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JONES & LAUGHLIN STEEL CORP.
ALIQUIPPA, PA

PROCESS DESCRIPTION

The Jones & Laughlin Steel Corp. operates its A-5 Coke Oven Battery for the destructive distillation of bituminous coal to form metallurgical coke at its Aliquippa Works facility. Stack Test No. 1978 was performed in the stack servicing the combustion exhaust from the A-5 Battery.

Coke oven operation consists of three processes: 1. Coking 2. Recovery of Coal Chemicals and 3. Combustion of coke oven gas.

The A-5 coke battery consists of 56 twin-flue underjet ovens underfired with coke oven gas. Each oven has a floor to roof height of 20.5 feet and is capable of coking approximately 33.9 tons of coal per charge.

Coal, preheated to approximately 500^{o}F at a coal preheating plant, is carried through an enclosed pipeline charging system to the oven to be charged using steam as a carrier gas. Diverter valves located at each oven are used in selecting the oven into which the coal is charged. The coal entering the oven distributes itself across the entire length of the oven.

During the coking process which lasts approximately 14 to 17 hours, the volatile matter content of the charged coal is reduced to less than one percent. Once coking is complete, the coke is pushed from the coking chamber by a pusher. This unit pushes the coke from the oven on the coking side into a coke quench car. The coke is transported to the quench tower where it is cooled by water sprays. The coke is then transported to a discharge area where it is distributed for plant use.

Each oven is equipped with a single ascension pipe connected to a two compartment collection main: a charging main and a primary collecting main. During the charging process the oven being charged is connected to the charging main where the effluent evolved during the charge is scrubbed with a charging liquor consisting of water, coal particles and tar before going to off-take mains for further processing. Once charging is complete, the oven is connected to the primary collecting main for the remainder of the coking operation. The volatile matter from the coking process is collected in the primary collecting main. The main recovers coke gas and carries it to a by-product recovery plant. The by-product recovery consists of tar, Ammonium sulfate, weak ammonia liquor, light oil, sulfur and gas removal. Figure I indicates a flow diagram and by-product production rates.

Coke oven gas is consumed at an average rate of approximately 509,000 cubic feet per hour in the heating chambers to provide heat for the coking chambers. Coke oven gas is ducted to separate gas risers each equipped with regulating nozzles to control the flow of gas to each flue.

There are sixteen twin-flues per oven designed to permit burning of coke oven gas simultaneously in alternate flues. Ambient air is drawn through a regenerative chamber prior to being introduced into the flues. Every 30 minutes, the air flow direction is reversed so that the combustion air is always preheated by a hot regenerative chamber.

