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RESULTS OF THE AUGUST 6-8, 1986, PARTICULATE AND SO2 COMPLIANCE TESTS ON THE INDURATING GAS WET SCRUBBER STACKS AT THE INLAND STEEL MINING COMPANY IN VIRGINIA, MINNESOTA

Submitted to:

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ABBREVIATIONS

ACFM	actual cubic feet per minute
cc (ml)	cubic centimeter (milliliter)
DSCFM	standard cubic foot of dry gas per minute
DSML	dry standard milliliter
DEG-F (^{o}F)	degrees Fahrenheit
DIA.	diameter
FT/SEC	feet per second
GPM	gallons per minute
GR/ACF	grains per actual cubic foot
GR/DSCF	grains per dry standard cubic foot
g	gram
HP	horsepower
HRS	hours
IN.	inches
IN. HG.	inches of mercury
IN. WC.	inches of water
LB	pound
LB/DSCF	pounds per dry standard cubic foot
LB/HR	pounds per hour
LB/10^{6}BTU	pounds per million British Thermal Units heat input
LB/MMBTU	pounds per million British Thermal Units heat input
MW	megawatt
mg/DSCM	milligrams per dry standard cubic meter
microns (µm)	micrometer
MIN.	minutes
ohm-cm	ohm-centimeter
PPH	pounds per hour
PPM	parts per million
PSI	pounds per square inch
SQ. FT.	square feet
v/v	percent by volume
w/w	percent by weight

Standard conditions are defined as 68 ^{o}F (20 ^{o}C) and 29.92 IN. of mercury pressure.

1 INTRODUCTION

On August 6, 7, and 8, 1986, Interpoll Inc. personnel conducted a series of particulate and SO_2 emission compliance tests as a part of a petroleum coke test burn on the Indurating Gas Scrubbers A, B, C and D Stacks at the Inland Steel Minorca Taconite Plant located near Virginia, Minnesota. On-site testing was performed by Dr. P. Lonnes, C. Mosser and L. Jennings. Coordination between plant operation and testing activities was provided by Dave Bednarz. The tests were witnessed by Bob Berresford of the Minnesota Pollution Control Agency.

Evaluations were performed in accordance with EPa Methods 1-6 and 9, CFR Title 40, Part 60, Appendix A (revised July 1, 1985). A preliminary determination of the gas linear velocity profile was made before the first particulate determination to allow selection of the appropriate nozzle diameter required for isokinetic sample withdrawal. An Interpoll sampling train which meets or exceeds specifications in the above-cited reference was used to collect the samples by means of heated stainless steel-lined probes. Sulfur dioxide determinations were performed using the large impinger version of EPA Method 6 via the back half of the Method 5 sampling train. Visible emissions were measured by C. Mosser, a currently-certified observer.

An integrated flue gas sample was extracted simultaneously with each particulate and sulfur dioxide sample using a specially designed gas sampling system. Integrated flue gas samples were collected in 44-liter Tedlar bags. After sampling was complete, the bags were sealed and returned to the laboratory for Orsat analysis. Prior to sampling, the Tedlar bags are leak checked at 15 IN.HG. vacuum with an in-line rotameter. Bags with any detectable inleakage are discarded.

Testing at each Indurating Gas Scrubber Stack was conducted from two test ports oriented at 90 degrees located more than eight stack

diameters downstream of a transition breeching and more than two stack diameters upstream of the stack outlet. A 12-point traverse was used to collect representative flyash samples from the scrubber stack. Each traverse point was sampled five minutes to give a total sampling time of 60 minutes per run.

The important results of the tests are summarized in Section 2. Detailed results are presented in Section 3. Field data and all other supporting information are presented in the appendices.

2 SUMMARY AND DISCUSSION

The important results of the particulate and sulfur dioxide tests are summarized in Tables 1-5. As will be noted, the particulate emission rate ranged from as low as 4.7 to 15.85 LB/Hr for the four scrubbers over the three days of testing. The average particulate and SO_2 emission rate for each of the four scrubbers is given below:

Scrubber	Emission Rate (LB/HR)	
	Particulate	SO_2
A	14.95	96.96
B	13.05	113.17
C	10.66	126.86
D	6.23	150.18

Particulate and SO_2 emission factors are given in Tables 1-5. As will be noted, emission factors were calculated using the F-factor method. Emission factors could not be calculated by the ratio method inasmuch as the heat input rate was unknown.

No difficulties were encountered in the field or in the laboratory evaluation of the samples. On the basis of this fact and a complete review of the entire data and results, it is our opinion that the particulate and sulfur dioxide concentrations and emission rates reported herein are accurate and closely reflect the actual values which existed at the time the tests were performed.

TABLE 1. Summary of the Results of the August 6, 1986, Particulate Emission Compliance Test on the Indurating Gas Scrubber 'A' Stack at the Inland Steel Plant Located in Virginia, Minnesota.

