

EMISSION TESTING REPORT
EPA REPORT 74-LIM-3-A
WOODVILLE LIME AND CHEMICAL CO.
WOODVILLE, OHIO

FINAL

PEDCo ENVIRONMENTAL



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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	<u>A</u>	<u>1</u>	<u>Average</u>
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		30.62	
<u>Particulates</u> - 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		1.41	
<u>Particulates</u> - 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		1.53	

^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

<u>Test no.</u>	<u>2</u>	<u>3</u>	<u>Average column</u>
Date:	<u>5/21/74</u>	<u>5/21/74</u>	
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

Table 3. Summary of Visual Opacity Readings

Date 5/21/74

		Lear Siegler			
		Obs. 1	Obs. 2	Obs. 1	Obs. 2
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 times² 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.

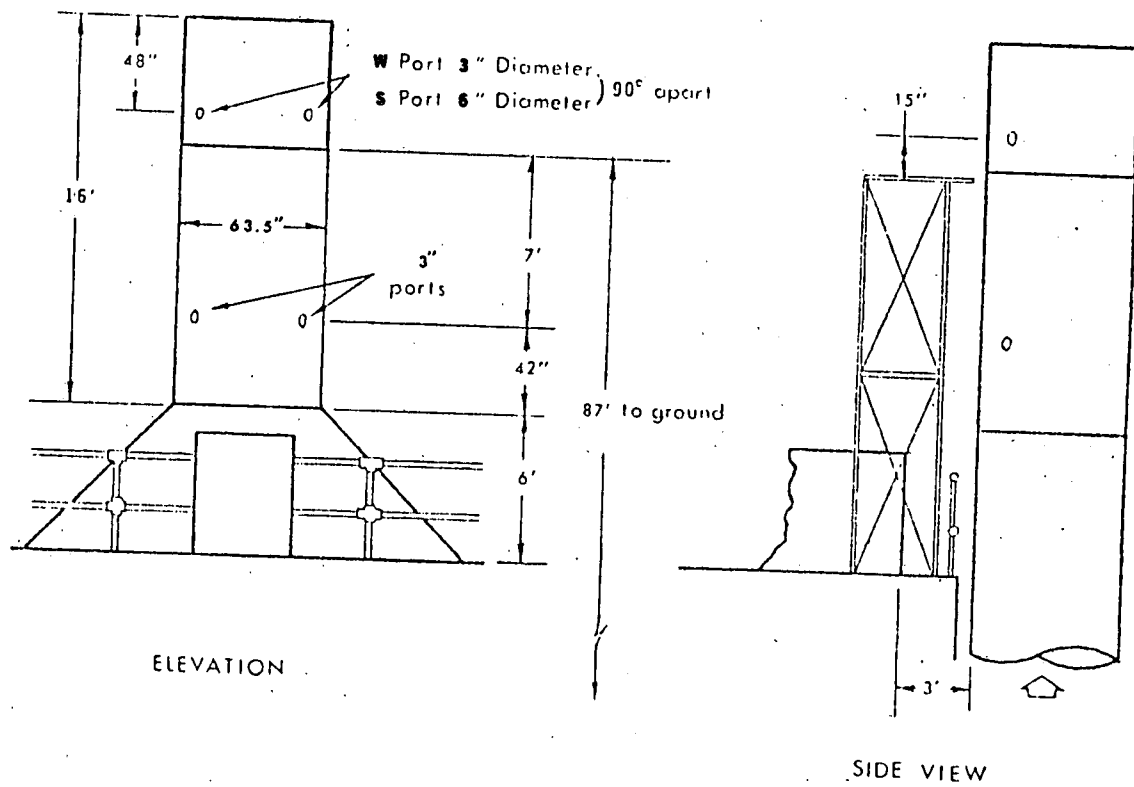
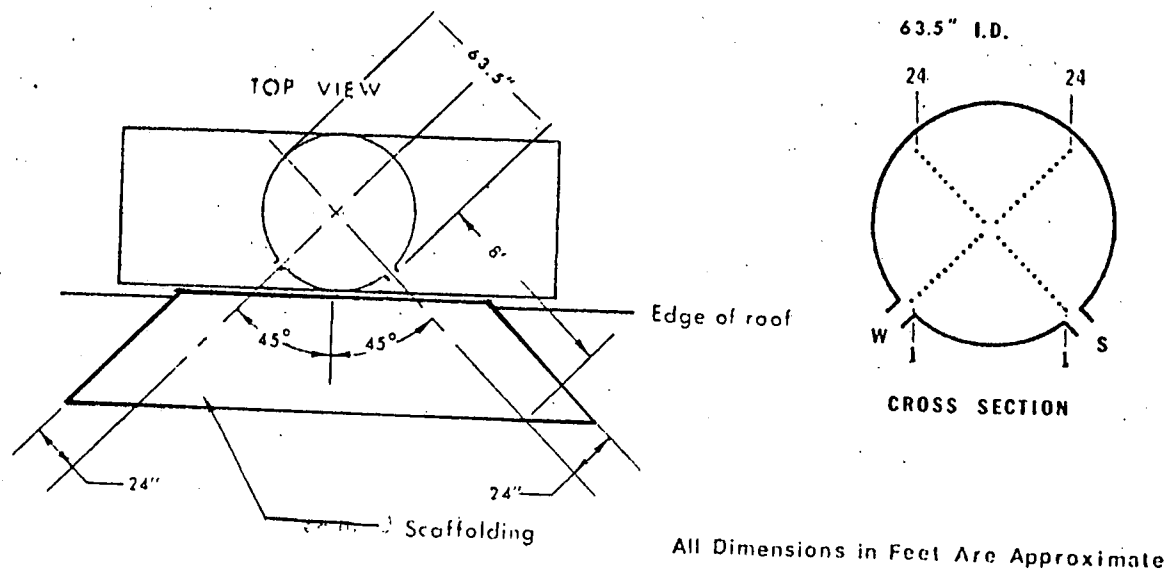