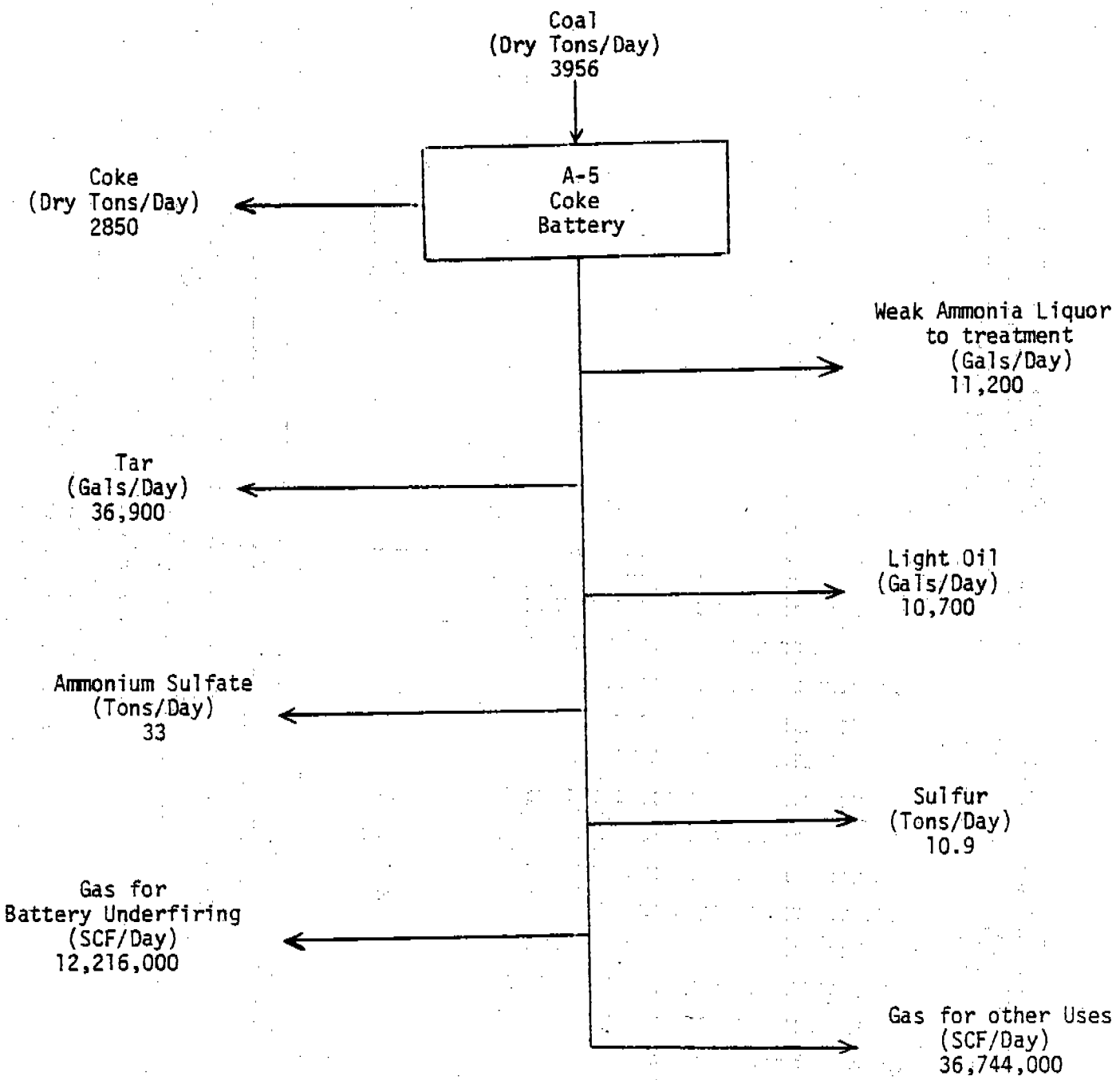
On the outlets of the regenerative chambers, there is a flue for the exhaust gas flow to the stack. The flue is opened in the direction of flow so that the exhaust gas is drawn by natural draft to the combustion exhaust stack.

The exhaust gases from the A-5 coke battery are exhausted to the atmosphere through a stack having a 10.6 feet diameter at the sampling location and a discharge point of 250 feet above grade.

Figure II shows a partial cross-sectional view of the heating chamber and coke chamber.