ITEM		Run 1	Run 2	Run 3
Date of test		08-06-86	08-06-86	08-06-86
Time runs were done	(HRS)	800/ 902	920/1022	1040/1144
Production Rate	(KLB/HR)	770.6	770.6	770.6
Volumetric flow				
actual	(ACFM)	172571	175205	176274
standard	(DSCFM)	132595	133579	134414
Gas temperature	(DEG-F)	122	123	123
Moisture content	(%V/V)	10.03	10.57	10.54
Gas composition	(%V/V,dry)			
carbon dioxide		0.80	0.60	0.60
oxygen		20.00	20.20	20.20
carbon monoxide		0.00	0.00	0.00
nitrogen		79.20	79.20	79.20
Isokinetic variation	(%)	96.9	100.1	99.9
Particulate concentration				
actual	(GR/ACF)	0.01071	0.01011	0.00914
standard	(GR/DSCF)	0.01394	0.01326	0.01199
Part. emission rate	(LB/HR)	15.85	15.19	13.81

= 385 T/HR

* DRY CATCH ONLY

TABLE 2. Summary of the Results of the August 6, 1986, Particulate Emission Compliance Test on the Indurating Gas Scrubber 'B' Stack at the Inland Steel Plant Located in Virginia, Minnesota.

ITEM		Run 1	Run 2	Run 3
Date of test		08-06-86	08-06-86	08-06-86
Time runs were done	(HRS)	1202/1305	1324/1424	1443/1548
Production Rate	(KLB/HR)	770.6	770.6	770.6
Volumetric flow				
actual	(ACFM)	179453	179516	182301
standard	(DSCFM)	136107	135427	137286
Gas temperature	(DEG-F)	123	123	123
Moisture content	(%V/V)	11.05	11.48	11.67
Gas composition	(%V/V,dry)			
carbon dioxide		0.60	0.60	0.80
oxygen		20.00	20.00	20.00
carbon monoxide		0.00	0.00	0.00
nitrogen		79.40	79.40	79.20
Isokinetic variation	(%)	99.9	100.1	99.9
Particulate concentration				
actual	(GR/ACF)	0.00720	0.00911	0.00899
standard	(GR/DSCF)	0.00950	0.01208	0.01194
Part. emission rate	(LB/HR)	11.08	14.02	14.05

* DRY CATCH ONLY

TABLE 3. Summary of the Results of the August 7, 1986, Particulate Emission Compliance Test on the Indurating Gas Scrubber 'C' Stack at the Inland Steel Plant Located in Virginia, Minnesota.

ITEM		Run 1	Run 2	Run 3
Date of test		08-07-86	08-07-86	08-07-86
Time runs were done	(HRS)	800/ 902	917/1018	1031/1132
Production Rate	(KLB/HR)	766.1	766.1	766.1
Volumetric flow				
actual	(ACFM)	164120	157830	159687
standard	(DSCFM)	120929	116612	117018
Gas temperature	(DEG-F)	126	125	126
Moisture content	(%V/V)	12.82	12.78	13.30
Gas composition	(%V/V,dry)			
carbon dioxide		0.80	0.80	0.80
oxygen		19.60	19.60	19.40
carbon monoxide		0.00	0.00	0.00
nitrogen		79.60	79.60	79.80
Isokinetic variation	(%)	101.9	99.7	100.2
Particulate concentration				
actual	(GR/ACF)	0.00876	0.00770	0.00675
standard	(GR/DSCF)	0.01189	0.01043	0.00921
Part. emission rate	(LB/HR)	12.32	10.42	9.24

383 T/HR

* DRY CATCH ONLY

TABLE 4. Summary of the Results of the August 8, 1986, Particulate Emission Compliance Test on the Indurating Gas Scrubber 'D' Stack at the Inland Steel Plant Located in Virginia, Minnesota.

ITEM		Run 1	Run 2	Run 3
Date of test		08-08-86	08-08-86	08-08-86
Time runs were done	(HRS)	800/ 901	913/1015	1027/1128
Production Rate	(KLB/HR)	777.3	777.3	777.3
Volumetric flow				
actual	(ACFM)	181622	182356	182475
standard	(DSCFM)	128440	128767	129197
Gas temperature	(DEG-F)	137	137	138
Moisture content	(%V/V)	14.85	14.92	14.61
Gas composition	(%V/V,dry)			
carbon dioxide		1.20	1.20	1.20
oxygen		18.80	18.80	18.80
carbon monoxide		0.00	0.00	0.00
nitrogen		80.00	80.00	80.00
Isokinetic variation	(%)	102.6	100.0	99.7
Particulate concentration				
actual	(GR/ACF)	0.00494	0.00301	0.00416
standard	(GR/DSCF)	0.00698	0.00426	0.00587
Part. emission rate	(LB/HR)	7.69	4.70	6.50

389 T/HR

* DRY CATCH ONLY

Table 5. Summary of the Results of the August 6, 7 and 8, 1986, Sulfur Dioxide Emission Compliance Tests on the Induration Gas Scrubber Stackks at the Inland Steel Mining Plant in Virginia, Minnesota.

