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MIDWEST RESEARCH INSTITUTE

EPA/600/X-85/343c

REPORT

CHARACTERIZATION OF INHALABLE PARTICULATE MATTER EMISSIONS FROM A WET PROCESS CEMENT PLANT

DRAFT REPORT

August 1983

Volume II - Appendices I through P

EPA Contract No. 68-02-3158, Technical Directive No. 10
MRI Project No. 4892-L(04)

For

Industrial Environmental Research Laboratory
Environmental Protection Agency
5555 Ridge Avenue
Cincinnati, Ohio 45268

Attn: Charles H. Darvin

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CHARACTERIZATION OF INHALABLE PARTICULATE MATTER EMISSIONS FROM A WET PROCESS CEMENT PLANT

by

Mark D. Hansen
John S. Kinsey
Fred J. Bergman

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APPENDIX I

RAW FIELD DATA - DUCTED SOURCES

I-1 Electrostatic Precipitator Inlet
I-1-1 Total Mass (EPA Method 5)
I-1-2 EPA Method 3 - Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight
I-1-3 Particle Sizing - Andersen High Capacity Stack Sampler with 15 μm Preseparator
I-2 Electrostatic Precipitator Outlet
I-2-1 Total Mass (EPA Method 17)
I-2-2 EPA Method 3 - Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight
I-2-3 Particle Sizing - Andersen Mark III Impactor with 15 μm Preseparator

I-1 Electrostatic Precipitator Inlet

I-1-1 Total Mass (EPA Method 5)

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Method 5

RUN ESP-I-1-1

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP-Inlet
Sampling Date 5/2/81

FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	T. Walker
	2	
	3	
Engr. Technician	1	M. Hansen
	2	
	3	
Lab Technician	1	J. Pavelonis
	2	G. Cobb
	3	D. Olson
Process Engineer	1	F. Hoffmeister
	2	
Other	1	
	2	

NOMOGRAPH DATA

PLANT Ideal

DATE 5/2/81

SAMPLING LOCATION ESP Inlet

ESP-I-1-1

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	65
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	29.2
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.89
STATIC PRESSURE IN STACK, in. Hg -5.8" ($P_m \pm 0.074$ STACK GAUGE PRESSURE in in. H_2O)	P_s	28.46
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.99
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	390
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.90
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	—
C FACTOR	.61	
CALCULATED NOZZLE DIAMETER, in.	.268	
ACTUAL NOZZLE DIAMETER, in. #42	.250	
REFERENCE Δp, in. H_2O	1.2	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal

Date 5/2/81

Sampling Location ESP-Inlet

Initial MDH

Test Number ESP-I-1-1

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

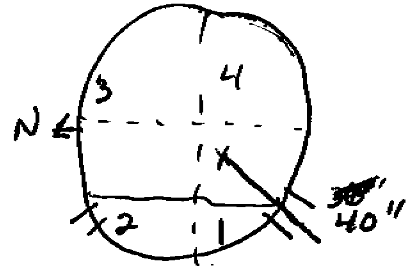
ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	65
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.71
Nozzle diameter, inches	Dn	.250
Barometric pressure, inches Hg	Pb	28.89
$\frac{5.168\ (65 + 460)\ (.84)\ (3)\ (.71)\ (.25^2)}{\sqrt{28.89}}$	K	56.45

FIELD DATA

PLANT Ideal
DATE 5/2/81
SAMPLING LOCATION ESP Inlet
SAMPLE TYPE Mass
RUN NUMBER ESP-I-1-1
OPERATOR T. Walker
AMBIENT TEMPERATURE 60°F
BAROMETRIC PRESSURE 28.89
STATIC PRESSURE, (P_s) -5.8"
FILTER NUMBER (s) 26



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 3', SS
NOZZLE I.D. .250
ASSUMED MOISTURE, % 29.2
SAMPLE BOX NUMBER 10
METER BOX NUMBER 3
METER $\Delta H_@$ 1.02
C FACTOR .61
PROBE HEATER SETTING 10
HEATER BOX SETTING max.
REFERENCE Δp 1.2

Leak CK: Initial at 15" Hg, CFM .005
Final at Hg, CFM .01

READ AND RECORD ALL DATA EVERY 3 MINUTES

$$VM = 56.45 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3		VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
			Desired	Actual		DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0	0945	542.90										
1	3	0948	544.40	544.42	.60	.92	.93	390	67	66	9	244	58
	6	0951	545.90	545.97	.60	.92	.93	394	69	66	8	238	58
	9	0954	547.40	547.50	.60	.92	.93	389	72	67	9	250	60
	12	0957	548.83	549.01	.55	.85	.85	392	74	67	9	255	58
			V_m = 6.11				ΔH = .91		Tm =	68.5			
					ΔP = .5875			T_s = 391.3					

COMMENTS:

31.9% H_2O

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP-Inlet
Test Number ESP-I-1-1

Date 5/2/81
Initial MDH

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	391.3
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = .91, Pb = 28.89, Tm = ~~89~~ 68.5, Vm = 6.11	Vm_{std}	5.91
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$	Mf	.681
Molecular wt. dry stack gas, lb/lb-mole $(\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 + \%CO \times 0.28)$	Md	31.58
Molecular wt. stack gas, lb/lb-mole $(Md)(Mf) + 18(1 - Mf)$	Ms	27.25
Static pressure in stack, absolute, in. Hg $(Pb) \pm (0.074 \times \text{stack gage pressure, in } H_2O)$	Ps	28.46
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	3,460
Total sample time, minutes	θ	12
Nozzle diameter, inches	Dn	.250
$\frac{1{,}039\,(391.3 + 460)(5.91)}{(3{,}460)(12)(28.46)(.681)(.25^2)}$	% I	103.9

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal
Sample Location ESP-Inlet
Sample Box No. 10
Sample Type MASS

Run No. ESP-I-1-1
Sample Date 5/2/81
Recovery Date
Cleanup Person

Filter No. 26
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

	1	2	3	4	5	SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/	M	SG	M			
Impinger Solution	H_2O	H_2O	dry			
Final Volume (wt) b/	149 ml	106 ml	1 ml			799.3
Initial Volume (wt) b/	100 ml	100 ml	—			796.5
Net Volume (wt) b/	49	6	1			2.8
Sample No.(s)						

Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked
Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 58.8

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier
Date Shipped:
Remarks:

Date of laboratory custody
Seal(s) broken by
Personnel accepting custody
Date broken
Remarks:

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Run No. ESP-I-4 PARTICULATE CLEAN-UP AND ANALYSIS

Date 5-2-81 FIELD ANALYSIS Performed by JP

Impinger Sequence	1	2	3	4	5	6
Impinger Type*	M	S	M	M		
Final Volume**	149ml	106ml	1ml	799.3g		
Initial Volume**	100	100	—	796.5g		
Difference	49	6	1	2.8g		

* S = Greenburg-Smith standard, M = modified, O = Other Silica gel (M)

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
10		4	103.1047	67.4469		JP	5/18/81
11 24		5	96.5835 97.7853	96.2620 96.5491	100 210		
	26	6	4.9837	3.7775			
		6					
		6					
		7					
		8					
		9					
*5/81/11		10	70.5701	70.5709	40	JP	5/18/81

Comments:

*ACETONE BLANK AVERAGE OF THREE BEAKERS

*WEIGHTS AVERAGE OF 3

FILTER BLANK = 0.2mg

ACETONE BLANK = -0.8mg

Codes:

1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP-Inlet

Test Run Number ESP-I-1-1

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/2/81	0945-0957 ~~5:49.01~~		
Probe Technician			Fritz Hoffmeister	
Meter Technician			Tom Walker	
Other			Mack Hansen	
Transport of Train to Cleanup Site	5/2/81	1005	M. Hansen	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

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METHOD 5

RUN ESP-I-2-1

MRI Project Number 48921-03
Field Dates
Plant IDEAL CEMENT CO
Sampling Location ESP INLET
Sampling Date 5/4/81

FIELD CREW

Crew Chief MARK HANSEN

Testing Engineer
1 Tom WALKER
2
3

Engr. Technician
1 FRITZ HOFFMEISTER
2 MARK HANSEN
3

Lab Technician
1 JOEL PAVELONIS
2 Dick Cobb
3

Process Engineer
1
2

Other
1
2

NOMOGRAPH DATA

PLANT Ideal Cement Co

DATE 5/4/81

SAMPLING LOCATION ESP-I-2-1

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	65
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	25
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.67
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.074$ STACK GAUGE PRESSURE in in. H_2O) = -5.8	P_s	28.24
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	390
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.85
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	—
C FACTOR	.68	
CALCULATED NOZZLE DIAMETER, in.	.262	
ACTUAL NOZZLE DIAMETER, in.	.25	
REFERENCE Δp, in. H_2O	1.0	

EPA (Dur) 234
4 72

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ISOKINETIC SAMPLING WORKSHEET

Plant Ideal Cement Co. Date 5/4/81
Sampling Location ESP Inlet Initial T.W.
Test Number ESP-I-2-1

Isokinetic sampling equation:

$$Vm_i = K\sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	65
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.75
Nozzle diameter, inches	Dn	.25
Barometric pressure, inches Hg	Pb	28.67
$\frac{5.168\ (65 + 460)\ (.84)\ (3)\ (.75)\ (.25^2)}{\sqrt{28.67}}$	K	59.86

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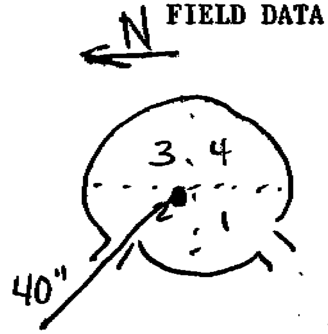
WATERPROOF PAPER

FIELD DATA



PLANT Ideal Cement Co
DATE 5/4/81
SAMPLING LOCATION ESP-INLET
SAMPLE TYPE PARTICULATE
RUN NUMBER ESP-I-2-1
OPERATOR Tom WALKER
AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 28.67
STATIC PRESSURE (P_s) -5.8
FILTER NUMBER(s) 22

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .25
ASSUMED MOISTURE, % 25
SAMPLE BOX NUMBER 8
METER BOX NUMBER 3
TEMPERATURE METER NO.
METER ΔH@ 1.963
METER CORRECTION
C FACTOR .68
REFERENCE Δp 1.0

Schematic of Traverse Point Layout

LEAK CK: Initial at 15" Hg, CFM .005 Read and Record All Data
Final at 8 Hg, CFM .005 Every 3 Minutes

$$VM = 59.86 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³		VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
			Desired	Actual		DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0	0844	593.96										
2	3	0847	595.58	595.70	.64	1.2	1.3	410	65	65	8	242	57
	6	0850	597.33	597.57	.75	1.4	1.4	416	67	65	8	257	60
	9	0853	598.87	599.16	.58	1.1	.98	418	68	65	7	257	60
	12	0857	600.35	600.71	.54	1.0	.95	422	70	65	8	269	60
			Vm=6.75		ΔpAvg=.63		ΔHAvg =1.16	Ts=417	TmAvg=66				

COMMENTS:

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Cement Co
Sampling Location ESP - Inlet
Test Number ESP - I - 2 - 1

Date 5/4/81
Initial T.W.

Isokinetic equation:

$$\% \, I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	417
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ 6.75, 1.16, 28.67, 66 — 6.51	Vm_{std}	6.51
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 31.62%	Mf	.68
Molecular wt. dry stack gas, lb/lb-mole $(\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 + \%CO \times 0.28)$	Md *	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 31.15 .68 .68	Ms	26.94
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) 28.67 -5.8	Ps	28.24
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ 417, .63, 28.24, 26.94	Vs	3671.42
Total sample time, minutes	θ	12
Nozzle diameter, inches	Dn	.25
$\frac{1{,}039\ (417 + 460)(6.51)}{(3671.42)(28.24)(.68)(12)(.25^2)}$	% I	112.18

* taken from data obtained on 5/2/81 at ESP Outlet

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PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant: IDEAL CEMENT Co
Run No.: ESP-I-2-1
Sample Location: ESP-INLET
Sample Date: 5/4/81
Sample Box No.: 8
Recovery Date:
Sample Type: PARTICULATE
Cleanup Person:

Filter No.: 22
Sample No.:
Sample Material Description:

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5
Impinger Type a/					
Impinger Solution	H_2O	H_2O	dry		
Final Volume (wt) b/	156	103	3		
Initial Volume (wt) b/	100	100	0		
Net Volume (wt) b/	56	3	0		
Sample No.(s)					

SILICA GEL

751.2
746.4
4.8

Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked
Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 63.8g

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier
Date Shipped:
Remarks:

Date of laboratory custody
Personnel accepting custody
Seal(s) broken by
Date broken
Remarks:

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Run No. ESP-I-2-1 PARTICULATE CLEAN-UP AND ANALYSIS

Date 5-4-81 FIELD ANALYSIS Performed by JP

	ml	ml	ml	g		
Impinger Sequence	1	2	3	4	5	6
Impinger Type*	M	S	M	~~O~~M		
Final Volume**	156	103	0	751.2		
Initial Volume**	100	100	0	746.4		
Difference	56	3	0	4.8		