JONES & LAUGHLIN STEEL CORP.
ALIQUIPPA, PA

FIGURE I
PROCESS FLOW DIAGRAM
BY-PRODUCT PRODUCTION RATES



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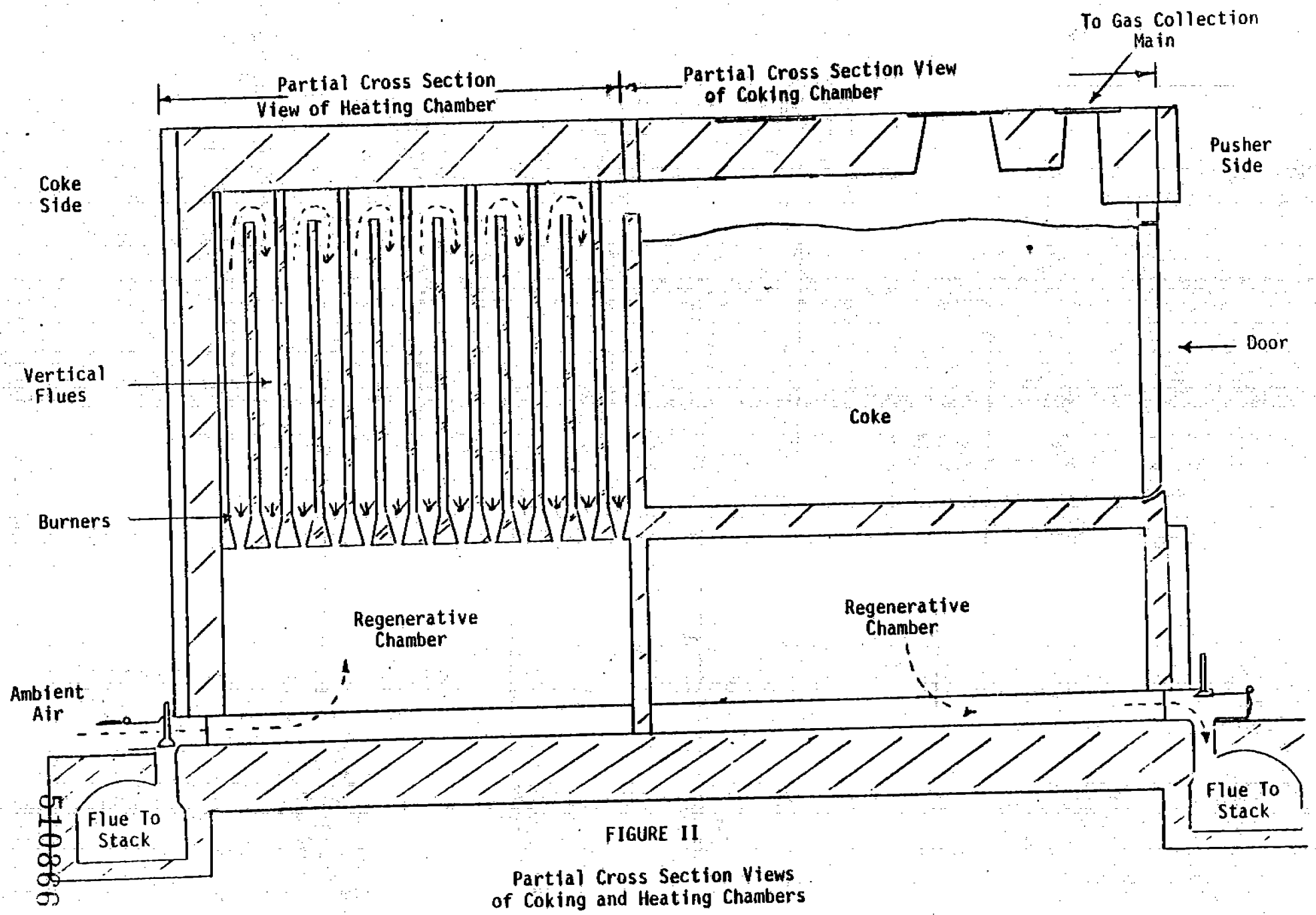


