.1 inches Hg.

SAMPLING REAGENTS

Filters - Glass fiber, MSA type 1106 BH of a suitable size to fit in the filterholder.

Silica Gel - Indicating type , 6-16 mesh.

Water - Deionized, distilled.

Isopropanol, 80% - Mix 800 ml. of isopropanol with 200 ml. of deionized, distilled water.

Hydrogen Peroxide, 3% - Dilute 100 ml. of 30% hydrogen peroxide to 1 liter with deionized, distilled water.

ANALYTICAL REAGENTS

Water - Deionized, distilled.

Isopropanol

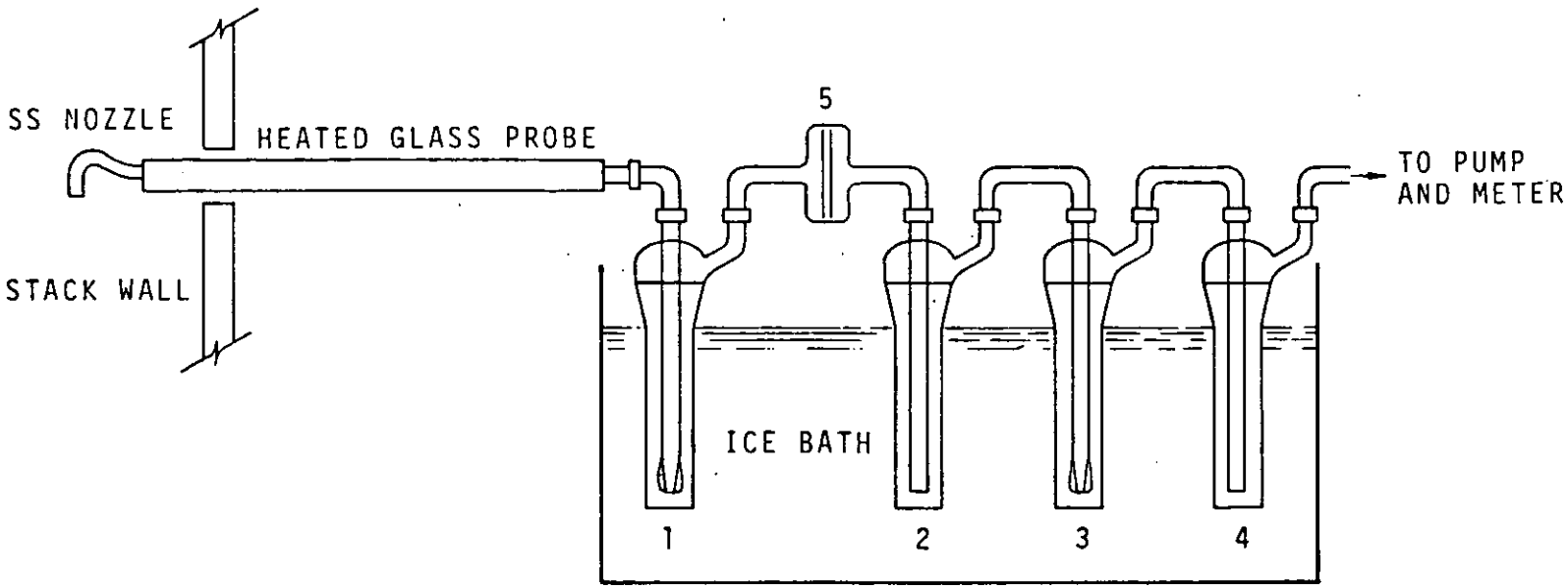
Thorin Indicator - 1 - (0-arsonophenylazo)-2-naphthol-3, 6-disulfonic acid, disodium salt. Dissolve 0.20 gram in 100 ml . distilled water.

Barium Chloride (0.0200N) - Dissolve 2.4431 grams of barium chloride [$BaCl_2$] in 200 ml. distilled water and dilute to 1 liter with isopropanol. Standardize with sulfuric acid.

Sulfuric Acid Standard (0.02N)- Standardize to ± 0.0002 N against 0.01N NaOH which has previously been standardized against primary standard potassium acid phthalate.

