AIRCO CARBIDE

Louisville, Kentucky

FURNACE OFFGAS EMISSIONS SURVEY

Sampling Performed

on

17 March 1975

Tests Performed

by

ENVIRONMENTAL CONSULTANTS, INC.
391 Newman Avenue Post Office Box 2037
Clarksville, Indiana 47130

EMISSION SURVEY

PURPOSE

The purpose of this survey is to develop in-house data on the efficiency of and residual emissions from the furnace offgas scrubbers. These two scrubbers were supplied by FMC and installed by Airco. The offgas stream is currently being flared. The data developed from this survey will be used to design a coke dryer system utilizing the offgas as fuel.

METHODS

Simultaneous particulate tests were run on the inlet and outlet ducts of the scrubber. The inlet method was ASME PTC-27, utilizing in-stack alundum thimbles. Sample was withdrawn isokinetically from points on two traverses, excepting points which could not be reached because of filter holder configuration. Outlet tests were performed according to E.P.A. methodology. Sampling locations in both cases were ideal.

A grab sample of offgas was analyzed. Molecular weight was determined by Orsat gasimetric determination. Carbon monoxide was confirmed by gas chromatograph.

Analysis of the particulate required several different procedures. Metals were determined by atomic absorption spectrography. Carbon was determined by the "Leco" gasimetric analyzer.

RESULTS

The results are presented in the two tables at the end of this section. The inlet data correlates extremely well with data from a test one year ago. Outlet data indicates a scrubber collection efficiency of 98.3%. Some sample was lost in recovery due to the problems of removing the particulate from the nozzle. Airco personnel are familiar with these difficulties. The resultant error is estimated to be less than 10% of the outlet weight rate. Using a dry bulk density of 30 lb/ft^3, this emission rate will plug 60 feet of exhaust duct in two weeks. This estimation confirms the order of magnitude of the problem.

Gas heat value is at the low end of self-conbustion. There may have been dilution in the grab sample. The levels of CO_2 and O_2 do not indicate this, however.

Particulate analysis indicates the major culprit is magnesium, probably as the hydroxide. The lack of wettability is apparently due to carbonaceous material.

TEST RESULTS

Test		AIR FLOW			CONCENTRATION		PARTICULATE EMISSIONS	
	Temperature °F.	Velocity ft/sec.	ACFM	SCFH Dry	Gr/SCF	lb/SCF	lb/hr.	lb/day
Inlet	700	45.7	8610	2.30×10^{5}	13.2	1.89×10^{-3}	434	10,400
Outlet*	100	53.7	4510	2.32×10^{5}	0.22	3.24×10^{-5}	7.5	180

Scrubber Particulate Removal Efficiency = 98.3%

Carbon monoxide concentration 64% by volume

Heat Value: 202 BTU/STD Ft^3 dry,

190 BTU/STD Ft^3 wet

(Basis: 4343 BTU/lb.)

Prod rate 17 TPH backcalculated from AP-42 EF

*--Due to recovery loss, the outlet loadings are estimated to be approximately 10% low.

PARTICULATE ANALYSES

Parameter	Percent of Dry Weight
Calcium as $Ca(OH)_2$	1.59 2.94
Magnesium as $Mg(OH)_2$*	41.1 99.3
Carbon	9.25
Loss on Ignition	8

*--This test, together with carbon and loss on ignition data, indicate that a portion of the Mg is tied up as the carbonate salt.