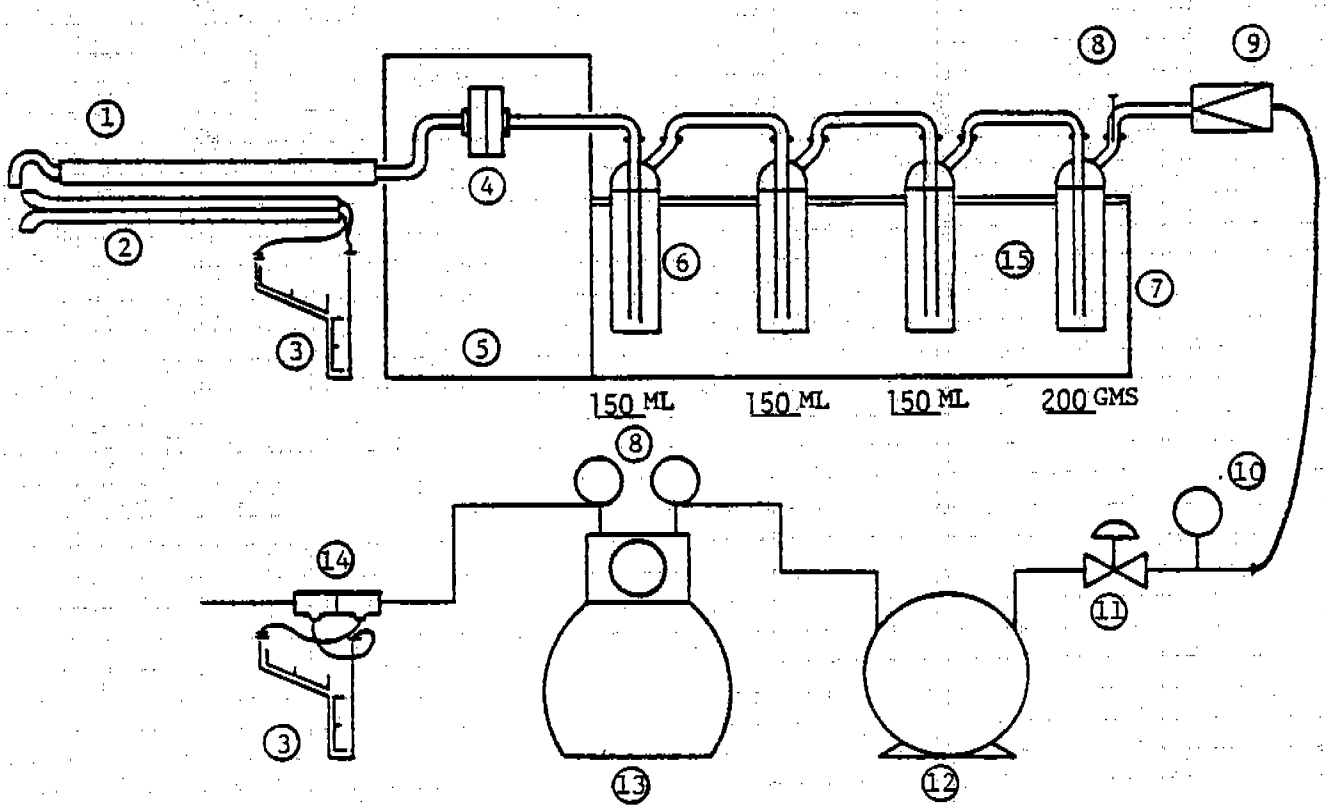
FIGURE II

Partial Cross Section Views
of Coking and Heating Chambers

Test No. 1978

SAMPLING APPARATUS

Date 6/7/78



1. Heated Sample Probe
2. "S" Type Pitot Tube
3. Inclined Manometer
4. 5 Inch Dia. Glass Fiber Filter
5. Heated Sample Box
6. Impinger
7. Ice Bath Container
8. Thermocouple
9. Check Valve
10. Vacuum Guage
11. Valves To Control Gas Flow Rate
12. Leak Free Pump
13. Dry Gas Meter
14. Orifice Meter
15. Silica Gel

Impinger Solution: Distilled Water

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ER-AQ-74: Rev. 6/78

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY CONTROL

TEST NO. 1978

GAS VOLUME DATA
PRELIMINARY TRAVERSE

NAME OF FIRM: Jones & Laughlin Steel Corp., Aliquippa, PA

DATE: 6/7/78

SAMPLE STATION: Sampling ports located in the combustion stack approximately 120 feet above grade

TIME	POINT	V. H.	T °F.	VEL FT/SEC
9:13 AM	B-6	0.11	526	30.2
	5	0.11	526	30.2
	4	0.10	529	28.8
	3	0.09	528	27.3
	2	0.09	524	27.3
	1	0.09	500	27.0
	1	0.09	500	27.0
	2	0.09	504	27.0
	3	0.10	505	28.5
	4	0.10	511	28.6
	5	0.11	512	30.0
	6	0.11	512	30.0
	6	0.10	513	28.6
	5	0.11	514	30.0
	4	0.10	516	28.6
	3	0.10	511	28.6
	2	0.11	511	30.0
	1	0.09	500	27.0

TIME	POINT	V. H.	T °F.	VEL FT/SEC
9:50 AM	A-5	0.13	510	32.6
	4	0.12	507	31.2
	3	0.11	507	29.9
	2	0.10	503	28.4
	1	0.08	490	25.3
	1	0.09	490	26.8
	2	0.10	503	28.4
	3	0.11	505	29.9
	4	0.13	504	32.5
	5	0.12	510	31.3
	5	0.13	513	32.6
	4	0.11	508	29.9
	3	0.12	507	31.2
	2	0.10	506	28.5
	1	0.08	490	25.3

$P_{Barometric}$ = 29.04 in. Hg

P_{Static} = -0.83 in. H_2O

P_{Stack} = 28.98 in. Hg.