Figure 1. Test Site-No. 1 Kiln Precipitator Outlet.

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 0.7291666 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 30.62 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)	30.62
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 Register¹ - 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 CO₂, O₂, 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.

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

2) Federal Register, Vol. 36, No. 159, August 17, 1971.

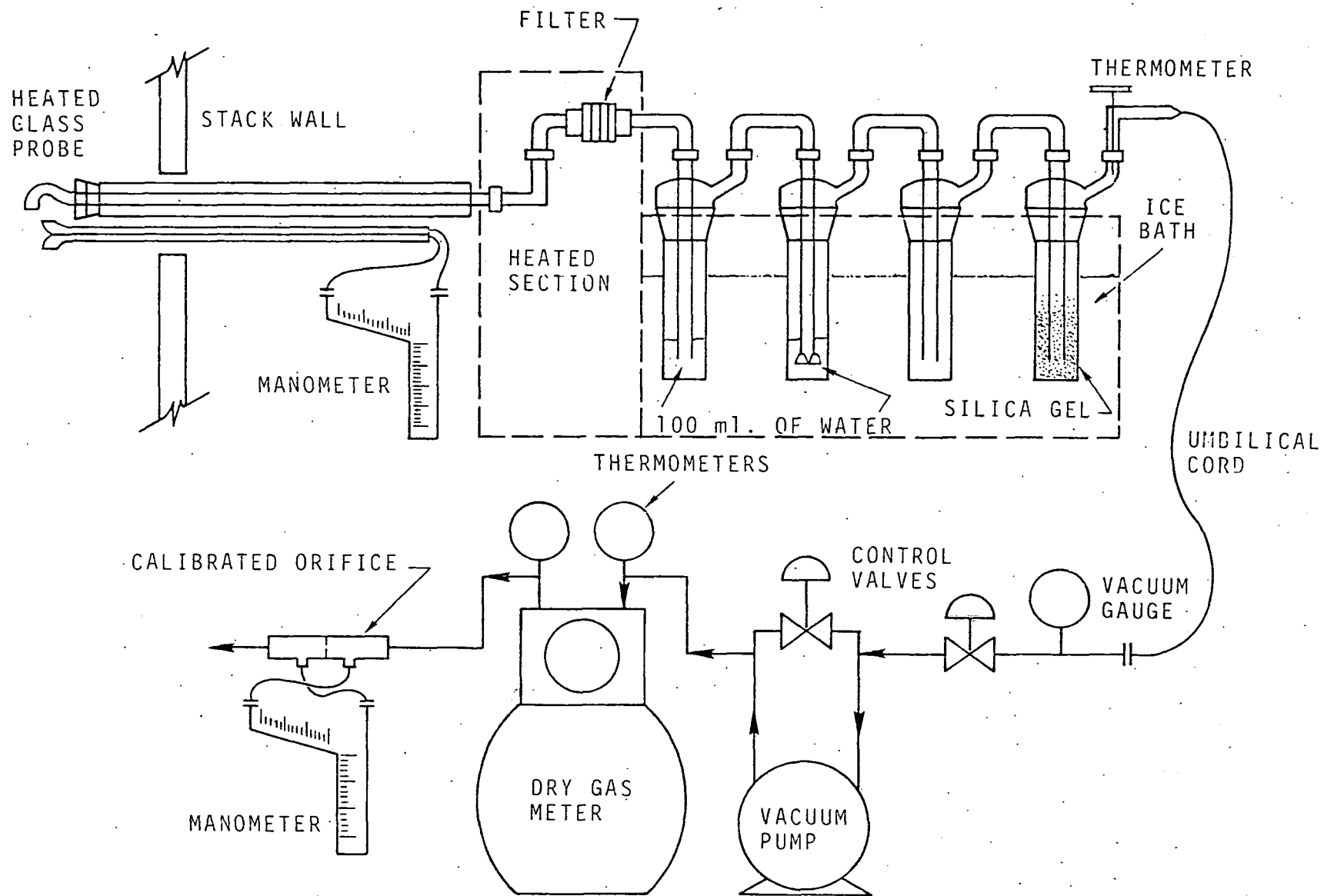


Figure 2. Particulate Sample Train

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 poly-vinyl 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 Register¹ except that the final flask vacuum was read immediately after sampling.

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.



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 (SO₂). Because the concentration was so low, less than 1 ml of titrant was required and an accurate measurement was not possible.