* S = Greenburg-Smith standard, M = modified, O = Other Silica gel (CM)
** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
72		4	111.4073	68.6799		JP	5/18/81
19		5	97.7865	~~68.6799~~ 96.6852	160		
	22	6	5.9933	3.8307			
		6					
		6					
		7					
		8					
		9					
5/81/11		10	70.5701	70.5709	40	JP	5/18/81

Comments: Codes:

FILTER BLANK = 0.1mg
ACETONE BLANK = 0.8mg

1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 48921-03

Source Identification ESP-INLET

Test Run Number ESP-I-2-1

Pollutant(s) in Sample PARTICULATE

Task	Date	Time	Personnel	Remarks
Sampling	5/4/81	0844-0857		
Probe Technician			FRITZ HOFFMEISTER	
Meter Technician			TOM WALKER	
Other				
Transport of Train to Cleanup Site				
Train Disassembly	5-4-81		Joel Pavelons	
Train Cleanout	5-4-81		Joel Pavelons	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

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RUN ESP-I-3-1

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/1/81

FIELD CREW

Crew Chief M. Hansen

Testing Engineer 1 T. Walker
2
3

Engr. Technician 1 M. Hansen
2
3

Lab Technician 1 J. Pavelonis
2 G. Cobb
3 D. Olson

Process Engineer 1 F. Hoffmeister
2

Other 1
2

NOMOGRAPH DATA

PLANT Ideal

DATE 5/1/81

SAMPLING LOCATION ESP Inlet

ESP-I-3-1

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\,avg.}$	85
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	18.9
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.92
STATIC PRESSURE IN STACK, in. Hg -5.8" (P_m±0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.49
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.99
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	390
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.92
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	—
C FACTOR		.78
CALCULATED NOZZLE DIAMETER, in.		.25
ACTUAL NOZZLE DIAMETER, in. #42		.250
REFERENCE Δp, in. H_2O		.92

assumed from 4/30/81

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal | Date 5/1/81

Sampling Location ESP Inlet | Initial MOH

Test Number ESP-I-3-1

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

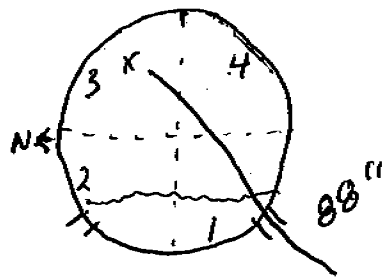
ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	85
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.81
Nozzle diameter, inches	Dn	.250
Barometric pressure, inches Hg	Pb	28.92
$\frac{5.168\ (85 + 460)\ (.84)\ (3)\ (.81)\ (.25^2)}{\sqrt{28.92}}$	K	66.82

FIELD DATA

PLANT Ideal
DATE 5/1/81
SAMPLING LOCATION ESP Inlet
SAMPLE TYPE MASS
RUN NUMBER ESP-I-3-1
OPERATOR T. Walker
AMBIENT TEMPERATURE 60°F
BAROMETRIC PRESSURE 28.92
STATIC PRESSURE, (P_s) -5.8"
FILTER NUMBER (s) 25



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .250
ASSUMED MOISTURE, % 18.9
SAMPLE BOX NUMBER 10
METER BOX NUMBER 3
METER $\Delta H_@$ 1.02
C FACTOR .78
PROBE HEATER SETTING
HEATER BOX SETTING Max
REFERENCE Δp .92

Leak CK: Initial at 15" Hg, CFM 0.0
Final at Hg, CFM 0.005

READ AND RECORD ALL DATA EVERY 3 MINUTES

$$VM = 66.82 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 515.70 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0942											
3	3	0945	517.93	517.83	.95	1.9	1.9	394	63	63	12	225	58
	6	0948	520.22	520.42	1.5	3.0	3.0	399	70	63	17	234	60
	9	0951	522.92	522.65	.93	1.85	2.0	400	73	64	14	230	60
	12	0954	524.90	524.70	.75	1.5	1.7	398	75	64	13	269	61
	15	0957	527.05	526.82	.89	1.8	2.0	396	78	65	17	276	62
		0957											
			Vm = 11	.12	Δp = 1.00	ΔH =	2.12	Ts = 397.4	Tm =	67.8			

COMMENTS:

30.04% moisture

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant *Ideal* Date *5/1/81*
Sampling Location *ESP-Inlet* Initial *MDH*
Test Number *ESP-I-3-1*

Isokinetic equation:

$$\% \text{ I} = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	397.4
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = 2.12$ $Pb = 28.92$ $Vm = 11.12$ $Tm = 67.8$ ~~Tm + 460 = 527.8~~	Vm_{std}	10.81
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$	Mf	.70 ~~30.07~~
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.51
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.49
Stack velocity, fpm $\Delta P = 1.00$ $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	4,506
Total sample time, minutes	θ	15
Nozzle diameter, inches	Dn	.250
$\frac{1{,}039\ (397.4 + 460)(10.81)}{(4506)(15)(28.49)(.70)(.25^2)}$	% I	114.3

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal　　Run No. ESP-I-3-1
Sample Location ESP-Inlet　　Sample Date 5/1/81
Sample Box No. 10　　Recovery Date ________
Sample Type MASS　　Cleanup Person ________

Filter No. 25 ________ ________
Sample No. ________ ________ ________
Sample Material Description ________

MOISTURE AND/OR SAMPLE

	1	2	3	4	5	SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/	M	S.G.	M			
Impinger Solution	H_2O	H_2O	DRY			
Final Volume (wt) b/	201	92	1			796.5
Initial Volume (wt) b/	100	100	0			792.4
Net Volume (wt) b/	101	-8	1			4.1
Sample No.(s)						Silica Gel
Combined impinger contents, Sample No.						Color ________

Liquid Level Marked ________ Container(s) Sealed ________
Description of Impinger Solution ________
Total Moisture, gm 98.1 g

a/ S = Greenburg-Smith standard, M = Modified, O = Other ________
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ________ Liquid Level Marked ________ Sealed ________
Dry Catch: Sample No. ________ Description ________ Sealed ________
Impinger Rinse: Sample No. ________ Liquid Level Marked ________ Sealed ________
Acetone Blank: Sample No. ________ Liquid Level Marked ________ Sealed ________
Water Blank: Sample No. ________ Liquid Level Marked ________
Filter Blank: Sample No. ________ Sealed ________
Sample Disposition ________
Carrier ________ Date Shipped: ________
Remarks: ________

Date of laboratory custody ________ Seal(s) broken by ________
Personnel accepting custody ________ Date broken ________
Remarks: ________

MIDWEST RESEARCH INSTITUTE

Run No. ESP-I-3-1 PARTICULATE CLEAN-UP AND ANALYSIS

Date 5-1-81 FIELD ANALYSIS Performed by JP

	ml	ml	ml	g		
Impinger Sequence	1	2	3	4	5	6
Impinger Type*	M	S	M	M		
Final Volume**	201	92	1	796.5		
Initial Volume**	100	100	0	792.4		
Difference	101	-8	1	4.1		

* S = Greenburg-Smith standard, M = modified, O = Other ______

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1				JP	5/18/81
		2					
		3					
77		4	84.9597	68.8882		JP	5/18/81
7 58		5	96.1867 117.9029	95.1005 115.3585	175 180		
	25	6	5.5274	3.8079			
		6					
		6					
		7					
		8					
		9					
5/87/11		10	70.5701	70.5709	40	JP	5/18/81

Comments:

Filter Blank - 0.1mg

Acetone Blank = -0.8mg

Codes:

1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-3-1

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/1/81	0942-0957	MASS	
Probe Technician			M. Hansen	
Meter Technician			T. Walker	
Other				
Transport of Train to Cleanup Site	5/1/81	1010	F. Hoffmeister	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-I-4-1

MRI Project Number 4892L-03
Field Dates
Plant IDEAL CEMENT Co.
Sampling Location ESP INLET
Sampling Date 5/2/81

FIELD CREW

Crew Chief		MARK HANSEN
Testing Engineer	1	Tom WALKER
	2	
	3	
Engr. Technician	1	FRITZ HOFFMEISTER
	2	
	3	
Lab Technician	1	JOEL PAVELONIS
	2	DICK COBB
	3	
Process Engineer	1	
	2	
Other	1	
	2	

NOMOGRAPH DATA

PLANT IDEAL CEMENT Co

DATE 5/2/81

SAMPLING LOCATION ESP INLET (ESPI-4-1)

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	80
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	29
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.83
STATIC PRESSURE IN STACK, in. Hg (P_m ±0.074 STACK GAUGE PRESSURE in in. H_2O) -5.8	P_s	28.40
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	390
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	1.00
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	.63	
CALCULATED NOZZLE DIAMETER, in.	1/4" + .257	
ACTUAL NOZZLE DIAMETER, in.	.250	
REFERENCE Δp, in. H_2O	1.1	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant IDEAL CEMENT CO Date 5/2/81
Sampling Location ESP INLET Initial DW
Test Number ESP-I-4-1

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

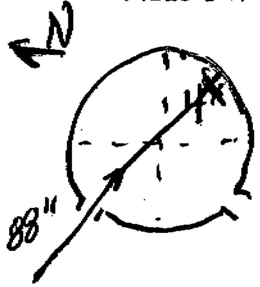
ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	80
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.71
Nozzle diameter, inches	Dn	.25
Barometric pressure, inches Hg	Pb	28.83
$\frac{5.168\ (80 + 460)\ (.84)\ (3)\ (.71)\ (.25^2)}{\sqrt{28.83}}$	K	58.12

FIELD DATA

PLANT Ideal Cement Co.
DATE 5/2/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE Particulate
RUN NUMBER ESP-I-4-1
OPERATOR Tom Walker
AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 28.83
STATIC PRESSURE, (P_s) -5.8
FILTER NUMBER (s) 27



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .25
ASSUMED MOISTURE, % 29
SAMPLE BOX NUMBER 10
METER BOX NUMBER 3
METER $\Delta H_@$ 1.963
C FACTOR .63
PROBE HEATER SETTING 10
HEATER BOX SETTING MAX
REFERENCE Δp 1.1

Leak CK: Initial at 15" Hg, CFM .005
Final at Hg, CFM .005

READ AND RECORD ALL DATA EVERY 3 MINUTES

$$VM = 58.12 \times \sqrt{\frac{Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1537	560.68										
4	3	1540	562.50	562.67	.80	1.35	1.4	360	80	79	9	248	71
	6	1543	564.32	564.54	.79	1.30	1.2	350	83	80	8	—	68
	9	1546	566.12	566.22	.78	1.30	1.1	352	85	80	8	202	68
	12	1549	567.91	568.00	.77	1.3	1.1	350	86	81	10	215	68
	15	1552	569.71	569.74	.77	1.3	1.2	340	88	81	10	216	68
	18	1555	571.52	571.56	.79	1.3	1.3	358	90	82	12	243	68
	21	1558	573.32	573.43	.77	1.3	1.3	342	92	83	13	255	68
	24	1601	575.13	575.30	.79	1.3	1.3	357	94	84	15	255	70
	27	1604	576.98	577.18	.83	1.4	1.4	360	95	85	17	218	70
	30	1607	578.83	579.02	.84	1.4	1.2	365	95	85	16	165	70
									Tm =	85.4			
			Vm=18.34		ΔP=.79		ΔH=1.25	Ts=353					

COMMENTS:

22.4%

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Cement Co. Date 5/2/81

Sampling Location ESP-Inlet Initial T.W.