TRAVERSE VELOCITY 29.0 FT./SEC.

REFERENCE POINT VELOCITY _____ FT. SEC.

Pressure Correction Factor
~~XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX~~ 1.02

PITOT CORRECTION FACTOR 0.860

GAS DENSITY CORRECTION FACTOR 1.03

CORRECTED TRAVERSE VELOCITY.

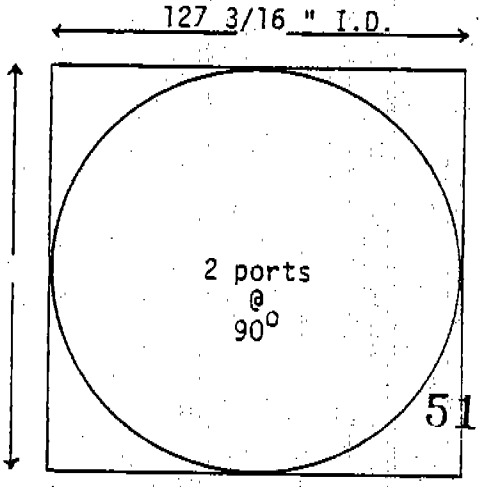
29.0 × 1.02 × 0.860 × 1.03 = 26.2 FT./SEC.

AREA OF FLUE 88.2 SQ. FT. AV. FLUE TEMP. 509 °F.

VOL. = 26.2 FT./SEC. × 88.2 SQ. FT. × 60 = 138,700 CFM

$$\text{VOL.} = 138{,}700 \text{ CFM} \times \frac{530^{\circ}R}{969^{\circ}R} \times \frac{28.98 \text{ in.Hg}}{29.92 \text{ in.Hg.}} = 73{,}500 \text{ SCFM}$$

Vol. = 73,500 SCFM x (100 - 17.4) %(H_2O) = 60,700 DSCFM



Distance from Inside Wall to Sampling Point:
1. 5 9/16" 3. 37 5/8" 5. 108 5/8"
2. 18 9/16" 4. 89 9/16" 6. 121 5/8"

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY CONTROL

TEST NO. 1978

GAS VOLUME DATA
SAMPLING TRAVERSE

NAME OF FIRM: Jones & Laughlin Steel Corp., Aliquippa, PA

DATE: 6/7/78

SAMPLE STATION: Sampling ports located in the combustion stack approximately 120 feet above grade

TIME	POINT	V. H.	T °F.	VEL FT/SEC
LEAK CHECK = 0.00 CFM @ 14 in. Hg.				
10:50 AM	A-5	0.13	505	32.5
+ 5		0.13	506	32.5
+ 10		0.13	506	32.5
11:00	A-4	0.12	507	31.2
+ 5		0.12	512	31.3
+ 10		0.12	516	31.4
11:10	A-3	0.10	520	28.7
+ 5		0.10	518	28.7
+ 10		0.10	507	28.5
11:20	A-2	0.10	504	28.5
+ 5		0.10	506	28.5
+ 10		0.10	506	28.5
11:30	A-1	0.08	500	25.4
+ 5		0.08	492	25.3
+ 10		0.08	494	25.3
11:55 AM	B-5	0.12	502	31.2
+ 5		0.12	505	31.2
+ 10		0.12	511	31.3
12:05 PM	B-4	0.09	515	27.2
+ 5		0.09	517	27.2
+ 10		0.09	519	27.2
12:15	B-3	0.09	523	27.3
+ 5		0.09	505	27.0
+ 10		0.09	507	27.0
12:25	B-2	0.09	503	27.0
+ 5		0.09	510	27.1
+ 10		0.09	510	27.1
12:35	B-1	0.08	500	25.4
+ 5		0.08	500	25.4
+ 10		0.08	500	25.4
LEAK CHECK = 0.00 CFM @ 10 in. Hg.				
$P_{Barometric}$ = 29.04 in. Hg.				
P_{Static} = -0.83 in. H_2O				
P_{Stack} = 28.98 in. Hg.				