Test/Run	Time (HRS)	Sulfur Dioxide Concentration (ppm,w)	Sulfur Dioxide Emission Factor ($LB/10^6BTU$)
SCRUBBER "A" (8-6-86)			
1/1	0800-0902	68	2.70
1/2	0920-1022	63	3.28
1/3	1040-1144	65	3.35
	Average:	65	3.11
SCRUBBER "B" (8-6-86)			
2/1	1202-1305	71	2.88
2/2	1324-1424	72	2.91
2/3	1443-1548	78	3.19
	Average:	74	2.99
SCRUBBER "C" (8-7-86)			
3/1	0800-0902	91	2.60
3/2	0917-1018	96	2.72
3/3	1031-1132	95	2.35
	Average:	94	2.56
SCRUBBER "D" (8-8-86)			
4/1	0800-0901	101	1.83
4/2	0913-1015	97	1.76
4/3	1027-1128	100	1.81
	Average:	99	1.80

3 RESULTS

The results of all field and laboratory evaluations are presented in this section. Gas composition results (Orsat and moisture) are presented first followed by the computer printout of the particulate, sulfur dioxide and opacity observations. Preliminary measurements including test port locations are given in the appendices.

The results have been calculated on a Sperry PC Computer using programs written in Extended BASIC specifically for source testing calculations. EPA-published equations have been used as the basis of the calculation techniques in these programs.

The particulate emission rate has been calculated using the product of the concentration times flow method (as recommended by the EPA) rather than the ratio of areas method. The dry particulate emission factor has been calculated by the Oxygen F-Factor Method using the latest EPA-published dry F-Factor for the stated fuel.

3.1 Results of Orsat and Moisture Analyses

Test No. 1
Indurating Gas Scrubber 'A'

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

Date of run	Run 1 08-06-86	Run 2 08-06-86	Run 3 08-06-86
Dry basis (orsat)			
carbon dioxide.....	0.80	0.60	0.60
oxygen.....	20.00	20.20	20.20
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.20	79.20	79.20
Wet basis (orsat)			
carbon dioxide.....	0.72	0.54	0.54
oxygen.....	17.99	18.06	18.07
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	71.25	70.82	70.86
water vapor.....	10.03	10.57	10.54
Dry molecular weight.....	28.93	28.90	28.90
Wet molecular weight.....	27.83	27.75	27.76
Specific gravity.....	0.961	0.959	0.959
Water mass flow.....(LB/HR)	41478	44309	44402
FO	1.125	1.167	1.167

Test No. 2
Indurating Gas Scrubber 'B'

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1	Run 2	Run 3
Date of run	08-06-86	08-06-86	08-06-86
Dry basis (orsat)			
carbon dioxide.....	0.60	0.60	0.80
oxygen.....	20.00	20.00	20.00
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.40	79.40	79.20
Wet basis (orsat)			
carbon dioxide.....	0.53	0.53	0.71
oxygen.....	17.79	17.70	17.67
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	70.62	70.29	69.96
water vapor.....	11.05	11.48	11.67
Dry molecular weight.....	28.90	28.90	28.93
Wet molecular weight.....	27.69	27.65	27.65
Specific gravity.....	0.957	0.955	0.955
Water mass flow.....(LB/HR)	47448	49260	50892

FO	1.500	1.500	1.125

Test No. 3
Indurating Gas Scrubber 'C'

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1	Run 2	Run 3
Date of run	08-07-86	08-07-86	08-07-86
Dry basis (orsat)			
carbon dioxide.....	0.80	0.80	0.80
oxygen.....	19.60	19.60	19.40
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	79.60	79.60	79.80
Wet basis (orsat)			
carbon dioxide.....	0.70	0.70	0.69
oxygen.....	17.09	17.09	16.82
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	69.39	69.43	69.19
water vapor.....	12.82	12.78	13.30
Dry molecular weight.....	28.91	28.91	28.90
Wet molecular weight.....	27.51	27.52	27.45
Specific gravity.....	0.950	0.951	0.948
Water mass flow.....(LB/HR)	49887	47937	50346
FO	1.625	1.625	1.875

Test No. 4
Indurating Gas Scrubber 'D'

Results of Orsat & Moisture Analyses-----Methods 3 & 4(%v/v)

	Run 1	Run 2	Run 3
Date of run	08-08-86	08-08-86	08-08-86
Dry basis (orsat)			
carbon dioxide.....	1.20	1.20	1.20
oxygen.....	18.80	18.80	18.80
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	80.00	80.00	80.00
Wet basis (orsat)			
carbon dioxide.....	1.02	1.02	1.02
oxygen.....	16.01	16.00	16.05
carbon monoxide.....	0.00	0.00	0.00
nitrogen.....	68.12	68.07	68.32
water vapor.....	14.85	14.92	14.61
Dry molecular weight.....	28.94	28.94	28.94
Wet molecular weight.....	27.32	27.31	27.35
Specific gravity.....	0.944	0.943	0.945
Water mass flow.....(LB/HR)	62830	63327	61984
FO	1.750	1.750	1.750