PARTICULATE DATA

TABLE 1-1. LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS
(PERCENT OF STACK DIAMETER FROM INSIDE WALL TO TRAVERSE POINT)

TRAVERSE POINT NUMBER ON A DIAMETER	NUMBER OF TRAVERSE POINTS ON A DIAMETER												
													24
	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1	1
	85.4	25.0	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2	3.5
		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5	7.1
		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9	16.9
			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5	20.5
			95.6	80.6	65.8	35.5	26.9	22.0	18.8	16.5	14.6	13.2	23.0
				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1	
				96.7	85.4	65.0	63.4	37.5	29.6	25.0	21.8	19.4	
					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0	
					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2	
						93.3	85.4	78.0	70.4	61.2	39.3	32.3	
						97.9	90.1	83.1	76.4	69.4	60.7	39.8	
							94.3	87.5	81.2	75.0	68.5	60.2	
							98.2	91.5	85.4	79.6	73.9	67.7	
								95.1	89.1	83.5	78.2	72.8	
								98.4	92.5	87.1	82.0	77.0	
									95.6	90.3	85.4	80.6	
									98.6	93.3	88.4	83.9	
										96.1	91.3	86.8	
										98.7	94.0	89.5	
											96.5	92.1	
											98.9	94.5	
												96.8	
												98.9	

TABLE 1

For circular stacks locate the traverse points on at least two diameters according to Figure 1 and Table 1. The traverse axes shall divide the stack cross section into equal parts.

For rectangular stacks divide the cross section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between one and two. Locate the traverse points at the centroid of each equal area.

Outlet

TABLE 1-1. LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS
(PERCENT OF STACK DIAMETER FROM INSIDE WALL TO TRAVERSE POINT)

TRAVERSE POINT NUMBER ON A DIAMETER	NUMBER OF TRAVERSE POINTS ON A DIAMETER												
													16
	14.6	6.7	4.4	3.3	2.5	2.1	1.8	1.6	1.4	1.3	1.1	1.1	1.35
	85.4	25.0	14.7	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2	4.0
		75.0	29.5	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5	12.0
		93.3	70.5	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9	14.65
			85.3	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5	
			95.6	80.6	65.8	35.5	26.9	22.0	18.8	16.5	14.6	13.2	
				89.5	77.4	64.5	36.6	28.3	23.6	20.4	18.0	16.1	
				96.7	85.4	65.0	63.4	37.5	29.6	25.0	21.8	19.4	
					91.8	82.3	73.1	62.5	38.2	30.6	26.1	23.0	
					97.5	88.2	79.9	71.7	61.8	38.8	31.5	27.2	
						93.3	85.4	78.0	70.4	61.2	39.3	32.3	
						97.9	90.1	83.1	76.4	69.4	60.7	39.8	
							94.3	87.5	81.2	75.0	68.5	60.2	
							98.2	91.5	85.4	79.6	73.9	67.7	
								95.1	89.1	83.5	78.2	72.8	
								98.4	92.5	87.1	82.0	77.0	
									95.6	90.3	85.4	80.6	
									98.6	93.3	88.4	83.9	
										96.1	91.3	86.8	
										98.7	94.0	89.5	
											96.5	92.1	
											98.9	94.5	
												96.8	
												98.9	

TABLE 1

For circular stacks locate the traverse points on at least two diameters according to Figure 1 and Table 1. The traverse axes shall divide the stack cross section into equal parts.

For rectangular stacks divide the cross section into as many equal rectangular areas as traverse points, such that the ratio of the length to the width of the elemental areas is between one and two. Locate the traverse points at the centroid of each equal area.

CONTAINER NUMBER 1 - FILTER

CONTAINER NUMBER 2 - PARTICULATE MATTER AND ACETONE WASHINGS FROM ALL SAMPLE-EXPOSED SURFACES AHEAD OF THE FILTER

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			7,520.0
2			3,373.8
TOTAL			10,893.8

CONTAINER NUMBER 3 - SILICA GEL FROM FOURTH IMPINGER

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME ml	SILICA GEL WEIGHT g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g	ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g. ml):

$$\frac{\text{INCREASE g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

CONTAINER NUMBER 1 - FILTER

CONTAINER NUMBER 2 - PARTICULATE MATTER AND ACETONE WASHINGS FROM ALL SAMPLE-EXPOSED SURFACES AHEAD OF THE FILTER

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			14,193.4
2			10,342.5
TOTAL			24,535.9