TRAVERSE VELOCITY 28.4 FT./SEC.

REFERENCE POINT VELOCITY _____ FT. SEC.

Pressure Correction Factor

~~XXXXXXXXXXXXXXXXXXXXXXXXXXXX~~ 1.02

PITOT CORRECTION FACTOR 0.860

GAS DENSITY CORRECTION FACTOR 1.03

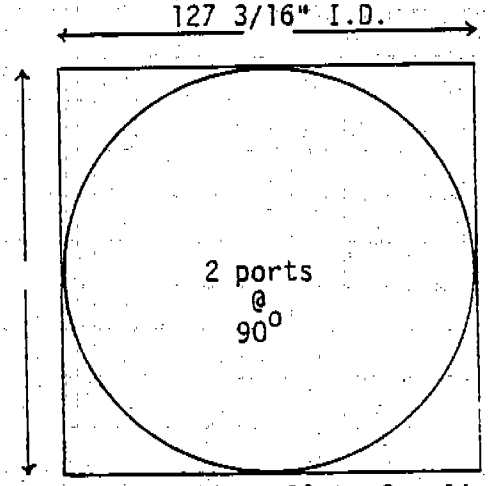
CORRECTED TRAVERSE VELOCITY

28.4 × 1.02 × 0.860 × 1.03 = 25.6 FT./SEC.

AREA OF FLUE 88.2 SQ. FT. AV. FLUE TEMP. 508 °F.

VOL. = 25.6 FT./SEC. × 88.2 SQ. FT. × 60 = 135,500 CFM

VOL. = 135,500 CFM × $\frac{530^{\circ}R}{968^{\circ}R}$ × $\frac{28.98 in.Hg.}{29.92 in.Hg.}$ = 71,900 SCFM



Distance from Inside Wall to Sampling Point
1. 5 9/16" 3. 37 5/8" 5. 108 5/8"
2. 18 9/16" 4. 89 9/16" 6. 121 5/8"

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY AND NOISE CONTROL

TEST NO. 1978

CALCULATION SHEET

NAME OF FIRM	DATE
Jones & Laughlin Steel Corp., Aliquippa, PA	6/7/78

SAMPLE STATION: Sampling ports located in the combustion stack approximately 120 feet above grade

COLLECTION TRAIN FOR	SAMPLE POINT	SAMPLE NOZZLE DIA.
Particulate	A, B (5-1)	0.440 inch

TOTAL WGT. COLLECTED (GMS)	CONDENSATE CC.
0.4716	320

CONDENSATE: 0.0474 x 320 = _____ = 15.2 S_{CF}

TOTAL METER VOL. = 77.0 + _____ = 77.0 D_{CF}

METER CORR. 77.0 x 530/551 x 29.16/29.92 = 72.2 D_{SCF}

CONCENTRATION $\frac{0.4716}{72.2}$ $\frac{GM \times 15.43}{DSCF}$ = 0.10 GR/DSCF

CALCULATED LOSS: $\frac{0.10 \text{ gr/DSCF} \times 60{,}700}{7000}$ $D_{SCFM} \times 60$ = 52.0 LBS/HR

