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EPA REPORT number 75-CBK-3

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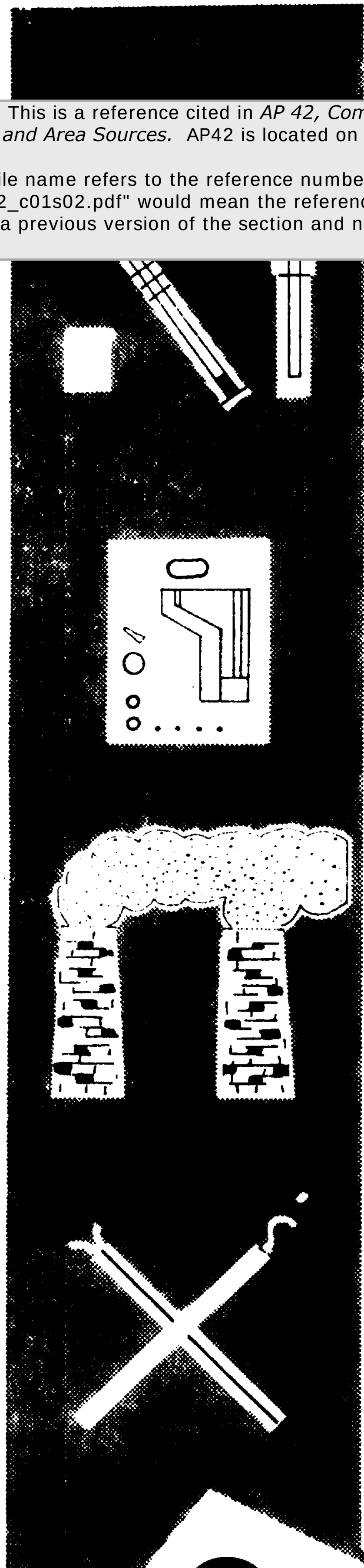

AIR POLLUTION EMISSION TEST

CABOT CARBON, LTD.

Sarnia, Ontario
Canada

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air and Waste Management
Office of Air Quality Planning and Standards
Emission Measurement Branch
Research Triangle Park, North Carolina

SOURCE TESTING OF A WASTE HEAT BOILER

EPA Report No. 75-CBK-3

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Prepared for

U.S. Environmental Protection Agency
Emission Measurement Branch
Research Triangle Park, North Carolina 27711

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EMISSION STUDY

Waste Heat Boiler
Cabot Carbon of Canada, Ltd.
Sarnia, Ontario, Canada
January 14-16, 1975

I. INTRODUCTION

The U.S. Environmental Protection Agency retained George D. Clayton & Associates to conduct an emission study of the No. 2 waste heat boiler at the Cabot Carbon of Canada, Ltd. facility in Sarnia, Ontario. The purpose of this study was to provide data for the establishment of performance standards for newly installed or modified carbon black manufacturing facilities.

The test program included measurement of particulate emissions at the boiler outlet and simultaneous measurement of hydrogen sulfide emissions at both the boiler inlet and outlet. Associated data, including exhaust gas composition, stack gas temperatures and flowrates, and moisture content, were also collected. A continuous instrumental measurement of carbon monoxide at the waste heat boiler outlet was conducted by a field team from Battelle Columbus Laboratories, and results are reported herein.

This study was conducted during January 14, 15, and 16, 1975 by Messrs. Fred Cooper, Richard Griffin, Richard Keller, Richard Marcus, George Santorilla, Kent Shoemaker, and Jon Schoch of Clayton & Associates. Mr. Sylas Miller of Battelle Columbus Laboratories conducted the carbon monoxide monitoring. Monitoring of production data was conducted by Mr. William DeWeiss of PEDCo-

Environmental Company. Mr. Robert Martin, Field Testing Section, Emission Measurement Branch, Office of Air Quality Planning and Standards directed the field test effort.

The study was designed to include measurement of particulate emissions, moisture content, and exhaust gas flowrates at the common inlet duct to the Nos. 1 and 2 waste heat boilers. Difficulties with sampling equipment at this location prevented the sample collection simultaneously with particulate samples collected at the outlet.

II. SUMMARY AND DISCUSSION OF RESULTS

Process Operation

During tests 1 and 3, tail gas from production of carbon black was supplemented by natural gas to fire the No. 2 waste heat boiler. During test 2, production units 2, 3, and 5 were operating; therefore, no natural gas was needed as auxiliary fuel. Because only two or three of six production units were operating during the study, no tail gas was vented through the thermal oxidizer.

Particulate

Tables I and II present the results of particulate emission measurements at the boiler outlet location in both English and metric units, respectively. Total particulate emissions varied from 6.0 to 8.4 and averaged 6.9 pounds per hour. Emission rates during use of gas-boosted fuel (tests 1 and 3) were not significantly different from that resulting from flue gas alone (test 2).

An average of 34 percent of the total weight was captured in the impinger portion of the train. All tests were conducted well within a range of 90 and 110 percent of isokinetic.

Attempts to collect particulate samples at the inlet to the boilers were unsuccessful. Highly positive static pressure and high moisture and carbon monoxide concentrations in the exhaust gas led to two problems. Short circuits in the heated stainless steel probe prevented sample collection. Finally the sampling nozzle and Pitot tube head were crushed in the gate valve (part of the leak-tight sampling port assembly) from slippage within the two-inch conduit probe sheath.

The exhaust gas flowrate and temperature at the inlet location were measured on January 15, 1975. Exhaust gas flowrates were 14,800 SCFM or 45,100 ACFM at a temperature of 393°F. Stack gas moisture content at this location was 47 percent by volume as measured by a moisture determination on January 15, 1975.

Hydrogen Sulfide

Hydrogen sulfide concentrations at the boiler inlet location varied from 592 to 1011 parts per million (Tables III and IV). Measurements of hydrogen sulfide emissions from the boiler (Tables V and VI) were greater during the first three tests than during test 5. Due to suspected contamination from the large volume of accumulated moisture in the first impinger, a dry midget impinger was added after the impinger containing hydrogen peroxide during test 5, which resulted in lower measured concentrations.