CONTAINER NUMBER 3 - SILICA GEL FROM FOURTH IMPINGER

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME ml	SILICA GEL WEIGHT g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g	ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g. ml):

$$\frac{\text{INCREASE g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

CONTAINER NUMBER 1 - FILTER

CONTAINER NUMBER 2 - PARTICULATE MATTER AND ACETONE WASHINGS FROM ALL SAMPLE-EXPOSED SURFACES AHEAD OF THE FILTER

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			211.2
2			72.8
TOTAL			284.0

CONTAINER NUMBER 3 - SILICA GEL FROM FOURTH IMPINGER

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME ml	SILICA GEL WEIGHT g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g	ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g. ml):

$$\frac{\text{INCREASE g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

CONTAINER NUMBER 1 - FILTER

CONTAINER NUMBER 2 - PARTICULATE MATTER AND ACETONE WASHINGS FROM ALL SAMPLE-EXPOSED SURFACES AHEAD OF THE FILTER

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			5,875.6
2			4,386.2
TOTAL			10,261.8

CONTAINER NUMBER 3 - SILICA GEL FROM FOURTH IMPINGER

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME ml	SILICA GEL WEIGHT g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g	ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g. ml):

$$\frac{\text{INCREASE g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

CONTAINER NUMBER 1 - FILTER

CONTAINER NUMBER 2 - PARTICULATE MATTER AND ACETONE WASHINGS FROM ALL SAMPLE-EXPOSED SURFACES AHEAD OF THE FILTER

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			141.7
2			328.0
TOTAL			469.7

CONTAINER NUMBER 3 - SILICA GEL FROM FOURTH IMPINGER

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME ml	SILICA GEL WEIGHT g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g	ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g. ml):

$$\frac{\text{INCREASE g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

CONTAINER NUMBER 1 - FILTER

CONTAINER NUMBER 2 - PARTICULATE MATTER AND ACETONE WASHINGS FROM ALL SAMPLE-EXPOSED SURFACES AHEAD OF THE FILTER

CONTAINER NUMBER	WEIGHT OF PARTICULATE COLLECTED mg		
	FINAL WEIGHT	TARE WEIGHT	WEIGHT GAIN
1			59.0
2			812.1
TOTAL			871.1

CONTAINER NUMBER 3 - SILICA GEL FROM FOURTH IMPINGER

	VOLUME OF LIQUID WATER COLLECTED		
	IMPINGER VOLUME ml	SILICA GEL WEIGHT g	
FINAL			
INITIAL			
LIQUID COLLECTED			
TOTAL VOLUME COLLECTED		g	ml

CONVERT WEIGHT OF WATER TO VOLUME BY DIVIDING TOTAL WEIGHT INCREASE BY DENSITY OF WATER. (1 g. ml):

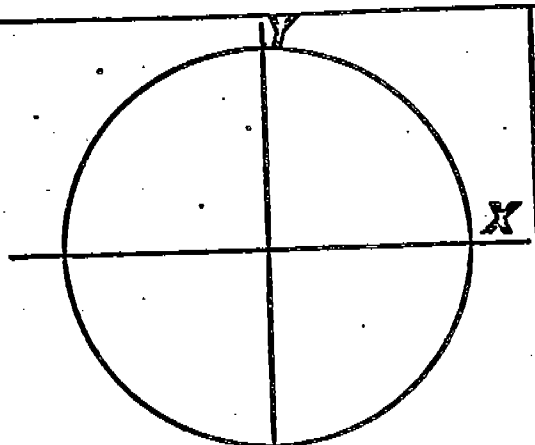
$$\frac{\text{INCREASE g}}{(1\ \text{g/ml})} = \text{VOLUME WATER, ml}$$

RUN NO. Inlet DATE 17 March 1975

BAROMETRIC PRESSURE, in. Hg. 29.40

STATIC PRESSURE IN STACK (P_g), in. Hg.