Test Number ESP-I-4-1

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	353
Meter volume (std), $\frac{17.64 \overset{18.34}{(Vm)}\left(\overset{28.83}{Pb}+\frac{\Delta H_{avg}^{1.25}}{13.6}\right)}{\underset{85.40}{Tm+460}}$ $\Delta H = 1.25$ Pb = 28.83 Tm = 85.40 Vm = 18.34	Vm_{std}	17.16
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$	Mf	.78
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole $\underset{31.58}{(Md)}\ \underset{.78}{(Mf)} + 18(1 - \underset{.78}{Mf})$	Ms	28.59
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) -5.8	Ps	28.40
Stack velocity, fpm $5{,}128.8\ \underset{.84}{(Cp)}\left(\underset{.79}{\sqrt{\Delta Ps}_{avg}}\right)\sqrt{\frac{\overset{353}{Ts}+460}{\underset{28.4}{Ps} \times \underset{28.59}{Ms}}}$	Vs	3831.67
Total sample time, minutes	θ	30
Nozzle diameter, inches	Dn	.25
$\frac{1{,}039\ (353 + 460)(17.16)}{(3831.67)(30)(28.4)(.78)(.25^2)}$	% I	91.08

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PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant IDEAL Cement Co   Run No. ESP-I-4-1
Sample Location ESP INLET   Sample Date 5/2/81
Sample Box No. 10   Recovery Date 5/2/81
Sample Type PARTICULATE   Cleanup Person

Filter No. 27
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE						SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution	H_2O	H_2O	dry	SiO_2		
Final Volume (wt) b/	200	100	0	804.6		804.2
Initial Volume (wt) b/	100	100	-	799.3		799.3
Net Volume (wt) b/	100	0	0			4.9
Sample No.(s)						Silica Gel
						Color

Combined impinger contents, Sample No.
Liquid Level Marked   Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 104.9

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed
Impinger Rinse: Sample No.
Liquid Level Marked
Sealed
Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed
Acetone Blank: Sample No.
Liquid Level Marked
Sealed
Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier   Date Shipped:
Remarks:

Date of laboratory custody   Seal(s) broken by
Personnel accepting custody   Date broken
Remarks:

MIDWEST RESEARCH INSTITUTE

Run No. ESP-I-4-1 PARTICULATE CLEAN-UP AND ANALYSIS

Date ______ FIELD ANALYSIS Performed by ______

	ml	ml	ml	g		
Impinger Sequence	1	2	3	4	5	6
Impinger Type*	M	S	M	M		
Final Volume**	200	100	0	804.2		
Initial Volume**	100	100	–	799.3		
Difference	100	0	0	4.9		

* S = Greenburg-Smith standard, M = modified, O = Other ______

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
61		4	104.0239	69.2797		JP	5/18/81
37		5	112.6857	110.6738	160	/	/
	27	6	6.5035	3.7680		/	/
		6					
		6					
		7					
		8					
		9					
9M/11		10	70.5701	70.5709	40	JP	5/19/81

Comments:

Filter Blank · 0.2 mg

Acetone Blank ÷ 0.8 mg

Codes:

1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 4892L-03

Source Identification ESP INLET

Test Run Number ESP-I-4-1

Pollutant(s) in Sample PARTICULATE

Task	Date	Time	Personnel	Remarks
Sampling	5/2/81	1537-1607		
Probe Technician			FRITZ HOFFMEISTER	
Meter Technician			TOM WALKER	
Other			MARK HANSEN	
Transport of Train to Cleanup Site	5/2/81	1615	M. Hansen	
Train Disassembly	5/2/81		Joel Pavlows	
Train Cleanout	5/2/81		Joel Pavlows	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis	5/2/81		Joel Pavlows	
Write Up				

MIDWEST RESEARCH INSTITUTE

METH 5

RUN ESP-I-1-2

MRI Project Number 4892L-03
Field Dates
Plant IDEAL CEMENT CO
Sampling Location ESP INLET
Sampling Date 5/4/81

FIELD CREW

Crew Chief		MARK HANSEN
Testing Engineer	1	TOM WALKER
	2	
	3	
Engr. Technician	1	FRITZ HOFFMEISTER
	2	
	3	
Lab Technician	1	JOEL PAVELONIS
	2	
	3	
Process Engineer	1	FRITZ HOFFMEISTER
	2	
Other	1	Dick Cobb
	2	DAN OLSON

NOMOGRAPH DATA

PLANT Ideal Cement Co.

DATE 5/4/81

SAMPLING LOCATION ESP-I-1-2

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\,avg.}$	80
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	30
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.72
STATIC PRESSURE IN STACK, in. Hg (P_m ±0.074 STACK GAUGE PRESSURE in in. H_2O) 28.72 -.58	P_s	28.29
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	390
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.85
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	.61	
CALCULATED NOZZLE DIAMETER, in.	.270	
ACTUAL NOZZLE DIAMETER, in.	.250	
REFERENCE Δp, in. H_2O	H 1.2	

EPA (Dur) 234
4 72

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ISOKINETIC SAMPLING WORKSHEET

Plant Ideal Cement Co Date 5/4/81
Sampling Location ESP Inlet Initial T.W.
Test Number ESP-I-1-2

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	80
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.7
Nozzle diameter, inches	Dn	.25
Barometric pressure, inches Hg	Pb	28.72
$\frac{5.168\ (80 + 460)\ (.84)\ (3)\ (.7)\ (.25^2)}{\sqrt{28.72}}$	K	57.41

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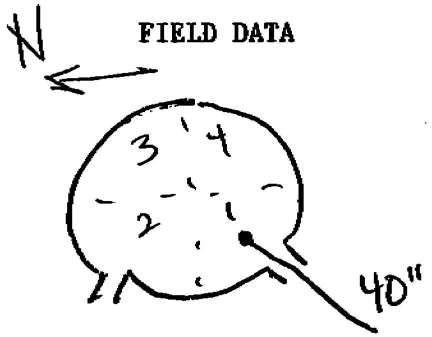
WATERPROOF PAPER

FIELD DATA



PLANT Ideal Cement Co
DATE 5/4/81
SAMPLING LOCATION ESP-INLET
SAMPLE TYPE Particulate Meth 5
RUN NUMBER ESP-I-1-2
OPERATOR Tom Walker
AMBIENT TEMPERATURE 75
BAROMETRIC PRESSURE 28.72
STATIC PRESSURE (P_s) -5.8
FILTER NUMBER(s) 24

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .25
ASSUMED MOISTURE, % 30
SAMPLE BOX NUMBER 4
METER BOX NUMBER 3
TEMPERATURE METER NO.
METER ΔH@
METER CORRECTION
C FACTOR .61
REFERENCE Δp 1.2

Schematic of Traverse Point Layout

LEAK CK: Initial at 15" Hg, CFM .005
Final at 22 Hg, CFM .01

Read and Record All Data Every 3 Minutes

$VM = 5.741 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1611	614.94										
1	3	1614	616.39	616.37	.52	.85	.85	350	71	71	21	243	70
	6	1617	617.99	618.01	.63	1.0	1.1	351	74	71	22	247	65
	9	1620	619.28	619.53	.42	.70	.68	368	77	72	7	290	65
	12	1623	620.09	620.89	.41	.60	.63	396	80	72	5	306	65
	1												
			Vm=5.95		ΔP=.50		ΔH=.82	Ts=366	Tm=73.5				

COMMENTS:

ISOKINETIC PERFORMANCE WORKSHEET

Plant: Ideal Cement Co

Sampling Location: ESP-INLET

Test Number: ESP-I-1-2

Date: 5/4/81

Initial: DW

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	366
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$; 5.95, 28.72, .82, 73.5 ; $\Delta H = .82$, $Pb = 28.72$, $Vm = 5.95$, $Tm+460 = 533.5$	Vm_{std}	5.66
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ Assume 30%	Mf	.7
Molecular wt. dry stack gas, lb/lb-mole $(\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 + \%CO \times 0.28)$	Md	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.21
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.29
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$; $\Delta P = .5$, $Cp = .84$	Vs	~~28.29~~ 3156
Total sample time, minutes	θ	12
Nozzle diameter, inches	Dn	.25
$\frac{1{,}039\,(366 + 460)(5.66)}{(3156)(12)(28.29)(.7)(.25^2)}$	% I	103.6

OBTAINED ~12% H_2O – POSSIBLY PULLED MOISTURE INTO FILTER CHAMBER (FILTER WAS WET) WILL ASSUME 30% MOISTURE FOR ISOKENITIC PERFORMANCE

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Cement Co Run No. ESP-I-1-2
Sample Location ESP INLET Sample Date 5/4/81
Sample Box No. 4 Recovery Date ______
Sample Type Particulate Meth 5 Cleanup Person ______

Filter No. 24 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

	1	2	3	4	5	SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/	M	S.G	M			
Impinger Solution	H_2O	H_2O	DRY			
Final Volume (wt) b/	167	48	0			751.4
Initial Volume (wt) b/	100	100	0			750.3
Net Volume (wt) b/	67	-52	0			1.1
Sample No.(s)						

Silica Gel Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 16.1g

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: * Possibly pulled moisture into filter chamber (filter was wet) Assumed 30% moisture for isokinetic performance.

MIDWEST RESEARCH INSTITUTE

Run No. 89-I-1-2 PARTICULATE CLEAN-UP AND ANALYSIS

Date ________ FIELD ANALYSIS Performed by ________

	ml	ml	ml	g		
Impinger Sequence	1	2	3	4	5	6
Impinger Type*	M	S	M	M		
Final Volume**	167	48	0	751.4		
Initial Volume**	100	100	0	750.3		
Difference	67	-52	0	1.1		

* S = Greenburg-Smith standard, M = modified, O = Other ________

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
28		4	138.4773	76.6563		JP	5/18/81
25		5	97.7439	96.3609	170	/	/
	24	6	6.2722	3.8233		/	/
		6					
		6					
		7					
		8					
		9					
5/81/11		10	70.5701	70.5709	40	JP	5/18/81

Comments:

Filter Blk. Wt. = 0.1mg

Acetone Blk Wt. = 0.8mg

Codes:

1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 48921-03

Source Identification ESP INLET

Test Run Number ESP-I-1-2

Pollutant(s) in Sample PARTICULATE

Task	Date	Time	Personnel	Remarks
Sampling	5/4/81	1611-1623		
Probe Technician			FRITZ HOFFMEISTER	
Meter Technician			TOM WALKER	
Other			MARK HANSEN	
Transport of Train to Cleanup Site				
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-I-2-2

MRI Project Number 4892L-03
Field Dates
Plant IDEAL CEMENT CO.
Sampling Location ESP-INLET
Sampling Date 5/5/81

FIELD CREW

Crew Chief MARK HANSEN

Testing Engineer 1 Tom WALKER
2
3

Engr. Technician 1 FRITZ HOFFMEISTER
2 MARK HANSEN
3

Lab Technician 1 JOEL PAVELONIS
2 RICK COBB
3

Process Engineer 1
2

Other 1
2

MRI - Form PO (10/72)

NOMOGRAPH DATA

PLANT Ideal Cement Co

DATE 5/5/81

SAMPLING LOCATION ESP INLET (ESP-I-2-2)

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	70
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	32
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.88
STATIC PRESSURE IN STACK, in. Hg (P_m ±0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.45
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	370
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.60
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR		.58
CALCULATED NOZZLE DIAMETER, in.		.295
ACTUAL NOZZLE DIAMETER, in.		.297
REFERENCE Δp, in. H_2O		.60

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal Cement

Sampling Location ESP-Inlet

Test Number ESP-I-2-2

Date 5/5/81

Initial T.W.

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	70
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.68
Nozzle diameter, inches	Dn	.297
Barometric pressure, inches Hg	Pb	28.88
$\frac{5.168\ (70 + 460)\ (.84)\ (3)\ (.68)\ (.297^2)}{\sqrt{28.88}}$	K	77.04

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WATERPROOF PAPER

FIELD DATA

PLANT Ideal Cement Co.
DATE 5/5/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE Method 5
RUN NUMBER ESP-I-2-2
OPERATOR Tom Walker
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.88
STATIC PRESSURE (P_s) -5.8
FILTER NUMBER(s) 28

Schematic of Traverse Point Layout

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .297
ASSUMED MOISTURE, % 32
SAMPLE BOX NUMBER 4
METER BOX NUMBER 3
TEMPERATURE METER NO.
METER ΔH@ 1.963
METER CORRECTION
C FACTOR .58
REFERENCE Δp .60

LEAK CK: Initial at 15" Hg, CFM .00
Final at 6 Hg, CFM .00

Read and Record All Data Every 3 Minutes

$$VM = 71.04 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1443	657.32										
2	3	1446	659.45	659.52	.62	1.9	1.9	345	69	69	4	222	60
	6	1449	661.54	661.55	.60	1.8	1.7	352	71	69	4	234	61
	9	1452	663.67	663.66	.62	1.9	1.8	348	74	70	5	225	62
	12	1455	665.90	665.92	.68	2.1	2.1	348	76	70	6	231	62

$V_m = 8.6$ AVG $\Delta P_s = .63$ AVG ΔH = 1.875 AVG $T_m = 71$

AVG $T_s = 348$

COMMENTS:

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Cement Co Date 5/5/81

Sampling Location ESP INLET Initial DW

Test Number ESP-I-2-2

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	348
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = 1.9 Pb = 28.88 Vm = 8.6 Tm+460 = 531	Vm_{std}	8.29
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 31.3%	Mf	.687
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.743
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.44
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) -5.8	Ps	28.45
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP = .63 Cp = .84	Vs	3,479
Total sample time, minutes	θ	12
Nozzle diameter, inches	Dn	.297
$\frac{1{,}039\ (348 + 460)(8.29)}{(3{,}479)(12)(28.45)(.687)(.297^2)}$	% I	96.7

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant IDEAL CEMENT Co. Run No. ESP-I-2-2
Sample Location ESP-INLET Sample Date 5/5/81
Sample Box No. 4 Recovery Date
Sample Type Cleanup Person

Filter No. 28
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5
Impinger Type a/					
Impinger Solution	H_2O	H_2O	dry		
Final Volume (wt) b/	166	118	1 ml		
Initial Volume (wt) b/	100	100	—		
Net Volume (wt) b/	66	10	1 ml		
Sample No.(s)					

Combined impinger contents, Sample No.
Liquid Level Marked Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 80.0 gm

SILICA GEL

758.7
755.7
3.0
Silica Gel Color

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier Date Shipped:
Remarks:

Date of laboratory custody Seal(s) broken by
Personnel accepting custody Date broken
Remarks:

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Run No. ESP-I-2-2 PARTICULATE CLEAN-UP AND ANALYSIS

Date 5/5/81 FIELD ANALYSIS Performed by ______

	ml	ml	ml	g		
Impinger Sequence	1	2	3	4	5	6
Impinger Type*	M	S	M	M		
Final Volume**	166	110	1	758.7		
Initial Volume**	100	100	–	755.7		
Difference	66	10	1	3.0		