Exhaust Gas Composition

Table VII presents the composition of the exhaust gas at the boiler outlet location. The oxygen concentration at this location averaged 3.5 percent for the three tests.

Table VIII shows the composition of flue gas at the boiler inlet. Reported results are the average of several grab samples.

Carbon Monoxide

Results of carbon monoxide monitoring (Table IX) indicate an overall average of 56 parts per million of carbon monoxide as analyzed at the field site. Because ascarite in an impinger preceding the analyzer removed the interfering carbon dioxide from the sampled gas stream, the concentration of carbon monoxide after correcting for the carbon dioxide concentration in the stack was slightly lower than that measured on a CO_2-free basis. Appendix 1 shows the strip chart output of continuous carbon monoxide analysis.

III. PROCESS DESCRIPTION AND OPERATION

Process Description

The Sarnia plant of the Cabot Carbon of Canada, Ltd. has six carbon black production units with four reactors in unit 1, six reactors in unit 2, one reactor each in units 3, 4, and 5, and two reactors in units 6, only one of which can be used at a time. A simplified flow diagram of the off-gas flow is shown in Figure 1. The plant was built in 1953. The No. 1 boiler was built with the original plant at a design capacity of 30,000 lb/hr of 250 psig steam. The No. 2 boiler was installed about 1960 with a design capacity of 60,000 lb/hr of steam. Finally a thermal oxidizer was installed in 1972 and has no heat recovery capacity. The plant design capacity was reported as 175 MM lb/yr. The average carbon black production rate is about 150 MM lb/yr.

Carbon black is produced at the Sarnia plant by controlled pyrolysis of residuum tar. The reaction zone in the furnace is maintained at approximately 2700°F by combustion of natural gas with controlled quantities of air. Carbon black oil, which has been heated to approximately 350°F by natural gas-fired heaters, is injected into the reaction zone where partial combustion and thermal decomposition of the liquid hydrocarbon takes place. The resulting gases and carbon black are cooled by means of a water quench to stop further reaction.

Quality of the carbon black is controlled mainly by varying air, oil, and natural gas ratios and water quench. At the Sarnia plant, several grades of carbon black are produced, and in some cases different grades are produced on the same unit. Units 1 and 2 normally produce non-reinforcing carbon black or relatively large particle size black while units 3, 4, 5, and 6 normally produce semi-reinforcing or relatively small particle size black.

The type of carbon black produced is important to the operation of the boilers, dryers, and oxidizer. No problems are experienced when the off-gas has a heating value of 50 BTU/scf (including water vapor). The typical flue gas heat values reported were 42 to 44 BTU/scf for fine particle black, about 53 BTU/scf for medium black and up to 65 BTU/scf for large particle black.

Separation of carbon black from furnace gases is accomplished by fiberglass and Nomex bag filters. Each of the six plant units has its own baghouse. Units 2, 3, and 4 use Wheelabrator bag filters with fiberglass bags while units 1, 5, and 6 use Micropulsair bag filters with Nomex bags. The Micropulsair bag filters can run with a very high air-to-cloth ratio of four to one but they have experienced a typical bag life of only 22 to 24 weeks. In addition to the short bag life, the gases have to be cooled to at least 375°F before entering the filter. The Micropulsair filters are cleaned using a rapid shot of steam every 30 seconds.

The Wheelabrator bag filters use fiberglass fabric which can withstand inlet temperatures of 450 to 500°F and typically run an air-to-cloth ratio of one and one-half to one. The fiberglass filters are cleaned on a three and one-half minute cycle with a back-flow of off-gas. The bag life was reported to be one to two years.

On units 1, 2, 3, and 4, the carbon black from the main process bag filter is conveyed by air to the process filter, through a hammermill, and into an agitator tank. On units 5 and 6, the carbon black flows by gravity through a hammermill, and into an agitator tank. From the agitator tanks, the carbon black is pelletized by means of a wet process, using water and a binder additive on units 1, 2, 5, and 6, and a dry process on units 3 and 4. Approximately equal weights of carbon black and water are used in the wet process to form the pellets. Drying the pellets to less than one-percent moisture content is accomplished in rotary drum dryers. Off-gas and natural gas are burned in these dryer furnaces and the resulting combustion gases are cooled to approximately 1400°F by dilution air to prevent hot spots and burning of the carbon black. The hot gases heat the carbon black indirectly from the outside of the dryer drum shell. Approximately 50 percent of the exhaust gases from this first pass are exhausted directly to the atmosphere at about 600°F. The remaining gases pass through the inside of the dryer drum and heat the carbon black by direct contact. These gases also serve to purge the water vapor from the dryer and exit through a fiberglass purge gas filter.

Normally, with six units in operation, approximately 56 percent of the off-gas produced is consumed in the dryers and the boilers. The remainder of the off-gas is burned in a thermal oxidizer. The boilers, dryers, and oxidizer are fed typical gas rates as shown in Figure 1. The gas from each unit enters a common flue gas line. However, the gas is not necessarily uniformly mixed before entering each combustion unit. The duct configuration is arranged so the oxidizer tends to receive a lower BTU gas stream than the boilers and dryers. The off-gas is capable of self-sustaining combustion in both the dryers and boilers. Due to the plant's need for about 80,000 lb/hr of steam, natural gas is normally used as a supplemental fuel in both boilers.

Process Operation

Due to the slowdown in the rubber industry, units 1 and 4 were shut down. Also, the off-gas from unit 6 was vented to the atmosphere because of its low BTU value. The only units introducing off-gas into the header were units 2, 3, and 5. This gas was consumed as fuel by boilers 1 and 2 and units 1, 5, and 6 dryers. The need for the thermal oxidizer was eliminated by the reduced volume of off-gas.

The plant operations were in good working order. All units maintained steady-state conditions while feeding off-gas to the header. When any operational problem occurred, the unit's off-gas was removed from the header and vented. For this reason no tests were performed during upset conditions.

Units 2 and 3 have Wheelabrator bag filters with new fiberglass bags installed on July 10, 1974 and August 12, 1974 respectively. The installation dates are well within the one to two year bag life. Unit 5 has a Micropulsair bag filter with new Nomex bags installed on November 27, 1974. The average Nomex bag life has been 22 to 24 weeks. All units should have been representative of a well-controlled carbon black process.

