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RESULTS OF THE MAY 22 AND 23, 1984, DUST COLLECTION EFFICIENCY TESTS ON THE D-2 AND E-2 FURNACE TOP GAS MECHANICAL COLLECTORS AT THE ERIE MINING COMPANY PELLET PLANT NEAR HOYT LAKES, MINNESOTA

Submitted to:

ERIE MINING COMPANY
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Attention: Frank Settimi

Approved by:

Perry Lonnes, Ph.D.
President

Report Number 4-1790
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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 May 22 and 23, 1984, Interpoll Inc. personnel conducted dust collection efficiency tests on the D-2 and E-2 Pellet Induration Furnace top gas mechanical collectors at the Erie Mining Company (EMCO) Pellet Plant located near Hoyt Lakes, Minnesota. On-site testing was performed by a five-man team under the direction of Dr. P. Lonnes. Coordination between testing activities and plant operation was provided by Neil Shields of EMCO.

Testing was performed simultaneously at the inlet to the mechanical collector serving the descending shaft induration furnace and in the stack. During the tests, the induration furnace throughput was approximately 58 to 60 wet LONG TONS/HR. The induration furnaces are fired with natural gas.

Evaluations were performed in accordance with EPA Methods 2-5, CFR Title 40, Part 60, Appendix A (revised July 1, 1983). Previous gas linear velocity information was used at both the dust collector inlet and stack test sites to allow selection of the appropriate nozzle diameter required for isokinetic sample withdrawal. Interpoll sampling trains which meet or exceed specifications in the above-cited reference were used to extract representative particulate samples. Heated stainless steel-lined probes were used at both test sites. A stainless steel filter thimble was used in place of the normal EPA Method 5 glass fiber filter at the inlet test location. This filter allows quantitative recovery of the particulate sample in the event subsequent chemical or physical analyses of the samples are required.

An integrated flue gas sample was extracted simultaneously with each particulate 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.

Testing at the inlet to the collector was performed in a 1'-4" x 14'-10" rectangular vertically oriented duct just downstream of a cross sectional convergence on the small dimension and just upstream of a 90 degree direction change on the small dimension side of the duct. A row of nine test ports on the 14'-10" side of the duct was used for entry to perform three 36-point traverse samplings. Each traverse point was sampled two minutes to give a total sampling time of 72 minutes per run. Testing in the stack was conducted from two test ports oriented at 90 degrees located approximately 26 feet downstream of a minor change in duct cross-section and six feet upstream of the stack outlet. A 20-point traverse was used at the stack location. Each traverse point was sampled three minutes to give a total sampling time of 60 minutes per run. During each of the particulate runs, a currently-certified opacity observer performed a one-hour visible emission test.

The important results of the test are summarized in Section 2. Detailed results are presented in Section 3. Results of preliminary measurements, field data and all other supporting information are presented in the appendices.

2 SUMMARY AND DISCUSSION

The important results of the mechanical collector particulate removal tests are summarized in Tables 1 and 2. As will be noted, the dust removal efficiency averaged well over 90% in the case of the D-2 Furnace when the furnace was operated in a so-called "dirty mode". In the case of the E-2 Furnace, the furnace was operated in a so-called "clean mode" and the collection efficiency averaged slightly less than 90%. In interpreting the results on the E-2 Furnace, it should be borne in mind that a blow occurred during the latter half of the first run. This probably contributed to the low collection efficiency observed for that run.

No difficulties were [illegible] in the laboratory [illegible] On the basis of this [illegible] results, it is our opinion [illegible] rates and particle [illegible] reflect the actual [illegible]

Table 1. Summary of the Results of the May 22, 1984 Performance Test on the D-2 Furnace Top Gas Dust Collector at the Erie Mining Company in Hoyt Lakes, Minnesota

ITEM	RUN 1		RUN 2		RUN 3	
	INLET	STACK	INLET	STACK	INLET	STACK
Time of Test (HRS)	[illegible]	[illegible]-1453	1135-1255	1142-1245	1335-1453	1345-1456
[illegible]		59		59		59
[illegible]		[illegible]		31.0		36.1
[illegible]						
ACTUAL [illegible]		[illegible]	66900	67800	66400	65300
[illegible]		[illegible]	42700	43500	41600	41900
Gas [illegible]		[illegible]	213	218	221	216
[illegible]		[illegible]	13.75	12.90	14.44	13.13
[illegible]		[illegible]	1.51	1.48	1.47	1.49
[illegible]		[illegible]	17.05	17.50	17.23	17.52
[illegible]		[illegible]	81.44	81.02	81.30	80.99
[illegible]		[illegible]	100.1	101.9	100.3	102.3
Particulate concentration						
ACTUAL [illegible]	[illegible]	.14	2.39	.21	3.76	.30
STANDARD [illegible]	[illegible]	.22	3.73	.33	5.97	.46
Particulate mass rate [illegible]	[illegible]	78.5	1364	122.1	2131	165.9
Removal efficiency (% w/w)		92.45		91.05		92.21

* [illegible]