STACK DIAMETER 24 in. CROSS SECTION AREA, FT^2 3.14



STACK CROSS SECTION

SCHEMATIC OF STACK ELEVATION VIEW

X TRAVERSE

TRA. PT. NO.	VEL. HD. IN. H_2O	$\sqrt{\Delta p}$	STACK TEMP.
1	.24	.48	700° F.
2	.32	.56	
3	.36	.60	
4	.29	.53	
5	.26	.50	
6	.16	.40	
	Average	.51	

Y TRAVERSE

TRA. PT. NO.	VEL. HD. IN. H_2O	$\sqrt{\Delta p}$	STACK TEMP
1	.22	.47	
2	.32	.565	
3	.36	.60	
4	.38	.62	
5	.31	.56	
6	.24	.49	
	Average	.55	

Avg = 0.53

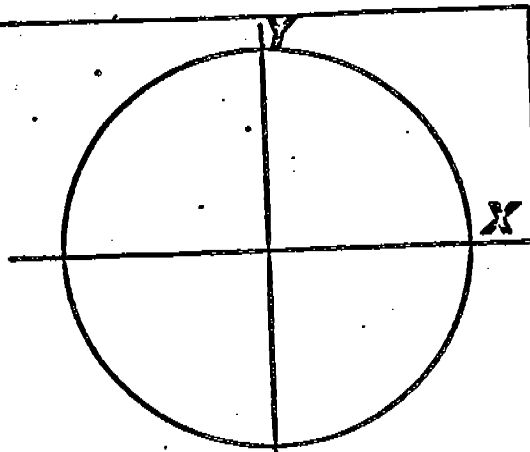
VELOCITY TRAVERSE DATA

RUN NO. Outlet DATE 17 March 1975

BAROMETRIC PRESSURE, in. Hg. 29.40

STATIC PRESSURE IN STACK (P_g), in. Hg.

STACK DIAMETER 16" CROSS SECTION AREA, FT^2 1.40



STACK CROSS SECTION

SCHEMATIC OF STACK ELEVATION VIEW

X TRAVERSE

TRA. PT. NO.	VEL. HD. IN. H_2O	$\sqrt{\Delta p}$	STACK TEMP.
1	.75	.866	100° F.
2	.72	.849	
3	.94	.970	
4	.90	.949	
	Average	.909	

Y TRAVERSE

TRA. PT. NO.	VEL. HD. IN. H_2O	$\sqrt{\Delta p}$	STACK TEMP
1	.91	.954	
2	.74	.860	
3	.73	.854	
4	.62	.787	
	Average	.864	

Avg. = 0.886

VELOCITY TRAVERSE DATA

DATE 17 March 1973

RUN NO. Inlet 1-3

AMBIENT TEMPERATURE ______

BAROMETRIC PRESSURE 29.40

ASSUMED MOISTURE % 1

PROBE LENGTH, FT. 5

NOZZLE DIAMETER, IN. 0.25

Trav. Pt. No.	Samp. Time (s)min.	Stat. Press. (P_s) in.Hg.	Stack Temp. (T_s) °F	Veloc. Head (P_s)	ΔP Orifice Meter (H) in.H_2O	Gas Samp. Vol. (Vm) ft^3	Gas Samp. Temp. At Dry Gas Mtr. Inlet (Tm_{in}) °F	Outlet (Tm_{out}) °F	Samp. Box Temp. °F	Temp. of Gas Leaving Conds. or last Imping. °F
X-1	5		700	.24	.48	046.6	42	42		
2	5			.32	.65		51	45		
3	5			.36	.72		55	48		
4	5			.29	.60		62	50		
5	5			.26	.52					
6	5			.16	.32					
Y-1	5			.22	.44		65	60		
2	5			.32	.65					
3	5			.36	.72					
4*						062.7				
5										
6										
X-1	5		700	.22	.44	062.8	50	50		
2	5			.32	.65		55	55		
3	5			.36	.72					
4	5			.38	.78		65	58		
5	5			.31	.63					
6	5			.24	.48					
Y-1	5			.36	.72		70	60		
2	5			.36	.72					
3	5			.36	.72					
4	5			.38	.78					
5	5			.31	.63					
6	5			.24	.48					
X-1	5		790	.36	.72	088.0	60	58		
2	5			.36	.72					
3	5			.36	.72					
4	5			.37	.78					
5	5			.31	.63					
6	*					098.9				
TOTAL							AVG.	AVG.		
AVERAGE							AVG.			