The following reported feed to the reactors on units 2, 3, and 5 are typical, and do not necessarily reflect exact feedstock, natural gas, and air usage during testing. Typical feed on unit 2 is 58,000 scfh air, 5,600 scfh natural gas, and 140 gph feedstock (cracker bottoms) per reactor. Unit 3 reactor's feed is 414,500 scfh air, 29,600 scfh natural gas, and 500 gph feedstock (Shell). Shell feedstock has approximately the same composition as Gulf. Unit 5 reactor's feed is 419,000 scfh air, 36,350 scfh natural gas, and 600 gph feedstock (Escarb). Feedstock and natural gas compositions are shown in Appendices 2 and 3, respectively.

The reactor's feed readout and baghouse temperatures and pressures are presented in Table X. All reactor feed readouts are expressed as percent of nozzle or orifice meter flow control.

Therefore, the numbers recorded are of little direct value except to show that the units remained constant throughout the test periods. The average production of carbon black was calculated by plant personnel from these data. The carbon black production during testing was about 5,500 lb/hr from the six reactors on unit 2, 2,100 lb/hr from the reactor on unit 3, and 3,400 lb/hr from the reactor on unit 5.

Boiler No. 2 was operated at 50,000 pounds of steam per hour at a pressure of 260 psig during all tests. The second test on boiler No. 2 was performed during the combustion of off-gas only. The first and third tests were performed with the addition of natural gas to the boiler. Boiler operating data are presented in Table XI. The off-gas flows could not be determined directly from panel board data, and only comparative orifice pressure drops are presented. Boiler combustion air flows were not measured directly either. Total heat input, based on steam production and a boiler efficiency of 75 percent was calculated for tests 1, 2, and 3, respectively, to be 81.3, 84.7, and 84.7 MM BTU/hr (1270 BTU/lb x steam rate/0.75). Natural gas provided 20 to 25 percent of the heat input in tests 1 and 3.

IV. LOCATION OF SAMPLING PORTS

The inlet sampling was conducted in the common duct from the six carbon black production units to the No. 1 and No. 2 waste heat boilers. This circular duct is four feet in diameter and runs horizontally along the edge of the building which houses the boilers (Figure 2). Two ports were utilized at this location, one on the side and one on the top of the duct. Although a bottom port would have been preferable, plant personnel suspected that the bottom of the duct was weak from corrosion due to moisture accumulation. The inlet sampling cross section was located more than eight duct diameters of straight, horizontal airflow downstream and more than two duct diameters upstream from duct elbows or transitions. Therefore, the stack was divided into 12 equal annular areas, six points on each diameter, as shown in Figure 3.

Due to the high positive pressure, high moisture content, toxicity, and flammability of the reactor tail gases at the inlet sampling location, a special port arrangement had to be constructed for the sampling probes. Each of the two ports consisted of a four-inch nipple welded to the stack to which a gate valve was attached. A three and one-half inch hole was drilled through the stack wall. The "pitobe" nozzle and Pitot tube head were located in a four-inch nipple and the probe was encased in two-inch conduit which could slide through a packing gland into the stack in order that the gases in the duct did not leak from the sampling port during testing.

Exhaust gases passing the inlet sampling location are drawn by either of two fans to the No. 1 and No. 2 waste heat boilers.

After passing through the waste heat boiler, exhaust gases are vented through each of two separate horizontal ducts. Exhaust gases from the two boilers are then combined in the breeching and are exhausted through a tall circular stack. Sampling was conducted at the outlet of the No. 2 boiler in the 80-inch high by 48-inch wide cross section as indicated in Figure 4. Eight ports located on the side of the duct were used for the collection of the samples. No. 2 boiler outlet samples were collected at each of 40 sampling ports at this location in spite of its proximity to a bend and dampers which were both within two diameters of the sampling cross section.

V. SAMPLING AND ANALYTICAL PROCEDURES

Particulate Sampling

Particulate sampling at the boiler outlet location was conducted according to the principles outlined in Method 5, 40CFR60. Deviations from this method are noted below:

1. The outlet duct was divided into 40 equal areas and sampling and velocity traverse measurements were made at the midpoints of these areas. Method 1, 40CFR60, would have required a larger number of sampling points due to the proximity of the bend upstream and dampers downstream. However, turning vanes in the bend upstream and the open dampers downstream both acted to produce a more uniform velocity traverse than would usually be expected.

2. A glass cyclone was placed in the heated filter box to remove some particulate materials prior to filtration.
3. Calculation of the average stack gas velocity included an averaging of the square roots of the products of velocity pressure and absolute stack temperature at each of the traverse points.
4. Rather than using Orsat analysis for the measurement of exhaust gas composition at the waste heat boiler inlet location, grab samples of the flue gas were collected in glass sample bombs with stopcocks on either end. These samples were analyzed by Cabot personnel using the gas chromatograph at the Sarnia plant. This method was used because of the unusual composition of this exhaust gas stream. (The Orsat apparatus cannot detect the large amounts of low molecular weight hydrogen gas present in this source.)

Moisture content and particulate sampling field data sheets are presented in Appendices 4 and 5, respectively. Appendix 6 contains the sample volume and percent isokinetic calculations for particulate samples collected at the boiler outlet, and Appendix 7 contains the laboratory weights of materials captured during these tests. Appendix 8 presents the nomenclature and sample calculations used in calculating particulate emission results.

Hydrogen Sulfide

Sampling and analysis for hydrogen sulfide at both the boiler inlet and outlet sampling locations was conducted according to the principles outlined in Method 11, 40CFR60, with the following exceptions:

1. Due to the high concentrations of hydrogen sulfide at the waste heat boiler inlet location, sampling periods were very brief. The yellow color of cadmium sulfide was visible in the third impinger soon after sampling commenced.
2. The high moisture content in the stack exhaust gas at the outlet location resulted in a large amount of moisture condensate in the first impinger. The increased liquid volume in this impinger resulted in carry-over of the solution from the first impinger into the second impinger which contains the cadmium hydroxide. This was suspected after completion of the first four tests; therefore, during the fifth test an additional impinger was added after the impinger containing hydrogen peroxide to collect the entrained solution. This arrangement resulted in no poisoning of the cadmium hydroxide containing impingers; therefore, contamination was avoided.
3. A heated glass probe was used at the boiler outlet to withdraw the sample from the stack. A probe was connected directly to the first impinger without the use of Teflon tubing.