SAMPLING POINT	TIME	Meter CU. FT.	Line VAC IN. HG	Meter Avg. T°F.	Orifice ΔH in. H_2O	SAMPLING POINT	TIME	Meter CU. FT.	Line VAC IN. HG	Meter Avg. T°F.	Orifice ΔH in. H_2O
LEAK	CHECK = 0.00 CFM @ 14 in. Hg.					B-4	12:05PM	332.6	5.0	92	1.6
A-5	10:50AM	284.3	5.2	71	2.1		+ 5	336.2	5.0	93	1.6
	+ 5	288.5	5.2	78	2.1		+ 10	339.9	5.0	94	1.6
	+ 10	292.7	5.2	81	2.1	B-3	12:15	339.9	5.0	94	1.6
A-4	11:00	292.7	6.0	81	2.0		+ 5	343.5	5.0	95	1.6
	+ 5	296.9	6.0	87	2.0		+ 10	347.1	5.0	96	1.6
	+ 10	301.1	6.0	86	2.0	B-2	12:25	347.1	5.4	96	1.6
A-3	11:10	301.1	5.5	86	1.8		+ 5	350.9	5.4	96	1.6
	+ 5	305.2	5.5	90	1.8		+ 10	354.4	5.4	96	1.6
	+ 10	309.1	5.5	92	1.8	B-1	12:35	354.4	5.0	96	1.4
A-2	11:20	309.1	5.5	92	1.8		+ 5	357.9	5.0	96	1.4
	+ 5	313.1	5.5	93	1.8		+ 10	361.3	5.0	96	1.4
	+ 10	317.1	5.5	94	1.8	Totals	100 min	77.0	Avg.	91	1.7
A-1	11:30	317.1	5.0	94	1.5						
	+ 5	320.7	4.7	94	1.4	LEAK CHECK = 0.00 CFM @ 10 in. Hg.					
	+ 10	324.2	4.7	96	1.4						
B-5	11:55	324.2	6.0	86	2.0						
	+ 5	328.4	6.0	90	2.0						
	+ 10	332.6	6.0	92	2.0						

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
AIR QUALITY & NOISE CONTROL

MOISTURE CALCULATIONS

DATE 6/7/78

	TEST NUMBERS				
1. PERCENT WATER VAPOR IN GASES	1978				
A. Gas pressure at meter (Inches HG + ΔH)	N.A.				
B. Vapor pressure of water at impinger temp. (In. HG.)	N.A.				
C. Vol. of metered gas (Cu. Ft.) Dry Std.	72.2				
D. Vol. of water vapor metered (BC/A, Cu. Ft.)	N.A.				
E. Vol. of water vapor condensed (Cu. Ft.) Std.	15.2				
F. Total vol. of water vapor in gas sample (D + E, Cu. Ft.) Std.	15.2				
G. Total vol. of gas sample (C + E, Cu. Ft.) Std.	87.4				
H. % water vapor in sampled gas (100 F/G)	17.4				
I. % water vapor (Average Value) Assumed	15.0				
2. ORSAT ANALYSIS – DRY BASIS					
A. CO_2 (%)	5.0				
B. CO (%)	N.D.				
C. O_2 (%)	10.0				
D. N_2 (%)	85.0				

LABORATORY RESULTS:

Sampling Train Component	Insoluble Wt. (gms)	Soluble Wt. (gms)
Nozzle, Probe, and Front Half of Filter Holder	0.0139	0.1640
Glass Fiber Filter No. 50417	0.2539	------
Back Half of Filter Holder, Impingers, and Conn. Glass	0.0041	0.0357
Subtotal Wt. (gms)	0.2719	0.1997
Total Wt. (gms)	0.4716	

Condensate Volume: Impingers (ml) 302

Silica Gel (gms) 18

Total (cc) 320

Water Soluble Sulfates Collected downstream of the Glass Fiber Filter (gms) = 0.0166

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY AND NOISE CONTROL

PROCESS DATA

DATE 6/7/78

TEST NUMBER 1978

NAME OF FIRM
Jones & Laughlin Steel Corp., Aliquippa, PA

DESCRIPTION OF EQUIPMENT TESTED AND OPERATION COVERED IN TEST

A-5 Coke Oven Battery

SAMPLING STATION LOCATION

Sampling ports located in the combustion stack approximately 120 feet above grade

LENGTH OF PROCESS CYCLE Continuous TIME CYCLE BEGINS _____ ENDS _____

TIME OF TEST: BEGINS 10:50 A.M. ENDS 12:45 P.M. CYCLE COVERAGE Complete

RAW MATERIAL CHARGED DURING THIS TIME:

MATERIAL	Bituminous Coal	WT(LBS.)	373,500 (Approx.)*
MATERIAL		WT(LBS.)	
MATERIAL		WT(LBS.)	
MATERIAL		WT(LBS.)	
MATERIAL		WT(LBS.)	
SOLID FUEL CHARGED		WT(LBS.)	
TOTAL POUNDS		WT(LBS.)	