FIGURE Particulate Field Data

*--Test terminated due to filter loading.

DATE 17 March 1975

RUN NO. Outlet 1-3

AMBIENT TEMPERATURE

BAROMETRIC PRESSURE 29.40

ASSUMED MOISTURE % 8

PROBE LENGTH, FT. 5

NOZZLE DIAMETER, IN. .25

Trav. Pt. No.	Samp. Time (s) min.	Stat. Press. (P_s) in. Hg.	Stack Temp. (T_s) °F	Veloc. Head (P_s)	Δ P Orifice Meter (H) in. H_2O	Gas Samp. Vol. (V_m) ft^3	Gas Samp. Temp. At Dry Gas Mtr. Inlet ($T_{m_{in}}$) °F	Gas Samp. Temp. At Dry Gas Mtr. Outlet ($T_{m_{out}}$) °F	Samp. Box Temp. °F	Temp. of Gas Leaving Conds. or last Imping. °F
X-1	0		100°	.75						
2	15			.72	2.30	534.4	42	43		
3	5			.94	3.00		62	48	55 Am	
4	0			.90						
Y-1	0			.91						
2	3			.74	2.4					
3	*					552.0				
4										
X-2	60		100°	.65	2.70	553.0	61	63		
							96	75		
							97	78		
							97	78		
						601.5				
X-2	60		100°	.65	2.70	601.5	71	71		
							95	86		
							103	81		
							104	82		
						650.5				
TOTAL							AVG.	AVG.		
AVERAGE							AVG.			

FIGURE Particulate Field Data

*--Test terminated due to filter loading.

CORRECTED DRY GAS VOLUME

Standard Conditions (70° F, 29.92 inches HG.)

$$Vm_{std} = Vm \left(\frac{T_{std}}{T_m}\right) \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}}\right) = 17.71\ Vm \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right)$$

Where:

Vm_{std} = Volume of gas sample through the dry gas meter (Standard Conditions), Ft.^{3}.

Vm = Volume of gas sample through the dry gas meter (Meter Conditions), Ft.^{3}.

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

ΔH = Average pressure drop across the orifice meter, inches H_2O.

13.6 = Specific gravity of Mercury.

T_m = Average gas meter temperature, °R.

RUN NO.	TYPE OF CHARGE	Vm Ft3	Pbar In.HG	ΔH In.H2O	Tm °R	Vmstd Ft3
1	Inlet	16.1	29.40	.567	515	16.3
2		25.2	29.40	.646	511	25.7
3		10.9	29.40	.714	519	10.9
Average						

CORRECTED DRY GAS VOLUME

Standard Conditions (70° F, 29.92 inches HG.)

$$Vm_{std} = Vm \left(\frac{T_{std}}{T_m}\right)\left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}}\right) = 17.71\ Vm \left(\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m}\right)$$

Where:

Vm_{std} = Volume of gas sample through the dry gas meter (Standard Conditions), $Ft.^3$.

Vm = Volume of gas sample through the dry gas meter (Meter Conditions), $Ft.^3$.

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

ΔH = Average pressure drop across the orifice meter, inches H_2O.

13.6 = Specific gravity of Mercury.

T_m = Average gas meter temperature, °R.