Appendix 9 presents the field data sheets for hydrogen sulfide sampling and Appendix 10 presents the sample calculations used to calculate these data.

Carbon Monoxide

Carbon monoxide was measured by Method 10, 40CFR60, with the following exceptions:

1. As shown in Figure 5, moisture from the stack gas was removed by passing the exhaust gas through modified Greenburg-Smith impingers rather than using an air-cooled condenser.
2. The carbon monoxide was continuously monitored by non-dispersive infrared techniques using a Beckman model 305B analyzer. The 0 to 1,250 ppm range was used. The sensitivity is rated at 0.5 percent of full scale with an accuracy of $\pm$ 1 percent. The analyzer was calibrated before and after each run with zero nitrogen and a certified standard carbon monoxide span gas of 1050 ppm.

This report prepared by: Fred I. Cooper

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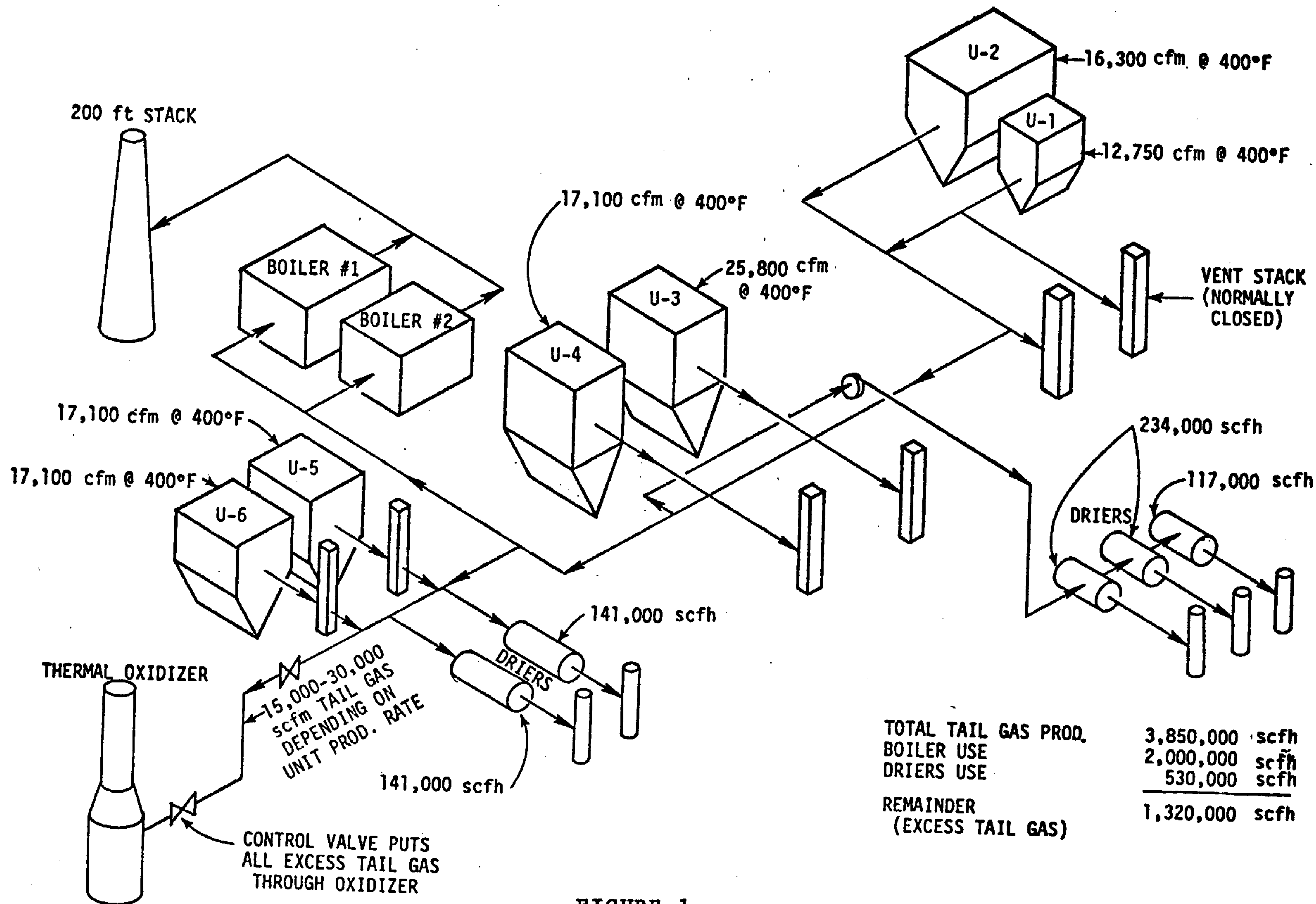