3.2 Results of Particulate Loading Determinations

Test No. 1
Indurating Gas Scrubber 'A'

Results of Particulate Loading Determinations-------Method 5

	Run 1	Run 2	Run 3
Date of run	08-06-86	08-06-86	08-06-86
Time run start/end.....(HRS)	800/ 902	920/1022	1040/1144
Static pressure.....(IN.WC)	-0.46	-0.46	-0.46
Cross sectional area (SQ.FT)	59.56	59.56	59.56
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	88.0	95.0	96.0
desiccant.....(GRAMS)	18.0	22.0	21.0
total.....(GRAMS)	106.0	117.0	117.0
Total particulate material..			
.....collected(grams)	0.0405	0.0401	0.0364
Gas meter coefficient.....	1.0033	1.0033	1.0033
Barometric pressure..(IN.HG)	28.20	28.20	28.20
Avg. orif.pres.drop..(IN.WC)	1.87	2.02	2.04
Avg. gas meter temp..(DEF-F)	59.7	65.6	67.1
Volume through gas meter....			
at meter conditions...(CF)	46.44	48.87	49.21
standard conditions.(DSCF)	44.82	46.65	46.84
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.252	.252	.252
Avg.stack gas temp ..(DEG-F)	122	123	123
Volumetric flow rate.....			
actual.....(ACFM)	172571	175205	176274
dry standard.....(DSCFM)	132595	133579	134414
Isokinetic variation.....(%)	96.9	100.1	99.9
Particulate concentration...			
actual.....(GR/ACF)	0.01071	0.01011	0.00914
dry standard.....(GR/DSCF)	0.01394	0.01326	0.01199
Particle mass rate...(LB/HR)	15.85	15.19	13.81
F-factor .....(DSCF/MMBTU)	9308	9308	9308
Emission factor...(LB/MMBTU)	0.431	0.527	0.476

Test No. 2
Indurating Gas Scrubber 'B'

Results of Particulate Loading Determinations-------Method 5

	Run 1	Run 2	Run 3
Date of run	08-06-86	08-06-86	08-06-86
Time run start/end.....(HRS)	1202/1305	1324/1424	1443/1548
Static pressure.....(IN.WC)	-0.45	-0.45	-0.45
Cross sectional area (SQ.FT)	59.56	59.56	59.56
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	103.0	110.0	111.0
desiccant.....(GRAMS)	22.0	20.0	23.0
total.....(GRAMS)	125.0	130.0	134.0
Total particulate material..			
.....collected(grams)	0.0292	0.0370	0.0370
Gas meter coefficient.....	1.0033	1.0033	1.0033
Barometric pressure..(IN.HG)	28.20	28.20	28.20
Avg. orif.pres.drop..(IN.WC)	2.12	2.11	2.17
Avg. gas meter temp..(DEF-F)	72.5	75.5	79.1
Volume through gas meter....			
at meter conditions...(CF)	50.32	50.44	51.35
standard conditions.(DSCF)	47.42	47.27	47.81
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.252	.252	.252
Avg.stack gas temp ..(DEG-F)	123	123	123
Volumetric flow rate.....			
actual.....(ACFM)	179453	179516	182301
dry standard.....(DSCFM)	136107	135427	137286
Isokinetic variation.....(%)	99.9	100.1	99.9
Particulate concentration...			
actual.....(GR/ACF)	0.00720	0.00911	0.00899
dry standard.....(GR/DSCF)	0.00950	0.01208	0.01194
Particle mass rate...(LB/HR)	11.08	14.02	14.05
F-factor .....(DSCF/MMBTU)	9308	9308	9308
Emission factor...(LB/MMBTU)	0.293	0.373	0.369

Test No. 3
Indurating Gas Scrubber 'C'

Results of Particulate Loading Determinations-------Method 5

	Run 1	Run 2	Run 3
Date of run	08-07-86	08-07-86	08-07-86
Time run start/end.....(HRS)	800/ 902	917/1018	1031/1132
Static pressure.....(IN.WC)	-0.46	-0.46	-0.46
Cross sectional area (SQ.FT)	59.56	59.56	59.56
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	118.0	109.0	116.0
desiccant.....(GRAMS)	16.0	17.0	17.0
total.....(GRAMS)	134.0	126.0	133.0
Total particulate material..			
.....collected(grams)	0.0331	0.0274	0.0244
Gas meter coefficient.....	1.0033	1.0033	1.0033
Barometric pressure..(IN.HG)	28.10	28.10	28.10
Avg. orif.pres.drop..(IN.WC)	1.73	1.55	1.58
Avg. gas meter temp..(DEF-F)	61.2	64.0	64.0
Volume through gas meter....			
at meter conditions...(CF)	44.82	42.54	42.90
standard conditions.(DSCF)	42.96	40.54	40.88
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.252	.252	.252
Avg.stack gas temp ..(DEG-F)	126	125	126
Volumetric flow rate.....			
actual.....(ACFM)	164120	157830	159687
dry standard.....(DSCFM)	120929	116612	117018
Isokinetic variation.....(%)	101.9	99.7	100.2
Particulate concentration...			
actual.....(GR/ACF)	0.00876	0.00770	0.00675
dry standard.....(GR/DSCF)	0.01189	0.01043	0.00921
Particle mass rate...(LB/HR)	12.32	10.42	9.24
F-factor .....(DSCF/MMBTU)	9308	9308	9308
Emission factor...(LB/MMBTU)	0.254	0.223	0.171