* S = Greenburg-Smith standard, M = modified, O = Other ______

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
34		4	110.1864	75.9393		JP	5/18/81
5		5	96.1453	95.1499	120	|	|
	28	6	6.8101	3.7800		|	|
		6					
		6					
		7					
		8					
		9					
5/81/11		10	70.5701	70.5709	40	JP	5/18/81

Comments:

Filter Blk. Wt = 0.3mg

Acetone Blk Wt = -0.8mg

Codes:
1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 48922-03

Source Identification ESP-INLET

Test Run Number ESP-I-2-2

Pollutant(s) in Sample PARTICULATE

Task	Date	Time	Personnel	Remarks
Sampling	5/5/81	1443-1455		
Probe Technician			FRITZ HOFFMEISTER	
Meter Technician			TOM WALKER	
Other				
Transport of Train to Cleanup Site				
Train Disassembly	5-5-81		JOEL PAVELONIS	
Train Cleanout	5-5-81		JOEL PAVELONIS	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

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METHOD 5

RUN ESP-I-3-2

MRI Project Number 4892L-03
Field Dates
Plant TOLTEC CEMENT Co
Sampling Location ESP INLET
Sampling Date 5/5/81

FIELD CREW

Crew Chief		MARK HANSEN
Testing Engineer	1	TOM WALKER
	2	
	3	
Engr. Technician	1	FRITZ HOFFMEISTER
	2	
	3	
Lab Technician	1	JOEL PAVELONIS
	2	
	3	
Process Engineer	1	
	2	
Other	1	
	2	

NOMOGRAPH DATA

PLANT IDEAL Cement Co

DATE 5/5/81

SAMPLING LOCATION ESP INLET (ESP-I-3-2)

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	68
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	30
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.82
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.074$ STACK GAUGE PRESSURE in in. H_2O)	P_s	28.39
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	390
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.85
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	—
C FACTOR	.60	
CALCULATED NOZZLE DIAMETER, in.	.270	
ACTUAL NOZZLE DIAMETER, in.	.250	
REFERENCE Δp, in. H_2O	1.2	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal Cement Co. Date 5/5/81

Sampling Location ESP Inlet Initial T.W.

Test Number ESP-I-3-2

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	68
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.7
Nozzle diameter, inches	Dn	.25
Barometric pressure, inches Hg	Pb	28.82
$\frac{5.168\ (68 + 460)\ (.84)\ (3)\ (.7)\ (.25^2)}{\sqrt{28.82}}$	K	56.04

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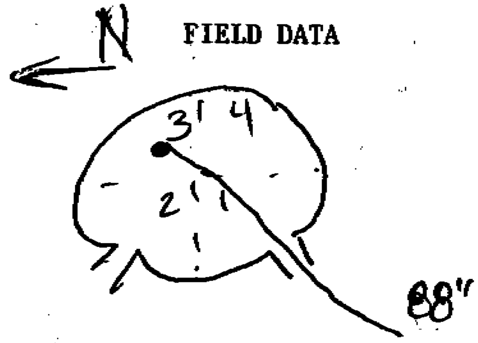
FIELD DATA

PLANT Ideal Cement Co
DATE 5/5/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE METHOD 5
RUN NUMBER ESP-I-3-2
OPERATOR Tom Walker
AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 28.82
STATIC PRESSURE (P_s) -5.8
FILTER NUMBER(s) 29



Schematic of Traverse Point Layout

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .25
ASSUMED MOISTURE, % 30
SAMPLE BOX NUMBER 4
METER BOX NUMBER 3
TEMPERATURE METER NO.
METER $\Delta H@$ 1.963
METER CORRECTION
C FACTOR .60
REFERENCE Δp 1.2

LEAK CK: Initial at 15" Hg, CFM .005
Final at .00 Hg, CFM

Read and Record All Data Every 3 Minutes

$$VM = 56.04 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 635.25 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0826											
3	3	0829	637.03	637.15	.85	1.3	1.4	380	69	69	15	246	60
	6	0832	638.72	638.86	.77	1.2	1.0	386	72	69	4	257	60
	9	0835	640.62	640.72	.95	1.5	1.5	370	74	69	4	271	62
	12	0838	642.56	642.56	.99	1.55	1.3	369	78	70	4	280	64
	15	0841	644.52	644.53	1.0	1.6	1.5	357	79	70	6	287	64
	18	0844	646.46	646.56	1.0	1.6	1.5	373	80	70	6	292	64
			Vm=11.31		AvG ΔP_s=.93	AvG ΔH=1.4			AvG T_m=72.4				
								AvG T_s=373					

COMMENTS:

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant IDEAL CEMENT CO — Date 5/5/81
Sampling Location ESP-INLET — Initial VW
Test Number ESP-I-3-2

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	373
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = 1.4 Pb = 28.92 Tm = 72.4 Vm = 11.31	Vm_{std}	10.84
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 31.6% this run	Mf	.684
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.743
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.40
Static pressure in stack, absolute, in. Hg −5.8" (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.39
Stack velocity, fpm ΔP = .93 $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	4,299
Total sample time, minutes	θ	18
Nozzle diameter, inches	Dn	.250
$\frac{1{,}039\ (373 + 460)(10.84)}{(4{,}299)(18)(28.39)(.684)(.25^2)}$	% I	99.9

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant: IDEAL CEMENT CO
Sample Location: INLET
Sample Box No.: 4
Sample Type: MASS

Run No.: ESP-I-3-2
Sample Date: 5-5-81
Recovery Date: 5-5-81
Cleanup Person: JP

Filter No.: 29
Sample No.:
Sample Material Description:

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL
Impinger Type[a]	M	S.G	M			
Impinger Solution	H_2O	H_2O	DRY			
Final Volume (wt)[b]	180	116	4			755.7
Initial Volume (wt)[b]	100	100	0			749.4
Net Volume (wt)[b]	80	16	4			6.3
Sample No.(s)						

Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 106.3

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier Date Shipped:
Remarks:

Date of laboratory custody Seal(s) broken by
Personnel accepting custody Date broken
Remarks:

MIDWEST RESEARCH INSTITUTE

Run No. ESP-I-3-2 PARTICULATE CLEAN-UP AND ANALYSIS

Date ________ FIELD ANALYSIS Performed by ________

	1	2	3	4	5	6
Impinger Sequence	1	2	3	4	5	6
Impinger Type*	M	S	M	M		
Final Volume**	180	116	4	755.7		
Initial Volume**	100	100	0	749.4		
Difference	80	16	4	6.3		

* S = Greenburg-Smith standard, M = modified, O = Other ________

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
8		4	91.8343	67.3474		JP	5/18/81
18		5	98.1810	96.5209	155		
	29	6	5.8653	3.8314			
		6					
		6					
		7					
		8					
		9					
5/81/11		10	70.5701	70.5709	40	JP	5/18/81

Comments:

Filter Blk. Wt. 0.3mg

Acetone Blk Wt = 0.8mg

Codes:

1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 4892-L03

Source Identification ESP Inlet

Test Run Number ESP-I-3-2

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/5/81	0826-0844	Tom Walker	
Probe Technician			M. Hansen	
Meter Technician			T. Walker	
Other			F. Hoffmeister	
Transport of Train to Cleanup Site	5/5/81	0851	M. Hansen	
Train Disassembly	5-5-81		Joel Pavelonis	
Train Cleanout	5-5-81		Joel Pavelonis	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis	~~5-5~~			
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-I-~~III~~4-2

MRI Project Number 4922-03
Field Dates
Plant IDEAL CEMENT CO
Sampling Location ESP-INLET
Sampling Date 5/6/81

FIELD CREW

Crew Chief		MACK HANSEN
Testing Engineer	1	TOM WALKER
	2	
	3	
Engr. Technician	1	FRITZ HOFFMEISTER
	2	JOEL PAVELOVIS
	3	
Lab Technician	1	JOEL PAVELOVIS
	2	DAN OLSON
	3	
Process Engineer	1	FRITZ HOFFMEISTER
	2	
Other	1	
	2	

MRI - Form PO (10/72)

NOMOGRAPH DATA

PLANT Ideal Cement Co

DATE 5/6/81

SAMPLING LOCATION ESP INLET

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84	
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	~~60~~ 62	
PERCENT MOISTURE IN GAS STREAM BY VOLUME ASSUMED	% H_2O	30	
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.87	
STATIC PRESSURE IN STACK, in. Hg (P_m ±0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.44	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1	
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	350	
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	~~.70~~ ~~.90~~	.85
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$		
C FACTOR		~~.59~~ .60	
CALCULATED NOZZLE DIAMETER, in.		~~.265~~ ~~.280~~	.269
ACTUAL NOZZLE DIAMETER, in.		~~.250~~ ~~.297~~	.25
REFERENCE Δp, in. H_2O		~~1.1~~ ~~.57~~	1.1

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal Cement Co. Date 5/6/81
Sampling Location ESP Inlet Initial T.W.
Test Number ESP-I-4-2

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	62
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.70
Nozzle diameter, inches	Dn	.25
Barometric pressure, inches Hg	Pb	28.87
$\frac{5.168\ (62 + 460)\ (.84)\ (3)\ (.7)\ (.25^2)}{\sqrt{28.87}}$	K	55.35

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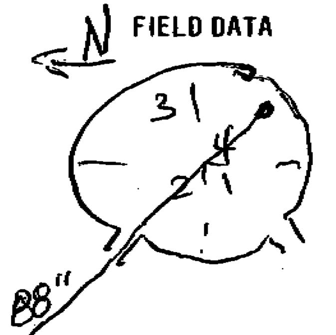
FIELD DATA



SCHEMATIC OF TRAVERSE POINT LAYOUT

PLANT Ideal Cement Co
DATE 5/6/81
SAMPLING LOCATION ESP-INLET
SAMPLE TYPE METHOD 5
RUN NUMBER ESP-I-4-2
OPERATOR Tom Walker
AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 28.87
STATIC PRESSURE, (P_s) -5.8
FILTER NUMBER (s) 31

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .25
ASSUMED MOISTURE, % 30
SAMPLE BOX NUMBER 4
METER BOX NUMBER 3
METER $\Delta H_@$ 1.963
C FACTOR .60
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp 1.1

Leak CK: Initial at 15" Hg, CFM .005
Final at Hg, CFM .015

READ AND RECORD ALL DATA EVERY 3 MINUTES

$$VM = 5535 \times \sqrt{\frac{Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1006	678.90										
4	3	1009	680.71	680.82	.86	1.5	1.5	345	60	59	3	210	60
	6	1012	682.46	682.59	.82	1.4	1.3	356	62	59	3	250	58
	9	1015	684.24	684.25	.83	1.4	1.2	340	65	59	4	262	60
	12	1018	685.98	686.02	.81	1.4	1.3	362	67	60	5	165	60
	15	1021	687.74	687.79	.82	1.4	1.3	353	69	61	6	200	60
	18	1024	689.52	689.58	.84	1.4	1.3	349	70	62	7	255	60
	21	1027	691.39	691.42	.87	1.5	1.4	351	71	62	8	216	60
			V_m=12.52		AVG Δp_s=.84	AVG ΔH=1.3		AVG T_s=351	T_m=63				

COMMENTS:

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Cement Co

Date 5/6/81

Sampling Location ESP - INLET

Initial [illegible]

Test Number ESP-I-4-2

Isokinetic equation:

$$\% \ I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	351
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = 1.3$ $Pb = 28.87$ $Vm = 12.52$ $Tm = 63$	Vm_{std}	12.23
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 32.1% = %H_2O	Mf	.679
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md *	31.743
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.33
Static pressure in stack, absolute, in. Hg (Pb) $\pm$ (0.074 x stack gage pressure, in H_2O)	Ps	28.44
Stack velocity, fpm $\Delta P = .84$ $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	4,033
Total sample time, minutes	θ	21
Nozzle diameter, inches	Dn	.250
$\frac{1{,}039\ (\ 351\ + 460)(\ 12.23\ )}{(4{,}033)(\ 21\ )(28.44)(.679)(.25^2)}$	% I	100.8

* obtained at 1810 on 5/5/81

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Cement Co

Run No. ESP-I-4-2

Sample Location ESP INLET

Sample Date 5/6/81

Sample Box No. 4

Recovery Date

Sample Type

Cleanup Person

Filter No. ~~30~~ 31

Sample No.

Sample Material Description

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5
Impinger Type a/					
Impinger Solution	H_2O	H_2O	dry		
Final Volume (wt) b/	202	114	1 ml		
Initial Volume (wt) b/	100	100	—		
Net Volume (wt) b/	102	14	1 ml		
Sample No.(s)					

Combined impinger contents, Sample No.