FIGURE 1

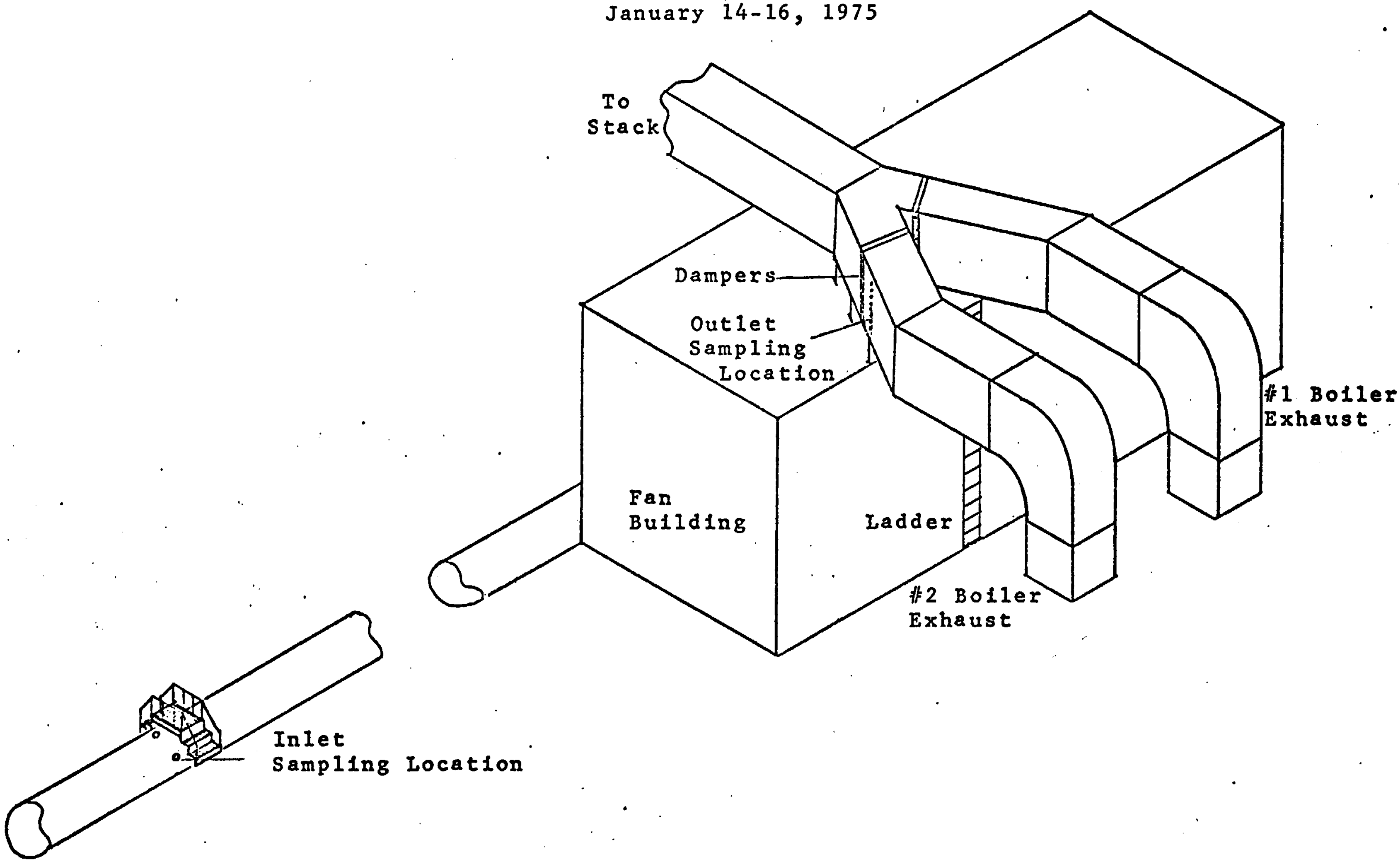
PROCESS GAS FLOW DIAGRAM

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

FIGURE 2

LOCATION OF INLET AND OUTLET SAMPLING PORTS

Waste Heat Boilers
Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975



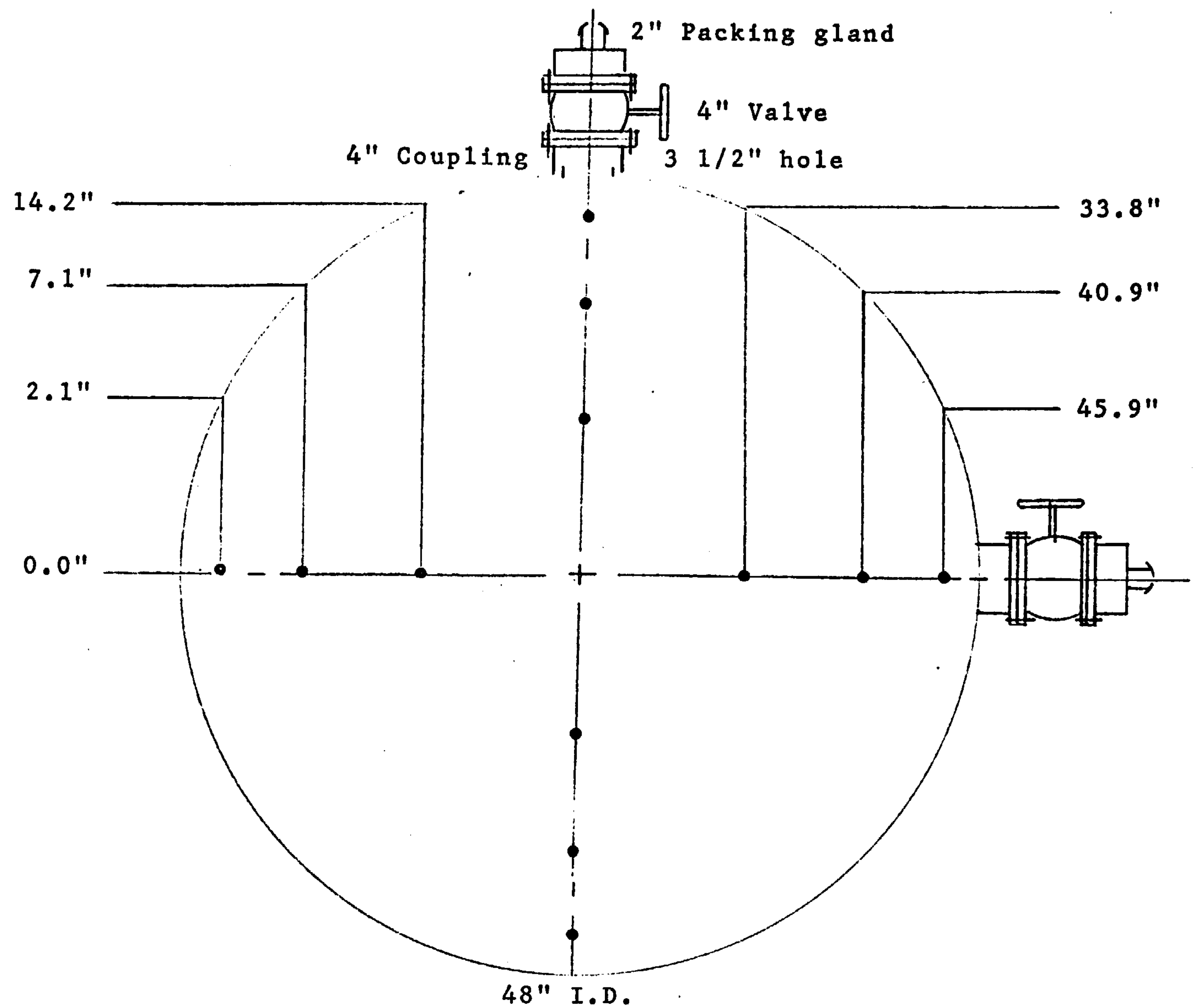


FIGURE 3

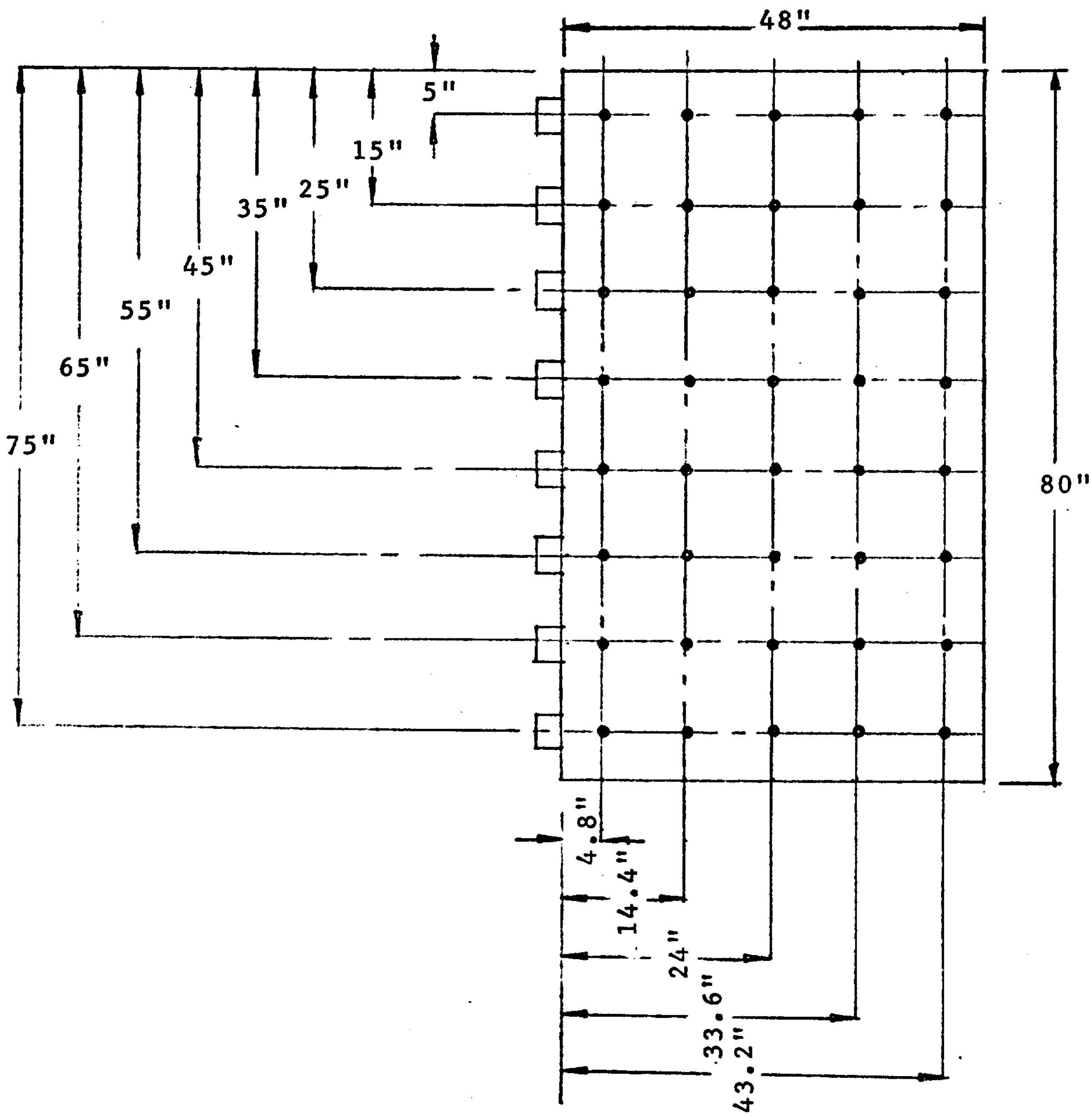
LOCATION OF SAMPLING POINTS - BOILER INLET LOCATION