SAMPLING PROCEDURE

One sampling point of average velocity was chosen which was more than 2 feet from the inner walls of the stack. The train was assembled as follows: 150 ml. of 80% isopropanol in the first impinger, 100 ml. of 3% hydrogen peroxide in both the second and third impingers,



1. G-S IMPINGER - 100 ml. 80% ISOPROPANOL
2. MODIFIED G-S IMPINGER - 100 ml. 3% H_2O_2
3. G-S IMPINGER - 100 ml. 3% H_2O_2
4. MODIFIED G-S IMPINGER - 200 g. SILICA GEL
5. FILTER HOLDER w/GLASS FIBER FILTER

Figure A-2. SO_2/SO_3 sampling train.

and about 200 grams of weighed silica gel in the fourth impinger. A portion of the reagents were retained for use as a blank. The train was assembled without the probe and was leak checked at the sampling site by plugging the inlet of the first impinger and pulling a 15-inch Hg vacuum. A leakage rate not in excess of 0.02 cfm at a vacuum of 15 inches Hg was recorded in all cases. The probe was then attached and the probe heating system turned on. The probe heater setting was adjusted during sampling to prevent any visible condensation. Crushed ice was placed around the impingers and more ice was added during the run to keep the temperature of the gases leaving the last impinger to 70°F or less.

For each run, the data were recorded at startup, on completion of the test and at 15 minute intervals. Sampling was begun by positioning the probe at the sample point. The pump was then started and sampling proceeded at a rate of approximately 0.8 cfm for a 240 minute period.

At the completion of the test, the probe was removed from the stack and the train was pruged for 20 minutes by drawing ambient air through the system.

SAMPLE RECOVERY

The solutions from the second and third impingers were transferred to a Wheaton bottle. These impingers and their connecting glassware were rinsed with deionized distilled water and other washings added to the same container. The 80% isopropanol form the first impinger and filter were discarded.

ANALYTICAL PROCEDURES

The volume of the sample was recorded. A 10 ml aliquot of sample was pippetted into a 100 ml Erlenmeyer flask. 40 ml of isopropanol and 2 to 4 drops of thorin indicator were added. The sample was then titrated with barium chloride to a pink end point. Each titration was repeated with a second aliquot of sample. The blanks were titrated in the same manner as the samples.

APPENDIX H

TEST LOG

SAMPLING TASK LOG

Plant Woodville Lime & Chemical Co.
Date 5/20/74 - 5/21/74

Plant Location Woodville, Ohio
Recorded by W. G. DeWees

Comments	Run	Sampling location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
5/20/74							
Start Particulate=test	A	West Port	Particulate	1630			
Preliminary test to check		West Port			1700		
moisture and see if any		South Port		1715			
problems would be incountered		South Port			1745		
during testing		Test Complete					
No gaseous or orsat was run							
5/21/74							
Start Particulate Test	1	West Port	Part	1055			
Start SO_2 Test	SO_2-1	South Port	SO_2	1058			
Start NO_x Test	NO-1	Bottom Port	NO_x	1136			
Complete NO_x Test	NO-1	Bottom Port	NO_x		1148	12	
Stop Particulate Test Change Ports	1	West to South	Part		1212		
Start NO_x Test	NO_2	Bottom port	NO_x	1249			
Change filter Restart Test	1	South	Part	1233			
Shut down to check pitot/tube	1	South Port	Part		1242		
Restart after cleaning pitot/tube	1	South Port	Part	1252			
Finish SO_2 test	SO_2-1	South Port	SO_2		1315		
Start NO_x test	NO-3	Bottom Port	NO_x	1339			
Finish Particulate test	1	South Port	Part		1339		

APPENDIX I

RELATED REPORTS

RELATED REPORTS

Because of the process and control equipment problems that were encountered, two additional test series were performed at the Woodville Lime and Chemical Company. The second test series began on July 8, 1974, and is discussed in EPA Report No. 74-LIM-3B. The last test series performed started on August 5, 1974, and is presented in EPA's Report No. 75-LIM-8.