Liquid Level Marked

Container(s) Sealed

Description of Impinger Solution

Total Moisture, gm 122.5g

SILICA GEL

764.2

~~5??.?~~ ~~578.7~~ 758.7

~~5?.5~~ 5.5

Silica Gel

Color

a/ S = Greenburg-Smith standard, M = Modified, O = Other

b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition

Carrier

Date Shipped:

Remarks:

Date of laboratory custody

Seal(s) broken by

Personnel accepting custody

Date broken

Remarks:

MIDWEST RESEARCH INSTITUTE

Run No. ESP-I-4-2 PARTICULATE CLEAN-UP AND ANALYSIS

Date 5/6/81 FIELD ANALYSIS Performed by

	ml	ml	ml	g		
Impinger Sequence	1	2	3	4	5	6
Impinger Type*	M	S	M	M		
Final Volume**	202	114	1	764.2		
Initial Volume**	100	100	0	758.7		
Difference	102	14	1	~~56.5~~ 5.5		

* S = Greenburg-Smith standard, M = modified, O = Other

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
74		4	121.8084	66.7895		JP	5/18/81
20		5	99.3505	95.6798	160	/	/
	31	6	3.9137	3.8003		/	/
		6					
		6					
		7					
		8					
		9					
5/21/11		10	70.5701	70.5709	40	JP	5/18/81

Comments:

Filter Blk wt. = 0.3mg

Acetone Blk wt. = -0.8mg

Codes:
1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 4892L-03

Source Identification ESP-INLET

Test Run Number ESP-I-4-2

Pollutant(s) in Sample METHOD 5

Task	Date	Time	Personnel	Remarks
Sampling	5/6/81	1006-1027		
Probe Technician			FRITZ HOFFMEISTER	
Meter Technician			TOM WALKER	
Other			MARK HANSEN	
Transport of Train to Cleanup Site				
Train Disassembly	5-5-81		J. Pavlovic	
Train Cleanout	5-6-81		JOSE PAVELO	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

I-1-2 EPA Method 3 - Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Ideal Basic Industries
DATE 4/30/81
SAMPLING TIME (24-hr CLOCK)
SAMPLING LOCATION ESP Inlet - Quad. 3 (80" into duct)
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) GRAB
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 75° F
OPERATOR T. Walker, F. Hoffmeister

COMMENTS:

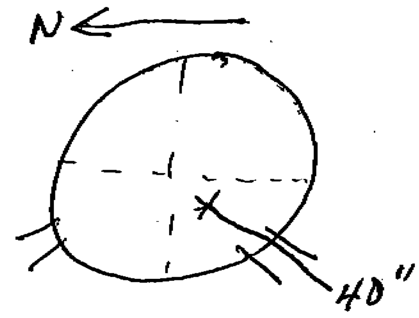
GAS \ RUN	1 ACTUAL READING	1 NET	2 ACTUAL READING	2 NET	3 ACTUAL READING	3 NET	AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
CO_2	20		20		21		20.3	44/100	8.932
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	9		8		8		8.3	32/100	2.656
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							71.4	28/100	19.992
								TOTAL	31.58

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Ideal
DATE 5/5/81
SAMPLING TIME (24-hr CLOCK) 1810
SAMPLING LOCATION ESP Inlet, Port A
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS, GRAB) GRAB
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 65°F
OPERATOR M. Hansen / F. Hoffmeister

COMMENTS:



GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2 *	~~8~~ 21.5		21.0		21.5		21.33	44/100	9.385
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	8.75		8.0		8.0		8.25	32/100	2.640
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							70.42	28/100	19.718
								TOTAL	31.743

* 20% scale

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT IDEAL CEMENT CO

DATE 5/6/81

SAMPLING TIME (24-hr CLOCK) 1630

SAMPLING LOCATION ESP INLET SOUTH PORT 88"

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB)

ANALYTICAL METHOD FYRITE

AMBIENT TEMPERATURE 75°F

OPERATOR TOM WALKER/FRITZ HOFFMEISTER

COMMENTS: NONE

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	21		21		21		21	44/100	9.24
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	8		8		8		8	32/100	2.56
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)	71		71		71		71	28/100	19.88
								TOTAL	31.68

EPA (Dur) 230
4/72

I-1-3 Particle Sizing - Andersen High Capacity Stack Sampler with 15 μm Preseparator

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-1-1

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/2/81

FIELD CREW

Crew Chief	M. Hausen
Testing Engineer	1 ~~T. Walker~~ M. Hensen
	2
	3
Engr. Technician	1 ~~M. Hansen~~ T. Walker
	2
	3
Lab Technician	1 J. Pavelonis
	2 G. Cobb
	3 D. Olson
Process Engineer	1 F. Hoffmeister
	2
Other	1
	2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal Date 5/2/81
Sampling Location ESP Inlet Initial MDH
Test No. ESP-I-1-1

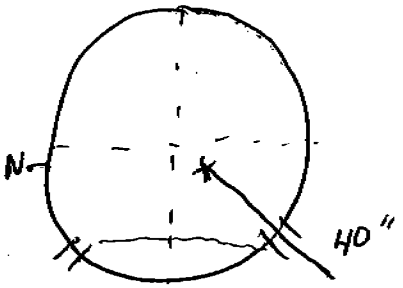
Velocity head at sampling location, in. H_2O	ΔPs	.59
Stack temperature at sample point, °F	Ts	391
Barometric pressure, in. Hg	Pb	28.91
Static pressure in stack, in. Hg −5.8" (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.48
Percent moisture in gas stream by volume	% H_2O	31.9
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.68
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.23
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	3,467
Calculated nozzle diameter, in. Fs=.60 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.178
Actual nozzle diameter, in. 61-4.5	D_{n_a}	.177
Assumed meter temperature, °F	Tm	70
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	.60
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	.250

FIELD DATA - ANDERSEN

.750 cf/3min.

PLANT Ideal
DATE 5/2/81
SAMPLING LOCATION ESP Inlet
SAMPLE TYPE HCS Particle Size
RUN NUMBER ESP-I-1-1
OPERATOR ~~T. Wetter~~ M. Hansen
AMBIENT TEMPERATURE 60°F
BAROMETRIC PRESSURE 28.91
STATIC PRESSURE, (P_s) -5.8
Filter Set 78

Leak CK: Inital at 15" Hg, CFM 0.0
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .250 (.063/15 sec.)
Probe Tip Diameter .177
CO_2 20.3 %
O_2 8.3 %
CO 0
N_2 71.4
% H_2O 31.9

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 549.60 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\,in})$, °F	OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1130											
1	3	1133	550.35	550.34	.72	.18	.18	393	70	70	1.0	NA	71
	6	1136	551.10	551.06	.75		.18	395	72	70	2.0		71
	9	1139	551.85	551.81	.76		.19	402	73	70	2.0		72
	12	1142	552.60	552.54	.75		.19	408	75	71	2.0		72
	15	1145	553.35	553.30	.74		.20	406	76	72	2.5		73
	18	1148	554.10	554.08	.75		.21	411	78	73	2.5		75
	21	1151	554.85	554.85	.72		.20	410	81	74	2.5		77
	24	1154	555.60	555.615	.70		.20	410	83	76	2.5		78
						ΔH=	.194						
									T_m =	74			
					Δp=.74								
			Vm=6.015					T_s=404.4					

COMMENTS: moisture collected = 41 ml   25.5% H_2O

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Date 5/2/81

Sampling Location ESP - Inlet Initial MDH

Test Number ESP-I-1-1

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	391 (404)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ Vm = 6.015 Pb = 28.41 Tm = 74 ΔH = .194	Vm_{std}	5.75
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 25.5	Mf	.745
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	28.12
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.48
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP = .59 ΔP = (.74) Ts = (404)	Vs	3,411 (3,849)
Total sample time, minutes	θ	24
Nozzle diameter, inches	Dn	.177
$\frac{1{,}039\,(391(404) + 460)(5.75)}{(3{,}411)(24)(28.48)(.745)(.177^2)}$	% I	93.4 (84.1)

(3,849)

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal　　　　Run No. ESP-I-1-1
Sample Location ESP -Inlet　　　　Sample Date 5/2/81
Sample Box No. ______　　　　Recovery Date ______
Sample Type HCSS Particle Size　　　　Cleanup Person ______

Filter No. 18 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE	1	2	3	4	5	SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	41					470.9
Initial Volume (wt) b/	0					470.0
Net Volume (wt) b/	41					.9
Sample No.(s)						Silica Gel Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______　Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 41.9

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______　Date Shipped: ______
Remarks: ______

Date of laboratory custody ______　Seal(s) broken by ______
Personnel accepting custody ______　Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-1-1

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/2/81	1130-1154		
Probe Technician			T. Walker	
Meter Technician			M. Hansen	
Other			F. Hoffmeister	
Transport of Train to Cleanup Site	5/2/81	1200	T. Walker F. Hoffmeister	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen HCSS

RUN ESP-I-2-1

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP-Inlet
Sampling Date 5/4/81

FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	T. Walker
	2	
	3	
Engr. Technician	1	F. Hoffmeister
	2	
	3	
Lab Technician	1	J. Pavelonis
	2	G. Cobb
	3	D. Olson
Process Engineer	1	F. Hoffmeister
	2	
Other	1	
	2	

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal
Sampling Location ESP - Inlet
Test No. ESP - I - 2 - 1

Date 5/4/81
Initial MDH

Velocity head at sampling location, in. H_2O	ΔPs	.63
Stack temperature at sample point, °F	Ts	410
Barometric pressure, in. Hg	Pb	28.69
Static pressure in stack, in. Hg (Pb) ± (0.074 x gage pressure, in. H_2O) 28.69 -5.8	Ps	28.26
Percent moisture in gas stream by volume	% H_2O	30
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.70
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md *	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 31.15 .7 .70	Ms	27.21
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$ Cp = .84, ΔPs = .63, Ts = 410, Ps = 28.26, Ms = 27.21	Vs	3637.26
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min .62	D_{n_c}	.177
Actual nozzle diameter, in.	D_{n_a}	.177
Assumed meter temperature, °F	Tm	68
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$ Fs = .62, Tm = 68, Ts = 410, Ps = 28.26, Pb = 28.69, Mf = .7	Fm	.259

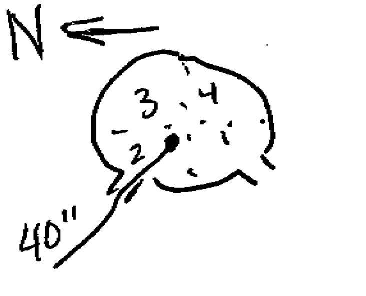
* Obtained from data on 5/2/81 AT ESP Outlet

(copy from original)

FIELD DATA - ANDERSEN HSS

PLANT Ideal
DATE 5/4/8
SAMPLING LOCATION ESP INLET
SAMPLE TYPE PARTICULATE
RUN NUMBER ESP-I-2-1
OPERATOR Tom Walker
AMBIENT TEMPERATURE 65
BAROMETRIC PRESSURE 28.69
STATIC PRESSURE, (P_s) -5.8
Filter Set 25

Leak CK: Inital at 15" Hg, CFM .005
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Calculated ACFM (desired) ~~.259~~ .26
Probe Tip Diameter .177
CO_2 17.67
O_2 8.33
CO 0
N_2 74
% H_2O 30

Console No.3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 602.19 ~~602.09~~ Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1137											
2	3	1140	~~602.87~~ 602.92	602.95	.75	.20	.20	375	72	72	1	—	72
	6	1143	~~603.~~ 603.73	603.73	.75		.21	375	72	72	2		72
	9	1146	604.53	604.51	.79		.22	375	73	72	2		72
	12	1149	605.31	605.30	.69		.22	370	75	73	2		72
	15	1152	606.09	606.09	.71		.22	375	75	74	2		71
	18	1155	606.87	606.88	.72		.22	380	76	74	2		71
	21	1158	607.65	607.66	.70		.22	380	76	74	3		71
	24	1201	608.43	608.44	.76		.21	380	77	75	3		71
					AVG ΔP=.73								
			V_m=6.25		* ΔP=.63	AVG ΔH=~~.22~~ .215		T_s=376.3	T_m=74		73.9		

COMMENTS: * THIS ΔP (.63) WAS ASSUMED AND USED IN ISOKENTIC CALCULATIONS

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Date 5/4/81

Sampling Location ESP-Inlet Initial TW

Test Number ESP-I-2-1

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(376) 410
Meter volume (std), $\frac{17.64(\overset{6.25}{Vm})\left(\overset{28.69}{Pb}+\frac{\Delta H_{avg}^{.22}}{13.6}\right)}{\overset{74}{Tm}+460}$ $\Delta H = .22$ Pb = 28.69 Vm = 6.25 Tm+460 = 534	Vm_{std}	5.93
Mole fraction dry gas, $\frac{100-\% \overset{30.51}{H_2O}}{100}$ $\% H_2O = 30.51$	Mf	.69
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md *	31.15
Molecular wt. stack gas, lb/lb-mole $\underset{31.15}{(Md)}\ \underset{.69}{(Mf)} + 18(1 - \underset{.69}{Mf})$	Ms	27.07
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) -5.8	Ps	28.26
Stack velocity, fpm $5{,}128.8\ \underset{.84}{(Cp)}\left(\sqrt{\Delta Ps}_{avg}\right)_{.63}\sqrt{\frac{\overset{410}{Ts}+460}{\underset{28.26}{Ps}\times \underset{27.67}{Ms}}}$ $\Delta P = .63$ Cp = .84 ΔP = (.73)	Vs	(3848) 3646.66
Total sample time, minutes	θ	24
Nozzle diameter, inches	Dn	.177
$\frac{1{,}039\ (\underline{410}^{(376)} + 460)(\underline{5.93})}{(\underline{3646.66})(\underline{24})(\underline{28.26})(\underline{.69})(\underline{.177^2})}$ (3848)	% I	(91.3) 100.26

* See sampling calculation ( ) actual

(copy from original)