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

FIGURE 4

LOCATION OF SAMPLING POINTS - NO. 2 BOILER OUTLET

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975



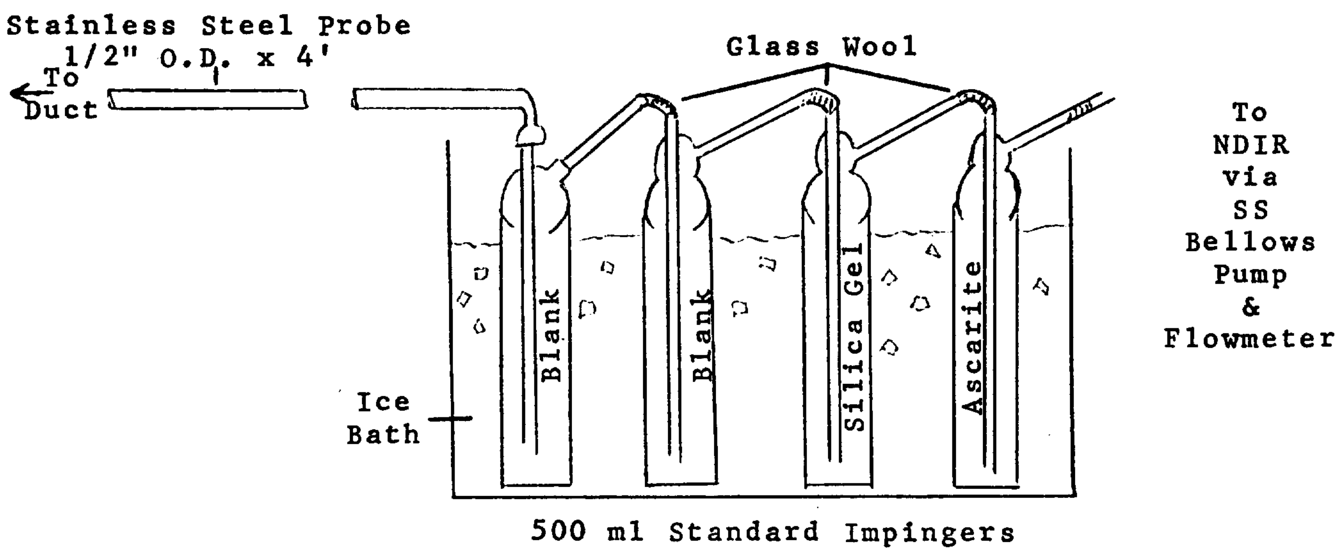


FIGURE 5

SCHEMATIC DIAGRAM OF SAMPLE GAS CONDITIONING SYSTEM FOR CARBON MONOXIDE DETERMINATION

No. 2 Boiler Outlet
Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

TABLE I

SUMMARY OF PARTICULATE EMISSIONS (ENGLISH UNITS)

No. 2 Boiler Outlet
Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Test Number	1975 Date	Sampling Period	Stack Gas Conditions		Filterable Particulate		Total Particulate	
			Temp (°F)	Flowrate (Dry SCFM)	gr/DSCF	lbs/hr	gr/DSCF	lbs/hr
1	1/14	16:30 - 18:30	460	15,800	0.029	4.0	0.045	6.0
2	1/15	13:20 - 15:20	415	20,600	0.028	5.0	0.048	8.4
3	1/16	09:52 - 11:12	385	17,200	0.032	4.6	0.042	6.2
A V E R A G E			420	17,900	0.030	4.5	0.045	6.9

George D. Clayton & Associates

TABLE II

SUMMARY OF PARTICULATE EMISSIONS (METRIC UNITS)

No. 2 Boiler Outlet
Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Test Number	1975 Date	Sampling Period	Stack Gas Conditions		Filterable Particulate		Total Particulate	
			Temp (°C)	Flowrate (DNm^3/min)	mg/DNm^3	kg/hr	mg/DNm^3	kg/hr
1	1/14	16:30 - 18:30	238	447	67.4	1.8	101.9	2.7
2	1/15	13:20 - 15:20	213	582	64.6	2.3	108.7	3.8
3	1/16	09:52 - 11:12	196	486	72.1	2.1	96.2	2.8
A V E R A G E			216	505	68.0	2.1	102.3	3.1

TABLE III

SUMMARY OF HYDROGEN SULFIDE EMISSIONS (ENGLISH UNITS)
INLET TO WASTE HEAT BOILERS

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Test Number	1975 Date	Sampling Period	Stack Gas Conditions		Hydrogen Sulfide Concentration		Hydrogen Sulfide Emission Rate
			Temp. (°F)	Flowrate (DSCFM)	gr/DSCF	ppm	(lbs/hr)
1	1-14	15:31-15:41	-	-	0.444	719	-
2	1-14	16:45-16:55	-	-	0.389	629	-
3	1-15	13:25-13:35	393	14,800	0.366	592	46.4
4	1-15	14:00-14:10	393	14,800	0.413	668	52.4
5	1-16	10:01-10:11	-	-	0.494	799	-
6	1-16	10:41-10:51	-	-	0.625	1011	-

TABLE IV

SUMMARY OF HYDROGEN SULFIDE EMISSIONS (METRIC UNITS)
INLET TO WASTE HEAT BOILERS

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Test Number	1975 Date	Sampling Period	Stack Gas Conditions		Hydrogen Sulfide Concentration		Hydrogen Sulfide Emission Rate
			Temp. (°C)	Flowrate (DNm^3/min)	mg/DNm^3	ppm	(kg/hr)
1	1-14	15:31-15:41	-	-	1017	719	-
2	1-14	16:45-16:55	-	-	889	629	-
3	1-15	13:25-13:35	201	418	837	592	21.1
4	1-15	14:00-14:10	201	418	945	668	23.8
5	1-16	10:01-10:11	-	-	1131	799	-
6	1-16	10:41-10:51	-	-	1430	1011	-

TABLE V

SUMMARY OF HYDROGEN SULFIDE EMISSIONS (ENGLISH UNITS)
NO. 2 BOILER OUTLET

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Test Number	1975 Date	Sampling Period	Stack Gas Conditions		Hydrogen Sulfide Concentration		Hydrogen Sulfide Emission Rate (lbs/hr)
			Temp (°F)	Flowrate (Dry SCFM)	gr/DSCF	ppm	
1	1/14	15:33 - 16:33	460	15,800	0.008	13.5	1.1
2	1/14	16:52 - 17:53	460	15,800	0.005	8.7	0.73
3	1/15	13:27 - 14:28	415	20,600	0.001	1.6	0.17
5*	1/16	09:59 - 10:59	385	17,200	0.00003	0.04	0.004

* Test number 4 is void

TABLE VI

SUMMARY OF HYDROGEN SULFIDE EMISSIONS (METRIC UNITS)
NO. 2 BOILER OUTLET

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Test Number	1975 Date	Sampling Period	Stack Gas Conditions		Hydrogen Sulfide Concentration		Hydrogen Sulfide Emission Rate
			Temp. (°C)	Flowrate (DNm^3/min)	mg/DNm^3	ppm	(kg/hr)
1	1-14	15:33-16:33	238	447	19.2	13.5	0.51
2	1-14	16:52-17:53	238	447	12.3	8.7	0.33
3	1-15	13:27-14:28	213	582	2.3	1.6	0.08
5*	1-16	09:59-10:59	196	486	0.06	0.04	0.002

*Test number 4 is void.