Table 2. Summary of the Results of the May 23, 1984 Performance Test on the E-2 Furnace Top Gas Dust Collector at the Erie Mining Company in Hoyt Lakes, Minnesota

ITEM	RUN 1*		RUN 2		RUN 3	
	INLET	STACK	INLET	STACK	INLET	STACK
Time of test (HRS)	0905-1025	0913-1016	1050-1211	1057-1159	1235-1354	1242-1344
Throughput (LONG TONS/H		60		60		60
Average opacity (%)		43.0		35.1		25.7
Volumetric flow						
ACTUAL (ACFM)	70700	65300	63100	65700	59900	66300
STANDARD (DSCFM)	44500	41500	40800	42200	38200	42700
Gas temperature (DEG-F)	211	211	198	209	206	207
Moisture content (%)		2.71	13.67	12.75	13.66	12.87
Gas composition (%)						
O2		1.40	1.60	1.40	1.40	1.40
CO2		17.80	17.60	17.80	17.60	17.80
N2		80.80	80.80	80.80	81.00	80.80
Isokinetic variation (%)	97.5	99.4	98.8	99.1	99.0	99.4
Particulate concentration						
ACTUAL (GR/ACF)	3.33	.746	1.21	.10	1.29	.13
STANDARD (GR/DSCF)	5.26	.71	1.86	.16	2.02	.20
Particulate mass rate (LB/HR)	2007	253.3	649	57.1	662	71.9
Removal efficiency (% w/w)		87.38		91.20		89.14

* Blow occurred

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 printouts of the particulate and visible emission data. Preliminary measurements including traverse point description are given in Appendices A and B.

The results have been calculated on a DEC PDP-11 Computer using standard Fortran programs. EPA-published equations have been used as the basis of the calculation techniques in these programs. It should be noted in interpreting these results that the particulate emission rates have been calculated by both the "concentration x flow" and the "ratio of areas" methods and the average reported. The average is the best estimate of the true value, since the bias introduced by anisokinetic sampling is approximately equal but of opposite sign in the two calculation techniques and thus cancels in the average.

Test No. 1
D-2 Furnace Top Gas MC Inlet

Results of Particulate Loadins Determinations -- Method 5

	Run 1	Run 2	Run 3
Date of run	05/22/84	05/22/84	05/22/84
Time run start/end (HRS)	0940/1106	1135/1255	1335/1453
Pitot tube coefficient	.853	.853	.853
Water in sample			
condensate (ml)	84.0	153.0	152.0
silica sel (srams)	76.0	21.0	28.0
Total particulate material collected (srams) *	9.2218	12.4093	19.4225
Meter correction coefficient	.9957	.9957	.9957
Volume throush sas meter			
at meter conditions...(CF)	55.17	57.22	55.79
standard conditions..(SCF)	50.18	51.40	50.20
Total samplins time (MIN)	72.0	72.0	72.0
Nozzle diameter (IN)	.246	.246	.246
Averase stack sas temperature during determination (DEG-F)	215	213	221
Volumetric flow			
actual.....(CFM)	66548	66860	66395
standard.....(DSCFM)	42775	42720	41634
Isokinetic variation (%)	97.5	100.1	100.3
Particle concentration			
actual.....(GR/ACF)	1.8303	2.3899	3.7591
dry standard.....(GR/DSCF)	2.8359	3.7251	5.9704
Particle mass flow (LB/HR)	1027.58	1365.20	2134.60
Water mass flow (KLB/HR)	17.8	19.1	19.8

* Dry Catch Only
mAmCQ/2

Test No. 1
D-2 Furnace Top Gas Stack

Results of Particulate Loading Determinations -- Method 5

	Run 1	Run 2	Run 3
Date of run	05/22/84	05/22/84	05/22/84
Time run start/end (HRS)	0940/1053	1142/1245	1345/1456
Pitot tube coefficient	.856	.856	.856
Water in sample			
condensate (ml)	84.0	106.0	108.0
silica sel (srams)	63.0	58.0	54.0
Total particulate material collected (srams) *	.6954	1.1079	1.5114
Meter correction coefficient	1.0067	1.0067	1.0067
Volume throush sas meter			
at meter conditions...(CF)	52.02	55.26	53.13
standard conditions..(SCF)	49.62	52.15	50.50
Total samplins time (MIN)	60.0	60.0	60.0
Nozzle diameter (IN)	.248	.248	.248
Averase stack sas temperature durins determination (DEG-F)	217	218	216
Volumetric flow			
actual.....(CFM)	65445	67809	65305
standard.....(DSCFM)	42358	43451	41902
Isokinetic variation (%)	99.5	101.9	102.3
Particle concentration			
actual.....(GR/ACF)	.1405	.2109	.2975
dry standard.....(GR/DSCF)	.2162	.3278	.4618
Particle mass flow (LB/HR)	78.35	123.32	167.90
Water mass flow (KLB/HR)	16.6	18.3	18.0