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I-2-1
Sample Location ESP-Inlet Sample Date 5/4/81
Sample Box No. ______ Recovery Date ______
Sample Type HCSS Particle Size Cleanup Person ______

Filter No. 25 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE						SILICA GEL	
Impinger Sequence	1	2	3	4	5		
Impinger Type a/							
Impinger Solution							
Final Volume (wt) b/	51.0					478.2	
Initial Volume (wt) b/	0					473.9	
Net Volume (wt) b/	51.0					4.3	
Sample No.(s)						Silica Gel	
Combined impinger contents, Sample No.						Color	

Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 55.3

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification Esp-Inlet

Test Run Number Esp-I-2-1

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/4/81	1137-1201		
Probe Technician			Fritz Hoffmeister	
Meter Technician			Tom Walker	
Other			Mark Hansen	
Transport of Train to Cleanup Site				
~~Train~~ Disassembly	5-4-81		Dick Cobb	
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-3-1

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/1/81

FIELD CREW

Crew Chief M. Hansen

Testing Engineer 1 T. Walker
2
3

Engr. Technician 1 M. Hansen
2
3

Lab Technician 1 J. Pavelonis
2 G. Cobb
3 D. Olson

Process Engineer 1 F. Hoffmeister
2

Other 1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

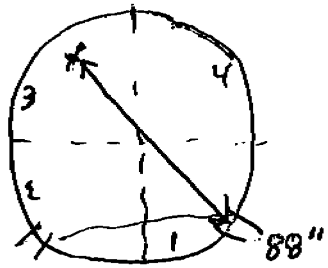
Plant Ideal Date 5/1/81
Sampling Location ESP Inlet Initial MDH
Test No. ESP-I-3-1

Velocity head at sampling location, in. H_2O	ΔPs	1.00
Stack temperature at sample point, °F	Ts	397
Barometric pressure, in. Hg	Pb	28.94
Static pressure in stack, in. Hg −5.8" (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.51
Percent moisture in gas stream by volume Assumed	% H_2O	~~18.9~~ 30
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	~~.81~~ .70
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~29.00~~ 27.51
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	~~4,386~~ 4,503
Calculated nozzle diameter, in. Fs = .60 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	~~.158~~ .156
Actual nozzle diameter, in. 60-4.0	D_{n_a}	.157
Assumed meter temperature, °F	Tm	75
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right)$ (Mf)	Fm	~~.299~~ .258

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5/1/81
SAMPLING LOCATION ESP-Inlet
SAMPLE TYPE HCSS Particulate size
RUN NUMBER ESP-I-3-1
OPERATOR M. Hansen / T. Walker
AMBIENT TEMPERATURE 65°F
BAROMETRIC PRESSURE 28.94
STATIC PRESSURE, (P_s) -5.8"
Filter Set 37

Leak CK: Inital at 15" Hg, CFM 0.0
Final at ~~2.5~~ 5" Hg, CFM



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

.77 cf/[illegible]in.

Calculated ACFM (desired)	~~.897 cf/3min~~ .258 (.065/15 sec) ~~.299~~ (.075 15 sec)
Probe Tip Diameter	.157
CO_2	20.3%
O_2	8.3%
CO	0
N_2	71.4%
% H_2O	~~18.9~~ 30.0

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 528.10 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1135											
3	3	1138	528.87	528.85	—	.19	.19	400	70	71	1.0	NA	~~NA~~ —
	6	1141	529.65	529.61	.84		.19	398	72	71	1.0		—
	9	1144	530.42	530.36	.85		.20	406	73	71	2.0		72
	12	1147	531.20	531.13	.93		.21	408	75	71	2		—
	15	1150	531.97	531.95	.87		.23	417	77	72	2		72
	18	1153	532.75	532.74	.84		.22	417	79	73	2		73
	21	1156	533.52	533.54	.85		.21	410	80	74	2		74
	24	1159	534.29	534.32	.86		.21	402	82	75	2		75
	27	1202	535.07	535.09	.80		.20	409	81	76	2.5		75
	30	1205	535.84	535.865	—		.19	410	81	77	2.5		74
	moisture =		59 mL										
						ΔH=	.205						
			V_m =	7.765	ΔP=.84			T_s=407.7	T_m =	75.05			

COMMENTS:

28.2% moisture

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal

Sampling Location ESP Inlet

Test Number ESP-I-3-1

Date 5/1/81

Initial MDH

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	397 (407.7)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = .205 Pb = 28.94 Tm = 75.1 Vm = 7.765	Vm_{std}	7.41
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 28.2% collected.	Mf	.718
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.75
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.51
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps x Ms}}$ ΔP = 1.00 ΔP = (.84) Ts = (407.7)	Vs	4,484 (4,135)
Total sample time, minutes	θ	30
Nozzle diameter, inches	Dn	.157
$\frac{1{,}039\ (\underline{397\ (407.7)}+460)(\underline{7.41})}{(\underline{4484})(\underline{30})(\underline{28.51})(\underline{.718})(\underline{.157}^2)}$	% I	97.2 (106.7)

(4,135)

(   ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I-3-1
Sample Location ESP-Inlet Sample Date 5/1/81
Sample Box No. ______ Recovery Date ______
Sample Type HCSS Particle Size Cleanup Person ______

Filter No. 37 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE | SILICA GEL

Impinger Sequence	1	2	3	4	5	Silica Gel	
Impinger Type a/							
Impinger Solution							
Final Volume (wt) b/	59					468.1	
Initial Volume (wt) b/	0					465.3	
Net Volume (wt) b/	59					2.8	
Sample No.(s)						Silica Gel Color	

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 61.8

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-3-1

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/1/81	1135-1205		
Probe Technician			T. Walker/F. Hoffmeister	
Meter Technician			M. Hansen	
Other				
Transport of Train to Gleanup Site	5/1/81	1230	T. Walker F. Hoffmeister	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-4-1

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP-Inlet
Sampling Date 5/2/81

FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	M. Hansen
	2	
	3	
Engr. Technician	1	T. Walker
	2	F. Hoffmeister
	3	
Lab Technician	1	J. Pavelonis
	2	G. Cobb
	3	D. Olson
Process Engineer	1	F. Hoffmeister
	2	
Other	1	
	2	

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal Date 5/2/81
Sampling Location ESP Inlet Initial MDH
Test No. ESP-I-4-1

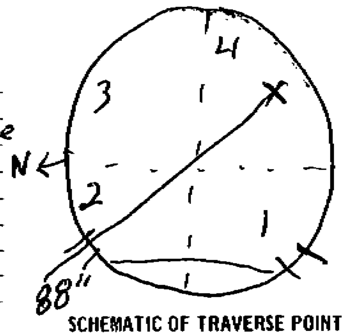
Velocity head at sampling location, in. H_2O	ΔPs	.79
Stack temperature at sample point, °F	Ts	355
Barometric pressure, in. Hg	Pb	28.77
Static pressure in stack, in. Hg −5.8 (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.34
Percent moisture in gas stream by volume	% H_2O	~~2~~ 29
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.71
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.64
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	3,906
Calculated nozzle diameter, in. Fs = .56 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.162
Actual nozzle diameter, in. 60-4.0	D_{n_a}	.157
Assumed meter temperature, °F	Tm	85
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	.56
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	.262

.786 cf/3min

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5/2/81
SAMPLING LOCATION ESP Inlet
SAMPLE TYPE HCSS Particle Size
RUN NUMBER ESP-I-4-1
OPERATOR M. Hansen
AMBIENT TEMPERATURE 80° F
BAROMETRIC PRESSURE 28.77
STATIC PRESSURE, (P_s) -5.8"
Filter Set 17

Leak CK: Inital at 15" Hg, CFM .01
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .262 (.066/15sec.)
Probe Tip Diameter .157
CO_2 20.3%
O_2 8.3%
CO 0
N_2 71.4%
% H_2O 29% assumed

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	GAS METER READING (V_m), ft^3 Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1718	580.40										
4	3	1721	581.19	581.08	.90	.20	.20	381	80	81	2.0	NA	76
	6	1724	581.97	581.89	.94		.23	383	81	81	2.0		76
	9	1727	582.76	582.68	.93		.22	385	82	82	2.0		75
	12	1730	583.54	583.51	.92		.24	387	84	82	2.0		75
	15	1733	584.33	584.31	.94		.23	368	85	82	2.0		75
	18	1736	585.12	585.12	.94		.23	371	86	82	2.0		75
	21	1739	585.90	585.93	.95		.23	382	87	83	2.0		75
	24	1741	586.69	586.75	.94		.22	377	88	84	2.0		75
						ΔH =	.225						
									T_m =	83.1			
			V_m = 6.35		ΔP = .93			Ts = 379.3					

COMMENTS: Moisture Collected = 51   29.2% Moisture

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal | Date 5/2/81
Sampling Location ESP Inlet | Initial MDH
Test Number ESP-I-4-1

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	355	(379.3)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ Vm = 6.35 Tm = 83.1 ΔH = .225 Pb = 28.77	Vm_{std}	5.94	
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 29.2%	Mf	.708	
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.58	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.61	
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.34	
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP = .79 ΔP = (.93) Ts = (379.3)	Vs	3,908 (4,303)	
Total sample time, minutes	θ	24	
Nozzle diameter, inches	Dn	.157	
$\frac{1{,}039\ (355^{(379.3)} + 460)(5.94)}{(3{,}908)(\cancel{28.34})(\cancel{.708})(.708)(.157^2)}$ 24 28.34	% I	108.4 (101.4)	

(4,303)

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I-4-1
Sample Location ESP Inlet Sample Date 5/3/81
Sample Box No. ______ Recovery Date ______
Sample Type HCSS Particle size Cleanup Person ______

Filter No. 17 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE						SILICA GEL	
Impinger Sequence	1	2	3	4	5		
Impinger Type a/							
Impinger Solution							
Final Volume (wt) b/	51					472.6	
Initial Volume (wt) b/	0					471.6	
Net Volume (wt) b/	51					1.0	
Sample No.(s)						Silica Gel	
Combined impinger contents, Sample No.						Color	

Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 52.0

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-4 1

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/2/81	1718 - 1741		
Probe Technician			T. Walker	
Meter Technician			M. Hansen	
Other			F. Hoffmeister	
Transport of Train to Cleanup Site	5/2/81	1750	G. Cobb	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-1-2

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/2/81

FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	M. Hansen
	2	
	3	
Engr. Technician	1	T. Walker
	2	F. Hoffmeister
	3	
Lab Technician	1	J. Pavelonis
	2	G. Cobb
	3	D. Olson
Process Engineer	1	F. Hoffmeister
	2	
Other	1	
	2	

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

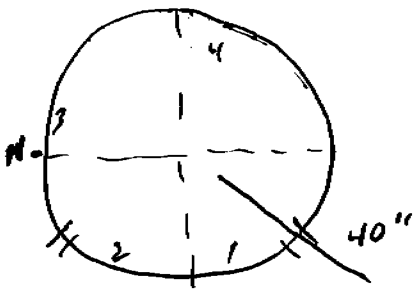
Plant Ideal Date 5/2/81
Sampling Location ESP Inlet Initial M.D.H.
Test No. ESP-I-1-2

Velocity head at sampling location, in. H_2O	ΔPs	.74
Stack temperature at sample point, °F	Ts	404
Barometric pressure, in. Hg	Pb	28.88
Static pressure in stack, in. Hg − 5.8" (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.45
Percent moisture in gas stream by volume	% H_2O	25.5
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.745
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	28.12
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	3,851
Calculated nozzle diameter, in. Fs = .61 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.170
Actual nozzle diameter, in. 61 − 4.5	D_{n_a}	.177
Assumed meter temperature, °F	Tm	78
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	.61
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	.279

.837 cf/3min

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5/2/81
SAMPLING LOCATION ESP Inlet
SAMPLE TYPE HCSS Particle size
RUN NUMBER ESP-I-1-2
OPERATOR M. Hansen
AMBIENT TEMPERATURE 70°F
BAROMETRIC PRESSURE 28.88
STATIC PRESSURE, (P_s) -5.8"
Filter Set 6



SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Calculated ACFM (desired) .279 (.07 cf/15 sec.)
Probe Tip Diameter .177
CO_2 20.3%
O_2 8.3%
CO 0
N_2 71.4%
% H_2O 25.5

Console No. 3

Leak CK: Inital at 15" Hg, CFM 0.0
Final at ____ Hg, CFM ____

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 556.30 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1332											
1	3	1335	557.14	557.14	.64	.24	.24	390	81	80	1.0	NA	85
	6	1338	557.97	557.95	.60		.24	384	82	80	2.0		85
	9	1341	558.81	558.76	.62		.24	385	84	81	2.5		85
	12	1344	559.65	559.61	.60		.25	379	85	82	2.5		84
	15	1347	560.49	560.46	.63		.25	380	86	82	2.5		84
						ΔH =	.244						
					ΔP = .618								
			V_m = 4.16					T_s = 384	T_m =	82.3			