RUN NO.	TYPE OF CHARGE	Vm Ft^3	Pbar In.HG	ΔH In.H_2O	Tm °R	Vm_{std} Ft^3
1	Outlet	17.6	29.40	2.46	507	18.2
2		48.5	29.40	2.70	541	47.0
3		49.0	29.40	2.70	547	47.0
Average						

ORSAT ANALYSIS

RUN NO.	TYPE OF CHARGE	VOLUME PERCENT DRY BASES (Ave. 3 Runs)			
		NITROGEN	OXYGEN	CARBON DIOXIDE	CARBON MONOXIDE
		30%	3.0%	2.0%	64%

? Nitrogen purge ?

DRY MOLECULAR WEIGHT (LB/LB-MOLE)

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

Where:

M_D = Dry molecular weight, Lb/Lb-Mole
$\%CO_2$ = Percent carbon dioxide by volume
$\%CO$ = Percent carbon monoxide by volume
$\%O_2$ = Percent oxygen by volume
$\%N_2$ = Percent nitrogen by volume
0.44 = Molecular weight carbon dioxide divided by 100
0.32 = Molecular weight of oxygen divided by 100
0.28 = Molecular weight of nitrogen and carbon monoxide divided by 100

RUN NO.	TYPE OF CHARGE	MD DRY MOLECULAR WEIGHT
	Off gas	28.16

MOLECULAR WEIGHT (WET BASES), (LB/LB-MOLE)

$$Ms = M_D\ (1-B_{WO}) + 18\ B_{WO}$$

Where:

M_D = Dry molecular weight, Lb/Lb-Mole.

B_{WO} = Proportion by volume of water vapor in the gas stream, dimensionless.

RUN NO.	TYPE OF CHARGE	M_D Lb/Lb-Mole	B_{WO}	Ms Lb/Lb-Mole
1	Off gas			
2	Inlet	28.16	.01	28.05
3	Outlet	28.16	.08	27.35
Average				

VELOCITY STACK GASES

Actual conditions (Stack Temperature and Pressure)

$$(Vs)\ Ave = KpCp\ (\sqrt{\Delta P})Ave.\ \sqrt{\frac{(Ts)\ Ave}{PsMs}}$$

Where:

(Vs) Ave = Stack gas velocity, feet per second, Ft/Sec

Kp = 85.48 Ft/sec $\left(\frac{Lb}{Lb\ Mole\ °R}\right)^{1/2}$

Cp = Pitot tube coefficient, dimensionless.
= 0.87 in velocity range of this test.

(Ts)Ave = Average absolute stack gas temperature, °R.

$(\sqrt{\Delta P})$Ave = Average velocity head of stack gases, inches H_2O.

Ms = Molecular weight of stack gas (wet basis) Lb/Lb/ - Mole.

Ps = Absolute stack gas pressure, inches HG.

RUN NO.	TYPE OF CHARGE	(Ts)Ave °R	Ps In.HG.	$(\sqrt{\Delta P})$Ave. In.H2O	Ms Lb/Lb.Mole	(Vs)Ave Ft/Sec
1	Inlet	1,160	29.40	.530	28.05	45.67
2	Outlet	560	29.40	.886	27.35	53.72
3						
Average						

VOLUMETRIC FLOW RATE STACK GASES

Standard Conditions (70° F, 29.92 inches HG.)

$$Qs = 3600\ (1-B_{wo})\ Vs\ A\ \left(\frac{Tstd}{(Ts)\ Ave}\right)\left(\frac{Ps}{Pstd}\right)$$

Where:

Qs = Volumetric Flow Rate, dry basis, standard conditions, Ft. 3/Hr.

A = Cross-sectional area of stack, $Ft.^2$

B_{wo} = Proportion by volume of water vapor in the gas stream, dimensionless.

Vs = Stack gas velocity, feet per second, Ft/Sec

(Ts)Ave = Average absolute stack gas temperature, °R

Tstd = Absolute temperature at standard conditions, 530° R.