Test No. 4
Indurating Gas Scrubber 'D'

Results of Particulate Loading Determinations-------Method 5

	Run 1	Run 2	Run 3
Date of run	08-08-86	08-08-86	08-08-86
Time run start/end.....(HRS)	800/ 901	913/1015	1027/1128
Static pressure.....(IN.WC)	-0.46	-0.46	-0.46
Cross sectional area (SQ.FT)	59.56	59.56	59.56
Pitot tube coefficient.....	.840	.840	.840
Water in sample gas			
condenser.....(ML)	0.0	0.0	0.0
impingers.....(GRAMS)	147.0	145.0	140.0
desiccant.....(GRAMS)	23.0	22.0	23.0
total.....(GRAMS)	170.0	167.0	163.0
Total particulate material..			
.....collected(grams)	0.0208	0.0124	0.0171
Gas meter coefficient.....	1.0033	1.0033	1.0033
Barometric pressure..(IN.HG)	28.13	28.13	28.13
Avg. orif.pres.drop..(IN.WC)	2.01	1.95	1.95
Avg. gas meter temp..(DEF-F)	69.3	75.7	78.2
Volume through gas meter....			
at meter conditions...(CF)	48.61	48.08	48.33
standard conditions.(DSCF)	45.96	44.91	44.93
Total sampling time....(MIN)	60.00	60.00	60.00
Nozzle diameter.....(IN)	.252	.252	.252
Avg.stack gas temp ..(DEG-F)	137	137	138
Volumetric flow rate.....			
actual.....(ACFM)	181622	182356	182475
dry standard.....(DSCFM)	128440	128767	129197
Isokinetic variation.....(%)	102.6	100.0	99.7
Particulate concentration...			
actual.....(GR/ACF)	0.00494	0.00301	0.00416
dry standard.....(GR/DSCF)	0.00698	0.00426	0.00587
Particle mass rate...(LB/HR)	7.69	4.70	6.50
F-factor .....(DSCF/MMBTU)	9308	9308	9308
Emission factor...(LB/MMBTU)	0.092	0.056	0.078

3.3 Results of Sulfur Dioxide Determinations

Test No. 1
Indurating Gas Scrubber 'A'

Results of Sulfur Dioxide Determinations----------Method 6

	Run 1	Run 2	Run 3
Date of run	08-06-86	08-06-86	08-06-86
Time run start/end.....(HRS)	800-902	920-1022	1040-1144
Barometric pressure..(IN.HG)	28.20	28.20	28.20
Meter temperature....(DEG-F)	59.70	65.60	67.10
Meter correction coefficient	1.0033	1.0033	1.0033
Volume through gas meter....			
at meter conditions...(CF)	46.440	48.870	49.210
standard conditions..(SCF)	44.816	46.649	46.843
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	10.03	10.57	10.54
Oxygen content....(%V/V DRY)	20.00	20.20	20.20
Milliequivalents of SO4 in..			
gas sample.....	7.9341	7.7851	7.9837
Sulfur dioxide concentration			
(GR/DSCF).....	0.0875	0.0825	0.0842
(MG/DSCM).....	200	189	193
(PPM-DRY).....	75	71	72
(PPM-WET).....	68	63	65
SO2 Emission rate....(LB/HR)	99.45	94.44	97.06
Sulfur dioxide emission.....			
.....factor (LB/MMBTU)*	2.702	3.275	3.345

* F = 9308 DSCF/MMBTU

Test No. 2
Indurating Gas Scrubber 'B'

Results of Sulfur Dioxide Determinations----------Method 6

	Run 1	Run 2	Run 3
Date of run	08-06-86	08-06-86	08-06-86
Time run start/end.....(HRS)	1202-1305	1324-1424	1443-1548
Barometric pressure..(IN.HG)	28.20	28.20	28.20
Meter temperature....(DEG-F)	72.50	75.50	79.10
Meter correction coefficient	1.0033	1.0033	1.0033
Volume through gas meter....			
at meter conditions...(CF)	50.320	50.440	51.350
standard conditions..(SCF)	47.424	47.269	47.808
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	11.05	11.48	11.67
Oxygen content....(%V/V DRY)	20.00	20.00	20.00
Milliequivalents of SO4 in..			
gas sample.....	8.9519	9.0015	9.9796
Sulfur dioxide concentration			
(GR/DSCF).....	0.0933	0.0941	0.1032
(MG/DSCM).....	214	215	236
(PPM-DRY).....	80	81	89
(PPM-WET).....	71	72	78
SO2 Emission rate....(LB/HR)	108.85	109.26	121.41
Sulfur dioxide emission.....			
.....factor (LB/MMBTU)*	2.881	2.906	3.186