* Dry Catch Only

Test No. 2
E-2 Furnace Top Gas MC Inlet

Results of Particulate Loading Determinations -- Method 5

	Run 1	Run 2	Run 3
Date of run	05/23/84	05/23/84	05/23/84
Time run start/end (HRS)	0905/1025	1050/1211	1235/1354
Pitot tube coefficient	.853	.853	.853
Water in sample			
condensate (ml)	150.0	135.0	130.0
silica sel (grams)	32.0	28.0	23.0
Total particulate material collected (grams) *	18.1127	5.8317	5.9567
Meter correction coefficient	.9957	.9957	.9957
Volume through gas meter			
at meter conditions...(CF)	58.30	53.77	50.74
standard conditions..(SCF)	53.17	48.47	45.55
Total sampling time (MIN)	72.0	72.0	72.0
Nozzle diameter (IN)	.246	.246	.246
Average stack gas temperature during determination (DEG-F)	213	198	206
Volumetric flow			
actual.....(CFM)	70681	63134	59934
standard.....(DSCFM)	44538	40801	38242
Isokinetic variation (%)	99.3	98.8	99.0
Particle concentration			
actual.....(GR/ACF)	3.3255	1.2047	1.2929
dry standard.....(GR/DSCF)	5.2559	1.8566	2.0179
Particle mass flow (LB/HR)	2000.42	645.70	658.68
Water mass flow (KLB/HR)	20.1	18.0	16.9

* Dry Catch Only

mAmCQ/2

Test No. 2
E-2 Furnace Top Gas Stack

Results of Particulate Loading Determinations -- Method 5

	Run 1	Run 2	Run 3
Date of run	05/23/84	05/23/84	05/23/84
Time run start/end (HRS)	0913/1016	1057/1159	1242/1344
Pitot tube coefficient	.856	.856	.856
Water in sample			
condensate (ml)	91.0	104.0	114.0
silica sel (srams)	60.0	49.0	43.0
Total particulate material collected (srams) *	2.2525	.5040	.6366
Meter correction coefficient	1.0067	1.0067	1.0067
Volume through sas meter			
at meter conditions...(CF)	50.86	52.74	53.60
standard conditions..(SCF)	48.83	49.32	50.03
Total samplins time (MIN)	60.0	60.0	60.0
Nozzle diameter (IN)	.248	.248	.248
Averase stack sas temperature durins determination (DEG-F)	216	209	207
Volumetric flow			
actual.....(CFM)	65274	65680	66342
standard.....(DSCFM)	41520	42243	42728
Isokinetic variation (%)	99.8	99.1	99.4
Particle concentration			
actual.....(GR/ACF)	.4546	.1018	.1270
dry standard.....(GR/DSCF)	.7118	.1577	.1963
Particle mass flow (LB/HR)	253.29	56.88	71.74
Water mass flow (KLB/HR)	17.0	17.3	17.7

* Dry Catch Only
mAmCQ/2

Source category: Taconite ore processing Date: 10/23/96

Plant name : Erie Mining Company Location: Hoyt Lakes, MN

Test date : May 22-23, 1984 Ref. No.: 12

Process : Induration furnace 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	Rating
E-2	Mechanical	filt. PM	1	253.29	61.2	2.1	4.1	
vertical	collector	filt. PM	2	56.88	61.2	0.47	0.93	
shaft		filt. PM	3	71.74	61.2	0.59	1.2	
induration				AVERAGE		1.0	2.1	C
furnace top		CO2	1	3988.0	61.2	33	65	
gas stack		CO2	2	4055.3	61.2	33	66	
(natural		CO2	3	4103.3	61.2	34	67	
gas fired)				AVERAGE		33	66	C
E-2	None	filt. PM	1	2000.42	61.2	16	33	
vertical		filt. PM	2	645.70	61.2	5.3	11	
shaft		filt. PM	3	658.68	61.2	5.4	11	
induration				AVERAGE		9.0	18	C
furnace top		CO2	1	4276.3	61.2	35	70	
gas stack		CO2	2	4480.8	61.2	37	73	
(natural		CO2	3	3670.9	61.2	30	60	
gas fired)				AVERAGE		34	68	C
D-2	Mechanical	filt. PM	1	78.35	60.1	0.65	1.3	
vertical	collector	filt. PM	2	123.32	60.1	1.0	2.1	
shaft		filt. PM	3	167.90	60.1	1.4	2.8	
induration				AVERAGE		1.0	2.0	C
furnace top		CO2	1	3754.3	60.1	31	62	
gas stack		CO2	2	4419.0	60.1	37	73	
(natural		CO2	3	4286.3	60.1	36	71	
gas fired)				AVERAGE		35	69	C
D-2	None	filt. PM	1	1027.58	60.1	8.5	17	
vertical		filt. PM	2	1365.20	60.1	11	23	
shaft		filt. PM	3	2134.60	60.1	18	35	
induration				AVERAGE		13	25	C
furnace top		CO2	1	4406.7	60.1	37	73	
gas stack		CO2	2	4425.7	60.1	37	74	
(natural		CO2	3	4197.5	60.1	35	70	
gas fired)				AVERAGE		36	72	C

Notes: Test report presents feed rate; production rate estimated as 91% of feed rate, based on information presented in References 56 and 57 for same plant.