Pstd = Absolute pressure at standard conditions, 29.92 inches HG.

Ps = Absolute stack gas pressure, inches HG.

RUN NO.	TYPE OF CHARGE	Vs Ft/Sec	(Ts)Ave ° R	Ps In.HG.	B_{wo}	A $Ft.^2$	Qs Ft^3/Hr
1	Inlet	45.67	1,160	29.40	.01	3.14	2.30×10^5
2	Outlet	53.72	560	29.40	.08	1.40	2.32×10^5
3							
Average							

PARTICULATE CONCENTRATION STACK GASES

Standard Conditions (70° F, 29.92 inches HG)

$$Cs = \frac{\left(\frac{1}{453600}\frac{Lb}{Mg}\right) Mn}{Vm_{std}}$$

$$= 2.205 \times 10^{-6} \frac{Mn}{Vm_{std}}$$

Where:

Cs = Concentration of particulate matter in stack gas, Lb/SCF, dry basis.

Mn = Total amount of particulate matter collected, MG.

Vm_{std} = Volume of gas sample through dry gas meter (standard conditions), $Ft.^3$.

RUN NO.	TYPE OF CHARGE	Mn MG.	Vm_{std} $Ft.^3$	Cs Lb/SCF
1	Inlet	10,893.8	16.3	1.47×10^{-3}
2		24,535.9	25.7	2.11×10^{-3}
3		10,261.8	10.9	2.08×10^{-3}
Average				1.89×10^{-3}

PARTICULATE CONCENTRATION STACK GASES

Standard Conditions (70° F, 29.92 inches HG)

$$Cs = \frac{\left(\frac{1}{453600}\ \frac{Lb}{Mg}\right) Mn}{Vm_{std}}$$

$$= 2.205 \times 10^{-6} \frac{Mn}{Vm_{std}}$$

Where:

Cs = Concentration of particulate matter in stack gas, Lb/SCF, dry basis.

Mn = Total amount of particulate matter collected, MG.

Vm_{std} = Volume of gas sample through dry gas meter (standard conditions), $Ft.^3$.

RUN NO.	TYPE OF CHARGE	Mn MG.	Vm_{std} $Ft.^3$	Cs Lb/SCF
1	Outlet	284.0	18.2	3.44×10^{-5}
2		469.7	47.0	2.20×10^{-5}
3		871.1	47.0	4.09×10^{-5}
Average				3.24×10^{-5}

PROCESS EMISSION RATE

Emission Rate = CsQs

Where:

Emission Rate = Total particulate matter discharged from stack into atmosphere, Lb/Hr.

Cs = Concentration of particulate matter in stack gas, Lb/SCF, dry bases.

Qs = Volumetric flow rate, dry bases, standard conditions, Ft.^{3}/Hr.

RUN NO.	TYPE OF CHARGE	Cs Lb/SCF	Qs Ft.^{3}/Hr.	EMISSION RATE Lb/Hr.
1	Inlet	1.47×10^{-3}	2.30×10^{5}	338
2		2.11×10^{-3}	2.30×10^{5}	485
3		2.08×10^{-3}	2.30×10^{5}	478
Average				434

PROCESS EMISSION RATE

Emission Rate = C_sQ_s

Where:

Emission Rate = Total particulate matter discharged from stack into atmosphere, Lb/Hr.

C_s = Concentration of particulate matter in stack gas, Lb/SCF, dry bases.

Q_s = Volumetric flow rate, dry bases, standard conditions, $Ft.^3/Hr.$

RUN NO.	TYPE OF CHARGE	Cs Lb/SCF	Qs $Ft.^3/Hr.$	EMISSION RATE Lb/Hr.
1	Outlet	3.44×10^{-5}	2.32×10^{5}	8.0
2		2.20×10^{-5}	2.32×10^{5}	5.1
3		4.09×10^{-5}	2.32×10^{5}	9.5
Average				7.5