COMMENTS: moisture collected = 27 ml. 25% H_2O

EPA (Dur) 235
4 72

<u>ISOKINETIC PERFORMANCE WORKSHEET</u>

Plant Ideal Date 5/2/81

Sampling Location ESP Inlet Initial MDH

Test Number ESP- I-1-2

Isokinetic equation:

$$\% I = \frac{1,039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	404	(384)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = .244 Pb = 28.88 Tm = 82.3 Vm = 4.16	Vm_{std}	3.91	
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 25.0	Mf	.75	
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.58	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	28.19	
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.45	
Stack velocity, fpm $5,128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP = .74 ΔP = (.618) Ts = (384)	Vs	3,847 (3,474)	
Total sample time, minutes	θ	15	
Nozzle diameter, inches	Dn	.177	
1,039 (404 (384) + 460)(3.91) / (3,847)(15)(28.45)(.75)(.177²)	% I	90.99 (98.4)	

(3,474)

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal | Run No. ESP-I-1-2
Sample Location ESP Inlet | Sample Date 5/2/81
Sample Box No. ______ | Recovery Date ______
Sample Type HCSS Particle Size | Cleanup Person ______

Filter No. 6
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	27					471.6
Initial Volume (wt) b/	0					470.9
Net Volume (wt) b/	27					0.7
Sample No.(s)						

Silica Gel Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 27.7

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-1-2

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/2/81	1332-1347		
Probe Technician			T. Walker	
Meter Technician			M. Hansen	
Other			F. Hoffmeister	
Transport of Train to Cleanup Site	5/2/81	1405	T. Walker F. Hoffmeister	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-2-2

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP-Inlet
Sampling Date 5/4/81

FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	T. Walker
	2	
	3	
Engr. Technician	1	F. Hoffmeister
	2	
	3	
Lab Technician	1	J. Pavelonis
	2	G. Cobb
	3	D. Olson
Process Engineer	1	F. Hoffmeister
	2	
Other	1	
	2	

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal Date 5/4/81
Sampling Location ESP-Inlet Initial TW
Test No. ESP-I-2-2

Velocity head at sampling location, in. H_2O	ΔPs	.73
Stack temperature at sample point, °F	Ts	380
Barometric pressure, in. Hg	Pb	28.73
Static pressure in stack, in. Hg $\underset{28.73}{(Pb)} \pm (0.074 \times \text{gage } \underset{-5.8}{\text{pressure}}, \text{ in. } H_2O)$	Ps	28.30
Percent moisture in gas stream by volume ASSUMED	% H_2O	30
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.70
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md *	31.15
Molecular wt. stack gas, lb/lb-mole $\underset{31.15}{(Md)}\ \underset{.7}{(Mf)} + 18(1 - \underset{.7}{Mf})$	Ms	27.21
Stack velocity, fpm $5{,}128.8\ \underset{.84}{(Cp)} \left(\sqrt{\underset{.73}{\Delta Ps}}\right) \sqrt{\frac{\overset{380}{Ts} + 460}{\underset{28.3}{Ps} \times \underset{27.21}{Ms}}}$	Vs	3844.49
Calculated nozzle diameter, in. $24 \sqrt{\frac{\overset{.59}{Fs}/\overset{3844.49}{Vs}}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min .59	D_{n_c}	.168
Actual nozzle diameter, in.	D_{n_a}	.177
Assumed meter temperature, °F	Tm	75
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $\underset{.59}{Fs}\left(\frac{\overset{75}{Tm}+460}{\underset{380}{Ts}+460}\right)\left(\frac{Ps}{Pb}\right)^{28.3}_{28.73}(Mf)\ .7$	Fm	.26

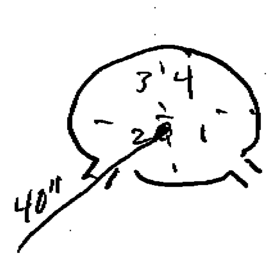
* OBTAINED FROM DATA ACQUIRED ON 5/2/81 AT ESP OUTLET

(copy from original)

FIELD DATA - ANDERSEN HESS

PLANT Ideal Cement
DATE 5/4/81
SAMPLING LOCATION ESP-INLET
SAMPLE TYPE PARTICULATE
RUN NUMBER ESP-I-2-2
OPERATOR Tom Walker
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.73
STATIC PRESSURE, (P_s) -5.8
Filter Set 10

Leak CK: Inital at 15" Hg, CFM .005
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .26
Probe Tip Diameter .177
CO_2 17.67
O_2 8.33
CO
N_2 74
% H_2O 30

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 608.51 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\,in})$, °F	OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1325											
2	3	1328	609.29	609.30	.81	.21	.21	365	75	75	1	—	76
	6	1331	610.07	610.07	.83		.21	350	78	75	2		75
	9	1334	610.85	610.86	.83		.22	375	77	75	2		75
	12	1337	611.63	611.63	.82		.21	360	78	76	2		76
	15	1340	612.41	612.41	.82		.21	375	79	77	2		75
	18	1343	613.19	613.19	.83		.21	365	80	77	2		75
	21	1346	613.97	613.98	.82		.21	350	81	78	2		75
	24	1349	614.75	614.76	.83		.21	370	82	78	3		75
			Vm=6.25		ΔP_s=.82	ΔH=.21		T_s 364	Tm = 77.6				

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Date 5/4/81

Sampling Location ESP - Inlet Initial ______

Test Number ESP - I - 2 - 2

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(364) 380
Meter volume (std), $\frac{17.64(\overset{6.25}{Vm})\left(\overset{28.73}{Pb}+\frac{\Delta H_{avg}^{.21}}{13.6}\right)}{\cancel{Tm+460}\ 71.6}$ ΔH = .21 Pb = 28.73 Vm = 6.25 Tm + 460 = 537.6	Vm_{std}	5.90
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ $\%\ H_2O = 31$	Mf	.7
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md *	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.21
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.30
Stack velocity, fpm $5{,}128.8\ (\underset{.84}{Cp})\left(\sqrt{\Delta Ps}_{avg}\right)_{.73}\sqrt{\frac{\overset{380}{Ts+460}}{\underset{28.3}{Ps}x\underset{27.21}{Ms}}}$ ΔP = .73 ΔP = (.82) Cp = .84	Vs	(4036) 3844.49
Total sample time, minutes	θ	24
Nozzle diameter, inches	Dn	.177
1,039 (380 (364) + 460)(5.90) / (3844.49 (4036))(24)(28.30)(.7)(.177^2)	% I	(84.0) 89.92

* SEE SAMPLING CALCULATIONS ( ) actual

(copy from original)

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I-2-2

Sample Location ESP-Inlet Sample Date 5/4/81

Sample Box No. ____ Recovery Date ____

Sample Type HCSS Particle size Cleanup Person ____

Filter No. 10

Sample No. ____

Sample Material Description ____

	MOISTURE AND/OR SAMPLE					SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	50.0					451.9g
Initial Volume (wt) b/	0					446.2g
Net Volume (wt) b/	50.0					5.7
Sample No.(s)						Silica Gel

Combined impinger contents, Sample No. ____ Color ____

Liquid Level Marked ____ Container(s) Sealed ____

Description of Impinger Solution ____

Total Moisture, gm 55.7

a/ S = Greenburg-Smith standard, M = Modified, O = Other ____

b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ____
Liquid Level Marked ____
Sealed ____

Impinger Rinse: Sample No. ____
Liquid Level Marked ____
Sealed ____

Water Blank: Sample No. ____
Liquid Level Marked ____

Dry Catch: Sample No. ____
Description ____
Sealed ____

Acetone Blank: Sample No. ____
Liquid Level Marked ____
Sealed ____

Filter Blank: Sample No. ____
Sealed ____

Sample Disposition ____

Carrier ____ Date Shipped: ____

Remarks: ____

Date of laboratory custody ____ Seal(s) broken by ____

Personnel accepting custody ____ Date broken ____

Remarks: ____

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ~~ESP-I-2-2~~ ESP-Inlet

Test Run Number ESP-I-2-2

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/4/81	1325 - 1349		
Probe Technician			M. Hansen	
Meter Technician			T. Walker	
Other			F. Hoffmeister	
Transport of Train to Cleanup Site				
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-3-2

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/1/81

FIELD CREW

Crew Chief M. Hansen

Testing Engineer 1 T. Walker
2
3

Engr. Technician 1 M. Hansen
2
3

Lab Technician 1 J. Pavelonis
2 G. Cobb
3 D. Olson

Process Engineer 1 F. Hoffmeister
2

Other 1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal　　　　　Date 5/1/81
Sampling Location ESP Inlet　　　　　Initial MOH
Test No. ESP-I-7-2

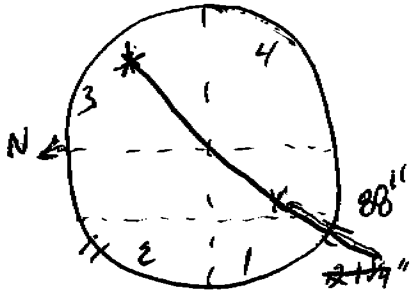
Velocity head at sampling location, in. H_2O	ΔPs	.84
Stack temperature at sample point, °F	Ts	408
Barometric pressure, in. Hg	Pb	28.94
Static pressure in stack, in. Hg -5.8" (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.51
Percent moisture in gas stream by volume	% H_2O	28.2
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.72
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.78
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	4,134
Calculated nozzle diameter, in. Fs = .615 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.165
Actual nozzle diameter, in. 6l-40	D_{n_a}	.156
Assumed meter temperature, °F	Tm	77
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	.270

FIELD DATA - ANDERSEN

0.81 cf/3 min

PLANT Ideal
DATE 5/1/81
SAMPLING LOCATION ESP Inlet
SAMPLE TYPE HCSS Particle Size
RUN NUMBER ESP-I 3
OPERATOR M. Hansen/T. Walker
AMBIENT TEMPERATURE 70°F
BAROMETRIC PRESSURE 28.94
STATIC PRESSURE, (P_s) -5.8"
Filter Set 38

Leak CK: Inital at 15" Hg, CFM 0.016
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .270 (.068/15 sec.)
Probe Tip Diameter .156
CO_2 20.3%
O_2 8.3%
CO 0
N_2 71.4%
% H_2O 28.2 assumed

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 536.50 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\,in})$, °F	OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1657											
E3	3	1700	537.31	537.30	.80	.20	.20	395	82	83	2	N/A	82
	6	1703	538.12	538.17	.74		.21	390	82	83	2		82
	9	1706	538.93	538.83	.76		.19	395	82	83	2		82
	12	1709	539.74	539.61	.78		.21	390	84	84	2		83
	15	1712	540.55	540.42	.77		.22	385	86	84	2		83
	18	1715	541.36	541.23	.73		.22	390	87	85	2		83
	21	1718	542.17	542.17	.79		.23	390	88	86	2		83
	24	1721	542.98	542.83	.75		.20	390	88	86	2		83
								$\bar{T}_s$ = 390.6					
							ΔH = .21						
					ΔP = .765								
			V_m = 6.33										
									Tm =	84.6			

COMMENTS: moisture = 50 ml

29.2% moisture

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP Inlet
Test Number ESP-I-3-2

Date 5/1/81
Initial MDH

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	408 (390.6)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = .21$ $Pb = 28.94$ $Tm = 84.6$ $Vm = 6.033$	Vm_{std}	5.94
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 29.2%	Mf	.708
Molecular wt. dry stack gas, lb/lb-mole $(\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 + \%CO \times 0.28)$	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.61
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.51
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ $\Delta P = .84$ $\Delta P = (.765)$ $T_s = (390.6)$	Vs	4,146 (3,917)
Total sample time, minutes	θ	24
Nozzle diameter, inches	Dn	.156
$\frac{1{,}039\ (408^{(390.6)} + 460)(5.94)}{(4{,}146)(24)(28.51)(.708)(.156^2)}$	% I	109.6 (113.7)

(3,917)

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I3-2

Sample Location ESP-Inlet Sample Date 5/1/81

Sample Box No. ______ Recovery Date ______

Sample Type HCSS Particle Size Cleanup Person ______

Filter No. 38 ______ ______

Sample No. ______ ______ ______

Sample Material Description ______

MOISTURE AND/OR SAMPLE						SILICA GEL	
Impinger Sequence	1	2	3	4	5		
Impinger Type[a]							
Impinger Solution							
Final Volume (wt)[b]	50					470.0	
Initial Volume (wt)[b]	0					468.1	
Net Volume (wt)[b]	50					1.9	
Sample No.(s)						Silica Gel	
						Color	

Combined impinger contents, Sample No. ______

Liquid Level Marked ______ Container(s) Sealed ______

Description of Impinger Solution ______

Total Moisture, gm 51.9

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______

b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______

Carrier ______ Date Shipped: ______

Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______

Personnel accepting custody ______ Date broken ______

Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP-Inlet

Test Run Number ESP-I-3-2

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/1/81	1657-1721		
Probe Technician			M. Hansen	
Meter Technician			T. Walker	
Other			F. Hoffmeister	
Transport of Train to Cleanup Site	5/1/81	1724	M. Hansen	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-4-2

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/2/81

FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	M. Hansen
	2	
	3	
Engr. Technician	1	T. Walker
	2	F. Hoffmeister
	3	
Lab Technician	1	J. Pavelonis
	2	G. Cobb
	3	D. Olson
Process Engineer	1	F. Hoffmeister
	2	
Other	1	
	2	