* F = 9308 DSCF/MMBTU

Test No. 3
Indurating Gas Scrubber 'C'

Results of Sulfur Dioxide Determinations----------Method 6

	Run 1	Run 2	Run 3
Date of run	08-07-86	08-07-86	08-07-86
Time run start/end.....(HRS)	800-902	917-1018	1031-1132
Barometric pressure..(IN.HG)	28.10	28.10	28.10
Meter temperature....(DEG-F)	61.20	64.00	64.00
Meter correction coefficient	1.0033	1.0033	1.0033
Volume through gas meter....			
at meter conditions...(CF)	44.820	42.540	42.900
standard conditions..(SCF)	42.960	40.538	40.884
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	12.82	12.78	13.30
Oxygen content....(%V/V DRY)	19.60	19.60	19.40
Milliequivalents of SO4 in..			
gas sample.....	10.5754	10.4414	10.4910
Sulfur dioxide concentration			
(GR/DSCF).....	0.1217	0.1273	0.1268
(MG/DSCM).....	278	291	290
(PPM-DRY).....	105	110	109
(PPM-WET).....	91	96	95
SO2 Emission rate....(LB/HR)	126.12	127.25	127.21
Sulfur dioxide emission.....			
.....factor (LB/MMBTU)*	2.601	2.722	2.350

* F = 9308 DSCF/MMBTU

Test No. 4
Indurating Gas Scrubber 'D'

Results of Sulfur Dioxide Determinations----------Method 6

	Run 1	Run 2	Run 3
Date of run	08-08-86	08-08-86	08-08-86
Time run start/end.....(HRS)	800-901	913-1015	1027-1128
Barometric pressure..(IN.HG)	28.13	28.13	28.13
Meter temperature....(DEG-F)	69.30	75.70	78.20
Meter correction coefficient	1.0033	1.0033	1.0033
Volume through gas meter....			
at meter conditions...(CF)	48.610	48.080	48.330
standard conditions..(SCF)	45.962	44.911	44.935
Total sampling time....(MIN)	60.0	60.0	60.0
Moisture content.....(%V/V)	14.85	14.92	14.61
Oxygen content....(%V/V DRY)	18.80	18.80	18.80
Milliequivalents of SO4 in..			
gas sample.....	12.8742	12.0798	12.4274
Sulfur dioxide concentration			
(GR/DSCF).....	0.1384	0.1329	0.1367
(MG/DSCM).....	317	304	313
(PPM-DRY).....	119	114	118
(PPM-WET).....	101	97	100
SO2 Emission rate....(LB/HR)	152.42	146.73	151.38
Sulfur dioxide emission.....			
.....factor (LB/MMBTU)*	1.832	1.759	1.809

* F = 9308 DSCF/MMBTU

3.4 Results of Opacity Observations

Test No. 1
Indurating Gas Scrubber A

Results of Opacity Observations - EPA Method 9*

Percent Opacity	Optical Density	Relative Frequency (%)
0	.0000	
5	.0223	
10	.0458	
15	.0706	
20	.0969	
25	.1249	
30	.1549	
35	.1871	
40	.2219	
45	.2596	
50	.3010	
55	.3468	
60	.3979	
65	.4559	
70	.5229	
75	.6021	
80	.6990	
85	.8239	
90	1.0000	
95	1.3010	
99	2.0000	

Time Average

Observer: C. Mosser
Cert Date: 4-29-86
Date of Observation: 8-6-86
Time of Observation:

*Unable to read due to overcast sky - no visible emissions were observable.

Test No. 2
Indurating Gas Scrubber B

Results of Opacity Observations - EPA Method 9*

Percent Opacity	Optical Density	Relative Frequency (%)
0	.0000	
5	.0223	
10	.0458	
15	.0706	
20	.0969	
25	.1249	
30	.1549	
35	.1871	
40	.2219	
45	.2596	
50	.3010	
55	.3468	
60	.3979	
65	.4559	
70	.5229	
75	.6021	
80	.6990	
85	.8239	
90	1.0000	
95	1.3010	
99	2.0000	

Time Average

Observer: C. Mosser
Cert Date: 4-29-86
Date of Observation: 8-6-86
Time of Observation:

*Unable to read due to overcast sky - no visible emissions were observable.