COLLECTION EQUIPMENT TYPE

None

PLANT OFFICIAL AND TITLE

Dr. George C. Smith, Technical Coordinator, Environmental Control

ADDITIONAL COMMENTS

*Based upon data taken from 9:16 A.M. to 12:50 P.M.

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Jones & Laughlin Steel Corp.
Aliquippa, PA
A-5 Coke Oven Battery
6/7/78 Test No. 1978

PROCESS DATA

OVEN NUMBER	BIN NUMBER	TIME PUSHED	TIME CHARGE BEGIN	TIME CHARGE END	WEIGHT CHARGED, LBS
76	1CB2	9:16 A.M.	9:45 A.M.	10:00 A.M.	62,400
56	2CB2	11:59 A.M.	12:30 P.M.	12:45 P.M.	62,400
1	2CB3	12:11 P.M.	12:50 P.M.	1:02 P.M.	61,900
11	1CB2	12:25 P.M.	12:50 P.M.	1:00 P.M.	62,400
21	2CB1	12:36 P.M.	1:09 P.M.	1:20 P.M.	62,300
31	1CB3	12:50 P.M.	1:10 P.M.	1:19 P.M.	62,100

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COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL RESOURCES
BUREAU OF AIR QUALITY AND NOISE CONTROL

TEST NO. 1978

SUMMARY

DATE 6/7/78

NAME OF FIRM

Jones & Laughlin Steel Corp., Aliquippa, PA

Description of Equipment Tested and Operation Covered in Test

A-5 Coke Oven Battery

Sampling Station Location	A, B (5-1)
Average Gas Velocity (Ft./Sec.)	26.2
Area of Flue at Sampling Station ($ft.^2$)	88.2
Flue Gas Volume (SCFM) Dry	60,700
Sample Nozzle Diameter (In.)	0.440
Sampling Rate at Meter (CFM) Dry	0.77 Avg.
Total Sampling Time (Minutes)	100
Avg. ΔH Orifice, in. H_2O	1.7
Meter Temperature – Average (°F)	91
Volume of Gas Sampled, Meter Conditions (CF) Dry	77.0
Water Vapor Condensate (CC)	320
Water Vapor Volume Std. Conditions (SCF)	15.2
Moisture in Gases (%)	17.4
Total Sampled Volume, Std. Conditions (SCF)	87.4
Corrected Sample Volume (SCF) Dry	72.2
Type Material Collected	Particulate
Total Weight Collected (GMS)	0.4716
Concentration Grains/SCF Dry	0.10
Calculated Loss (Lbs./Hr.)	52.0
% Isokinetic	101.5

REGULATORY STANDARD

Type of Material
Particulate

Allowable Loss ~~XXXXXX~~ (Gr/DSCF)
0.04 Chapter 123 § 123.13(c)

COLLECTOR EFFICIENCY

Total Material to Collector (Lbs./Hr.)

Total Loss to Atmosphere (Lbs./Hr.)

Total Material Collected

COMMENTS

510874

Approved By
L. Blaine DeHaven, P.E. 7/12/78

Test Conducted By
Richard St. Louis

Test Computed and Checked By
Richard St. Louis 6/27/78

JONES & LAUGHLIN STEEL CORP.
ALIQUIPPA, PA

DISCUSSION

Stack Test No. 1978 was conducted using standard procedures as specified in Chapter 139 of the Pennsylvania Department of Environmental Resources' Rules and Regulations for the isokinetic collection of a particulate sample. Twelve point preliminary and sampling traverses were planned. However, due to equipment limitations these were reduced to eleven and ten points respectively. The sampling program was conducted with a ten minute sampling period at each point. The total sampling time was 100 minutes.

Results of sampling indicate an actual concentration of 0.10 gr/DSCF based upon particulate collection for all sampling train components and a concentration of 0.097 gr/DSCF after elimination of the soluble sulfate portion of the sample collected in sampling components downstream of the glass fiber filter. The allowable concentration as determined according to Chapter 123 § 123.13(c) is 0.04 gr/DSCF.

The concentration reported for Stack Test No. 1978 is representative of the emissions from the process at the operating conditions which existed during the test.

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