TABLE VII

EXHAUST GAS COMPOSITION - ORSAT ANALYSES

No. 2 Boiler Outlet
Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Particulate Test Number	Exhaust Gas Composition, Percent (Dry Basis)				Moisture Content (Percent)
	Carbon Dioxide	Oxygen	Carbon Monoxide	Nitrogen	
1	9.2	3.2	<0.2	87.6	32.9
2	8.4	4.0	<0.2	87.6	36.7
3	9.1	3.4	<0.2	87.5	31.5
AVERAGE	8.9	3.5	<0.2	87.6	33.7

TABLE VIII

COMPOSITION OF FLUE GAS AT INLET TO BOILERS

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

1975 Date	Flue Gas Composition (percent by volume, dry basis)						
	CO_2	C_2H_2	H_2	Ar	N_2	CH_4	CO
1-14	3.9	0.5	17.9	0.9	63.7	0.7	12.4
1-15	4.1	0.5	17.2	0.9	64.4	0.6	12.3

TABLE IX

CARBON MONOXIDE EMISSIONS

No. 2 Boiler Outlet
Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Run Number	Sample Port	1975 Date	Sampling Time		Carbon Monoxide Concentration (ppm by volume)					
					dry basis, CO_2 free			dry basis		
			Start	Stop	Max.	Min.	Avg.	Max.	Min.	Avg.
1	8	1-14	15:45	16:35	60	20	31	54	18	28
2	8	1-15	10:55	14:00	100	60	68	92	55	62
3	5	1-16	09:45	10:40	60	45	50	55	41	45
4	2	1-16	13:05	13:45	90	50	75	82	45	68

TABLE X

REACTOR FEED READINGS AND BAGHOUSE CONDITIONS

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Test No. Date 1975 Time		1 1/14 3:30	1 1/14 4:30	1 1/14 5:30	2 1/15 1:30	2 1/15 2:30	2 1/15 3:30	2 1/15 4:30	3 1/16 10:00	3 1/16 11:00
Unit 2										
Reactor 1	Oil	67	67	67	67	67	67	67	Unit Down	
	Gas	8.6	8.6	8.6	8.5	8.6	8.6	8.6		
	Air	64	64	64	62	62	62	62		
Reactor 2	Oil	67	68	68	67	67	67	67		
	Gas	8.8	8.8	8.8	8.7	8.7	8.7	8.7		
	Air	64	64	64	62	62	62	62		
Reactor 3	Oil	68	67	68	68	68	68	68		
	Gas	8.8	8.8	8.8	8.6	8.6	8.6	8.6		
	Air	63	63	63	61	61	61	61		
Reactor 4	Oil	70	70	70	70	70	70	70		
	Gas	8.6	8.6	8.6	8.6	8.6	8.6	8.6		
	Air	62	62	62	61	61	61	61		
Reactor 5	Oil	71	72	72	71	71	71	71		
	Gas	8.8	8.8	8.8	8.8	8.7	8.7	8.7		
	Air	64	64	64	62	62	62	62		
Reactor 6	Oil	73	72	72	73	72	72	72		
	Gas	8.7	8.8	8.8	8.6	8.6	8.6	8.6		
	Air		64	64	62	61	62	62		
Baghouse	In °F	470	470	470	470	470	470	470		
	Out °F	410	410	410	410	410	410	410		
	ΔP IWC	4.8	4.2	4.5	4.5	4.6	4.5	4.2		
	Inlet IWC	11.0	11.0	11.0	12	12	12	12		
Type of Carbon Black		SRFX46			SRFX46					
Unit 3										
Reactor	Oil	Shut Down			67	67	67	67	67	67
	Gas				62	62	62	62	60	60
	Air				60	60	60	60	63	63
Baghouse	In °F				480	480	480	480	475	475
	Out °F				435	435	435	435	435	435
	ΔP IWC				4.7	4.8	4.8	5.0	4.0	4.5
	Inlet IWC				11	12	11	12	10	11
Type of Carbon Black					V6				V6	
Unit 5										
Reactor	Oil	84	84	84	83	83	83	83	83	83
	Gas	74	74	74	73	73	73	73	74	74
	Air	60	60	60	60	60	61	61	62	62
Baghouse	In °F	375	375	375	375	375	375	375	375	375
	Out °F	350	350	350	350	350	350	350	350	350
	ΔP IWC	11	10.2	12	9.5	12.3	10	12.4	10	10
	Inlet IWC	14.5	14.5	17	15.5	14.8	15.5	15.2	14.2	14.4
Type of Carbon Black		VM			VM				VM	

TABLE XI

SUMMARY OF NO. 2 BOILER DATA

Cabot Carbon of Canada, Ltd.
Sarnia, Ontario
January 14-16, 1975

Test No.	1	1	1	2	2	2	2	3	3
Date 1975	1/14	1/14	1/14	1/15	1/15	1/15	1/15	1/16	1/16
Time	3:30	4:30	5:30	1:30	2:30	3:30	4:30	10:00	11:00
Off-Gas Flow[a]	48	34	34	82	84	84	84	57	57
Temp., °F	375	375	375	395	395	400	400	395	395
Press., IWC[b]	4.0	4.0	4.0	6	7	7	7	2.7	2.8
Boiler Press., IWC[b]	1.5	1.5	1.5	3	3.2	3.2	3.2	1.8	1.8
Air Flow[a]	50	50	50	50	50	50	50	50	50
Nat. Gas Flow, scfh X 10^3 [d]	17	21	21	0	0	0	0	16	16
Outlet Gas Temp., °F	415	415	415	445	445	445	445	415	415
O_2, %	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9
Steam Flow, lb/hr x 10^3	48	48	48	50	50	50	50	50	50
Temp., °F	517	520	520	520	515	520	515	515	520
Header Press., psig	250	250	250	250	250	250	250	250	250
Boiler Press., psig	260	260	260	260	260	260	260	260	260

a Percent of scale reading, orifice coefficient unknown.

b IWC = inch of water column.

c Percent of scale reading to maintain two percent oxygen at boiler outlet.

d Standard cubic feet per hour at 60°F.

Note: Data obtained or calculated from panel board.