Test No. 3
Indurating Gas Scrubber C

Results of Opacity Observations - EPA Method 9*

Percent Opacity	Optical Density	Relative Frequency (%)
0	.0000	
5	.0223	
10	.0458	
15	.0706	
20	.0969	
25	.1249	
30	.1549	
35	.1871	
40	.2219	
45	.2596	
50	.3010	
55	.3468	
60	.3979	
65	.4559	
70	.5229	
75	.6021	
80	.6990	
85	.8239	
90	1.0000	
95	1.3010	
99	2.0000	

Time Average

Observer: C. Mosser
Cert Date: 4-29-86
Date of Observation: 8-7-86
Time of Observation:

*Unable to read due to overcast sky - no visible emissions were observable.

Test No. 4
Indurating Gas Scrubber D

Results of Opacity Observations - EPA Method 9

Percent Opacity	Optical Density	Relative Frequency (%)
0	.0000	100
5	.0223	0
10	.0458	0
15	.0706	0
20	.0969	0
25	.1249	0
30	.1549	0
35	.1871	0
40	.2219	0
45	.2596	0
50	.3010	0
55	.3468	0
60	.3979	0
65	.4559	0
70	.5229	0
75	.6021	0
80	.6990	0
85	.8239	0
90	1.0000	0
95	1.3010	0
99	2.0000	0
0	0	Time Average

Observer: C. Mosser
Cert Date: 4-29-86
Date of Observation: 8-8-86
Time of Observation: 0915-1015

APPENDIX A

RESULTS OF VOLUMETRIC FLOW RATE DETERMINATIONS

Test No. 1
Indurating Gas Scrubber 'A'

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination.....	08-06-86
Time of Determination.....(HRS)	740
Barometric pressure.....(IN.HG)	28.2
Pitot tube coefficient.....	.84
Number of sampling ports.....	2
Total number of points.....	12
Shape of duct.....	Round
Stack diameter.....(IN)	104.5
Duct area.....(SQ.FT)	59.56
Direction of flow.....	UP
Static pressure.....(IN.WC)	-.46
Avg. gas temp.....(DEG-F)	122
Moisture content.....(% V/V)	10.03
Avg. linear velocity.....(FT/SEC)	48.3
Gas density.....(LB/ACF)	.06173
Molecular weight.....(LB/LBMOLE)	28.93
Mass flow of gas.....(LB/HR)	639802
Volumetric flow rate.....	
actual.....(ACFM)	172751
dry standard.....(DSCFM)	132738

Test No. 2
Indurating Gas Scrubber 'B'

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination.....	08-06-86
Time of Determination.....(HRS)	1140
Barometric pressure.....(IN.HG)	28.2
Pitot tube coefficient.....	.84
Number of sampling ports.....	2
Total number of points.....	12
Shape of duct.....	Round
Stack diameter.....(IN)	104.5
Duct area.....(SQ.FT)	59.56
Direction of flow.....	UP
Static pressure.....(IN.WC)	-.45
Avg. gas temp.....(DEG-F)	123
Moisture content.....(% V/V)	11.05
Avg. linear velocity.....(FT/SEC)	50.3
Gas density.....(LB/ACF)	.06131
Molecular weight.....(LB/LBMOLE)	28.90
Mass flow of gas.....(LB/HR)	661269
Volumetric flow rate.....	
actual.....(ACFM)	179753
dry standard.....(DSCFM)	136322

Test No. 3
Indurating Gas Scrubber 'C'

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination.....	08-07-86
Time of Determination.....(HRS)	740
Barometric pressure.....(IN.HG)	28.1
Pitot tube coefficient.....	.84
Number of sampling ports.....	2
Total number of points.....	12
Shape of duct.....	Round
Stack diameter.....(IN)	104.5
Duct area.....(SQ.FT)	59.56
Direction of flow.....	UP
Static pressure.....(IN.WC)	-.46
Avg. gas temp.....(DEG-F)	126
Moisture content.....(% V/V)	12.82
Avg. linear velocity.....(FT/SEC)	45.6
Gas density.....(LB/ACF)	.06039
Molecular weight.....(LB/LBMOLE)	28.91
Mass flow of gas.....(LB/HR)	590613
Volumetric flow rate.....	
actual.....(ACFM)	163005
dry standard.....(DSCFM)	120109

Test No. 4
Indurating Gas Scrubber 'D'

Results of Volumetric Flow Rate Determination-------Method 2

Date of Determination.....	08-08-86
Time of Determination.....(HRS)	740
Barometric pressure.....(IN.HG)	28.13
Pitot tube coefficient.....	.84
Number of sampling ports.....	2
Total number of points.....	12
Shape of duct.....	Round
Stack diameter.....(IN)	104.5
Duct area.....(SQ.FT)	59.56
Direction of flow.....	UP
Static pressure.....(IN.WC)	-.46
Avg. gas temp.....(DEG-F)	140
Moisture content.....(% V/V)	14.85
Avg. linear velocity.....(FT/SEC)	51.0
Gas density.....(LB/ACF)	.05863
Molecular weight.....(LB/LBMOLE)	28.94
Mass flow of gas.....(LB/HR)	640551
Volumetric flow rate.....	
actual.....(ACFM)	182104
dry standard.....(DSCFM)	128136

TACON 11

Source category: Taconite ore processing
Plant name : Inland Steel Mining
Test date : August 6-8, 1986
Process : Indurating furnace

Date:
Location:
Ref. No.: 30

Basis for process rate :

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor kg/Mg	Emission factor lb/ton
Indurating furnace Total (petroleum coke fired) straight grate	Scrubber	filt. PM	1	46.94	386.00	0.061	0.12
		filt. PM	2	44.33	386.00	0.057	0.11
		filt. PM	3	43.60	386.00	0.056	0.11
				AVERAGE		0.058	0.12
		SO2	1	486.84	386.00	0.63	1.3
		SO2	2	477.68	386.00	0.62	1.2
		SO2	3	497.06	386.00	0.64	1.3
				AVERAGE		0.63	1.3
		CO2	1	30106	386.00	39	78
		CO2	2	28088	386.00	36	73
		CO2	3	30142	386.00	39	78
				AVERAGE		38	76

TACON II P.1

Source category: Taconite ore processing
Plant name : Inland Steel Mining
Test date : August 6-8, 1986
Process : Indurating furnace

Date:
Location:
Ref. No.: (30)

Basis for process rate :

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor kg/Mg	Emission factor lb/ton
Indurating furnace scrubber A stack (petroleum coke fired)	Scrubber	filt. PM	1	15.85	385.00	0.02	0.04
		filt. PM	2	15.19	385.00	0.02	0.04
		filt. PM	3	13.81	385.00	0.02	0.04
				AVERAGE		0.02	0.04
		SO2	1	99.45	385.00	0.129	0.258
		SO2	2	94.44	385.00	0.123	0.245
		SO2	3	97.06	385.00	0.126	0.252
				AVERAGE		0.126	0.252
		CO2	1	7281.1	385.00	9.4559	18.9118
		CO2	2	5501.3	385.00	7.145	14.289
		CO2	3	5535.7	385.00	7.189	14.378
				AVERAGE		7.9299	15.860
Indurating furnace scrubber B stack (petroleum coke fired)	Scrubber	filt. PM	1	11.08	385.00	0.01	0.03
		filt. PM	2	14.02	385.00	0.02	0.04
		filt. PM	3	14.05	385.00	0.02	0.04
				AVERAGE		0.02	0.03
		SO2	1	108.85	385.00	0.141	0.283
		SO2	2	109.26	385.00	0.142	0.284
		SO2	3	121.41	385.00	0.158	0.315
				AVERAGE		0.147	0.294
		CO2	1	5605.4	385.00	7.2798	14.5596
		CO2	2	5577.4	385.00	7.243	14.487
		CO2	3	7538.6	385.00	9.790	19.581
				AVERAGE		8.1045	16.209
Indurating furnace scrubber C stack (petroleum coke fired)	Scrubber	filt. PM	1	12.32	383.00	0.02	0.03
		filt. PM	2	10.42	383.00	0.01	0.03
		filt. PM	3	9.24	383.00	0.01	0.02
				AVERAGE		0.01	0.03
		SO2	1	126.12	383.00	0.165	0.329
		SO2	2	127.25	383.00	0.166	0.332
		SO2	3	127.21	383.00	0.166	0.332
				AVERAGE		0.166	0.331
		CO2	1	6640.5	383.00	8.6690	17.3380
		CO2	2	6403.4	383.00	8.360	16.719
		CO2	3	6425.7	383.00	8.389	16.777
				AVERAGE		8.4724	16.945

TACON 11 p. 2

Source category: Taconite ore processing
Plant name : Inland Steel Mining
Test date : August 6-8, 1986
Process : Indurating furnace

Date:
Location:
Ref. No.: (30)

Basis for process rate :

Source	Type of control	Pollutant	Run No.	Emission rate, lb/hr	Process rate, ton/hr	Emission factor kg/Mg	Emission factor lb/ton
Indurating furnace scrubber D stack (petroleum coke fired)	Scrubber	filt. PM	1	7.69	389.00	0.01	0.02
		filt. PM	2	4.70	389.00	0.01	0.01
		filt. PM	3	6.50	389.00	0.01	0.02
		AVERAGE				0.01	0.02
		SO2	1	152.42	389.00	0.196	0.392
		SO2	2	146.73	389.00	0.189	0.377
		SO2	3	151.38	389.00	0.195	0.389
		AVERAGE				0.193	0.386
		CO2	1	10579.3	389.00	13.5981	27.1963
		CO2	2	10606.3	389.00	13.633	27.266
		CO2	3	10641.7	389.00	13.678	27.357
		AVERAGE				13.6364	27.273

Q - 4 stacks ; 1 furnace

- Type 1 furnace ?