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

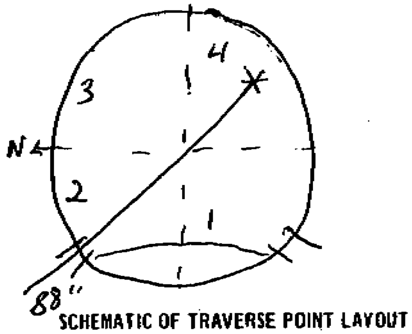
Plant Ideal　　　　Date 5/2/81
Sampling Location ESP-Inlet　　　　Initial MDH
Test No. ESP-I-4-2

Velocity head at sampling location, in. H_2O	ΔPs	.93
Stack temperature at sample point, °F	Ts	380
Barometric pressure, in. Hg	Pb	28.75
Static pressure in stack, in. Hg　– 5.8″ (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.32
Percent moisture in gas stream by volume	% H_2O	29.2
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.708
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.61
Stack velocity, fpm $5,128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	4,306
Calculated nozzle diameter, in.　Fs = .58 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.157
Actual nozzle diameter, in.　60-4.0	D_{n_a}	.157
Assumed meter temperature, °F	Tm	83
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	.58
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right)$ (Mf)	Fm	.261

FIELD DATA - ANDERSEN

.783 cf/3min

PLANT Ideal
DATE 5/2/81
SAMPLING LOCATION ESP Inlet
SAMPLE TYPE HCSS Particle Size
RUN NUMBER ESP-I-4-2
OPERATOR M. Hansen
AMBIENT TEMPERATURE 80°F
BAROMETRIC PRESSURE 28.75
STATIC PRESSURE, (P_s) -5.8"
Filter Set 19



SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Calculated ACFM (desired) .261 (.065 cf/15sec.)
Probe Tip Diameter .157
CO_2 20.3 %
O_2 8.3%
CO 0
N_2 70.4
% H_2O 29.2

Leak CK: Inital at 15" Hg, CFM 0.0
Final at ____ Hg, CFM ____

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 587.50 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1850											
4	3	1853	588.28	588.32	.97	.24	.25	377	77	78	2.0	NA	73
	6	1856	589.07	589.13	1.02		.24	391	78	78	2.0		73
	9	1859	589.85	589.93	1.00		.23	385	80	78	2.0		73
	12	1902	590.63	590.71	.99		.22	385	81	78	2.0		73
	15	1905	591.42	591.51	.92		.22	384	82	79	2.0		73
	18	1908	592.20	592.27	.94		.21	391	82	80	2.0		73
	21	1911	592.98	593.04	.99		.21	390	83	80	2.0		73
	24	1914	593.76	593.79	—		.20	382	84	81	2.0		73
						ΔH=	.22						
									Tm=	79.9			
					ΔP=.98			Ts=385.6					
			Vm=6.29										

COMMENTS: moisture Collected = 49 28.6% moisture

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Date 5/2/81
Sampling Location ESP Inlet Initial MDH
Test Number ESP-I-4-2

Isokinetic equation:

$$\% \ I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	380 (385.6)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ Vm = 6.29 Pb = 28.75 ΔH = .22 Tm = 79.9	Vm_{std}	5.91
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$	Mf	.714 ~~.708~~
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.70
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.32
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps\times Ms}}$ Δp = .93 Δp = (.98) Ts = (385.6)	Vs	4,299 (4,428)
Total sample time, minutes	θ	24
Nozzle diameter, inches	Dn	.157
$\frac{1{,}039\ (\ 380\ (385.6) + 460)(\ 5.91\ )}{(4{,}299)(24)(28.32)(.714)(.157^2)}$ (4,428)	% I	100.3 (98.0)

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I-4-2
Sample Location ESP-Inlet Sample Date 5/2/81
Sample Box No. ______ Recovery Date ______
Sample Type HCSS Particle Size Cleanup Person ______

Filter No. 19 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE	1	2	3	4	5	SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	49					473.9
Initial Volume (wt) b/	0					472.6
Net Volume (wt) b/	49					1.3
Sample No.(s)						Silica Gel
Combined impinger contents, Sample No.						Color ______

Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 50.3

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP-Inlet

Test Run Number ESP-I-4-2

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/2/81	1850-1914		
Probe Technician			T. Walker	
Meter Technician			M. Hansen	
Other			F. Hoffmeister	
Transport of Train to Cleanup Site	5/2/81	1920	F. Hoffmeister T. Walker	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen HCSS

RUN ESP-I-1-3(B)

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/4/81

FIELD CREW

Crew Chief M. Hansen

Testing Engineer
1 T. Walker
2
3

Engr. Technician
1 F. Hoffmeister
2 M. Hansen
3

Lab Technician
1 J. Pavelonis
2 B. Cobb
3 D. Olson

Process Engineer
1 F. Hoffmeister
2

Other
1
2

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal

Sampling Location ESP Inlet

Test No. ESP-I-1-3(B)

Date 5/4/81

Initial TW

Velocity head at sampling location, in. H_2O	ΔPs	.71
Stack temperature at sample point, °F	Ts	374
Barometric pressure, in. Hg	Pb	28.72
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.29
Percent moisture in gas stream by volume	% H_2O	27.7
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.723
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.51
Stack velocity, fpm $5{,}128.8\ (\underset{.84}{Cp})\ (\sqrt{\underset{.71}{\Delta Ps}})\ \sqrt{\frac{\overset{374}{Ts} + 460}{\underset{28.29}{Ps} \times \underset{27.51}{Ms}}}$	Vs	3757.9
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$ .54 3757.9, where Fs = 0.5 to 0.75 ft^3/min .54	D_{n_c}	.162
Actual nozzle diameter, in.	D_{n_a}	.157
Assumed meter temperature, °F	Tm	74
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $\underset{.54}{Fs}\left(\frac{\overset{74}{Tm}+460}{\underset{374}{Ts}+460}\right)\left(\frac{Ps}{Pb}\right)^{28.29}_{28.72}(Mf)\ .723$	Fm	.25

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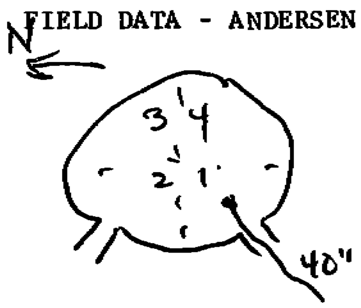
WATERPROOF PAPER

31ml

FIELD DATA - ANDERSEN

PLANT Ideal Cement Co
DATE 5/4/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE HCSS Particle Size
RUN NUMBER ESP-I-1-3(B)
OPERATOR Tom Walker
AMBIENT TEMPERATURE 25
BAROMETRIC PRESSURE 28.72
STATIC PRESSURE, (P_s) -5.6
Filter Set 39

Leak CK: Inital at 15" Hg, CFM 0.00
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .25
Probe Tip Diameter .157
CO_2
O_2
CO
N_2
% H_2O 27.7

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	2110	631.40										
1	3	2113	632.15	632.19	.80	.20	.20	375	72	72	1	—	66
	6	2116	632.90	632.90	.78		.19	380	72	72	2		66
	9	2119	633.65	633.67	.77		.20	385	74	72	2		68
	12	2122	634.40	634.46	.75		.19	390	74	72	2		68
	15	2125	635.15	635.17	.74		.19	380	75	72	2		68
			V_m=3.77		AVG ΔP_s=.77	AVG ΔH=.19		T_s=382	T_m=73				

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal — Date 5/4/81

Sampling Location ESP Inlet — Initial GC

Test Number ESP-I-1-3(B)

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(382) 374
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ 3.77 28.72 .19 73 — ΔH = .19, Pb = 28.72, Vm = 3.77, Tm+460 = 533	Vm_{std}	3.59
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ — % H_2O = 31.9	Mf	.68
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	26.94
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) −5.8	Ps	28.29
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ .84 .71 374 28.29 — ΔP = .71, ΔP = (.77), Cp = .84	Vs	3797 (3974)
Total sample time, minutes	θ	15
Nozzle diameter, inches	Dn	.157
$\frac{1{,}039\,(\underline{374\ (382)} + 460)(\underline{3.59})}{(\underline{3797\ (3974)})(\underline{15})(\underline{28.29})(\underline{.68})(\underline{.157}^2)}$	% I	115.2 (111.1)

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal　　Run No. ESP-I-1-3(B)

Sample Location ESP Inlet　　Sample Date 5/4/81

Sample Box No. ______　　Recovery Date ______

Sample Type HCSS Particle Size　　Cleanup Person ______

Filter No. 39

Sample No. ______

Sample Material Description ______

MOISTURE AND/OR SAMPLE						SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	31					454.0
Initial Volume (wt) b/	0					449.3
Net Volume (wt) b/	31					4.7
Sample No.(s)						Silica Gel Color ______

Combined impinger contents, Sample No. ______

Liquid Level Marked ______　　Container(s) Sealed ______

Description of Impinger Solution ______

Total Moisture, gm 35.7

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______

b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______ Liquid Level Marked ______ Sealed ______

Dry Catch: Sample No. ______ Description ______ Sealed ______

Impinger Rinse: Sample No. ______ Liquid Level Marked ______ Sealed ______

Acetone Blank: Sample No. ______ Liquid Level Marked ______ Sealed ______

Water Blank: Sample No. ______ Liquid Level Marked ______

Filter Blank: Sample No. ______ Sealed ______

Sample Disposition ______

Carrier ______　　Date Shipped: ______

Remarks: ______

Date of laboratory custody ______　　Seal(s) broken by ______

Personnel accepting custody ______　　Date broken ______

Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-1-3(B)

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/4/81	2110-2125 ~~LATE~~		
Probe Technician			Fritz Hoffmeister	
Meter Technician			Tom Walker	
Other			Mark Hansen	
Transport of Train to Cleanup Site				
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen HCSS

RUN ESP-I-2-3

MRI Project Number 4892L-03
Field Dates
Plant IDEAL CEMENT CO.
Sampling Location ESP INLET
Sampling Date 5/5/81

FIELD CREW

Crew Chief		MARK HANSEN ?
Testing Engineer	1	TOM WALKER
	2	
	3	
Engr. Technician	1	FRITZ HOFFMEISTER
	2	
	3	
Lab Technician	1	JOEL PAVELONIS
	2	DICK COBB
	3	
Process Engineer	1	
	2	
Other	1	
	2	

ANDERSEN SAMPLING CALCULATIONS

Plant IDEAL CEMENT CO　　Date 5/5/81

Sampling Location ESP INLET　　Initial TW

Test No. ESP-I-2-3

Velocity head at sampling location, in. H_2O	ΔPs	.63
Stack temperature at sample point, °F	Ts	350
Barometric pressure, in. Hg	Pb	28.85
Static pressure in stack, in. Hg (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.42
Percent moisture in gas stream by volume *	% H_2O	31
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.69
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md *2	30.91
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 30.91 .69 .69	Ms	26.91
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$ Cp = .84, ΔPs = .63, Ts = 350, Ps = 28.42, Ms = 26.91	Vs	3519.16
Calculated nozzle diameter, in. Fs = .55 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min .55 Fs = .55, Vs = 3519.16	D_{n_c}	.169
Actual nozzle diameter, in.	D_{n_a}	.176
Assumed meter temperature, °F	Tm	75
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs\left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$ Fs = .55, Tm = 75, Ts = 350, Ps = 28.42, Pb = 28.85, Mf = .69	Fm	.25

*ASSUMED FROM CALCULATIONS OF PREVIOUS MASS RUN

*2 FROM 5/4/81 (pm) DATA AT OUTLET

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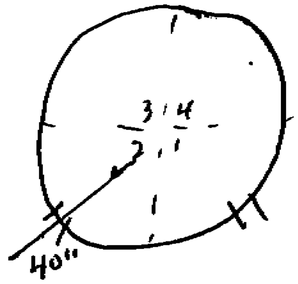
WATERPROOF PAPER

42 ml

FIELD DATA - ANDERSEN HCSS

PLANT Ideal Cement Co
DATE 5/5/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE HCSS
RUN NUMBER ESD-I-2-3
OPERATOR Tom Walker
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.65
STATIC PRESSURE, (P_s) -5.6
Filter Set 8

Leak CK: Inital at 15" Hg, CFM .005
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .25
Probe Tip Diameter .176
CO_2
O_2
CO
N_2
% H_2O

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1610	666.07										
2	3	1613	666.82	666.83	.77	.20	.20	340	74	74	2	–	72
	6	1616	667.57	667.58	.77		.20	345	74	74	2		72
	9	1619	668.32	668.32	.77		.20	350	76	74	2		72
	12	1622	669.07	669.08	.74		.20	340	78	74	2		74
	15	1625	669.82	669.83	.77		.20	345	79	75	2		74
	18	1628	670.57	670.57	.74		.20	345	80	76	2		74
	21	1631	671.32	671.33	.71		.20	345	80	77	2		74
			V_m = 5.26		Avg ΔP_s = .25	Avg ΔH = .20			Avg T_m = 76				
								Avg T_s = 344.3					

COMMENTS:

EPA (Dur) 235
4/72

ISOKINETIC PERFORMANCE WORKSHEET

Plant IDEAL CEMENT Co Date 5/5/81
Sampling Location ESP INLET Initial DW
Test Number ESP-I-2-3

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(344) 350
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH=.20 Pb=28.85 Tm=76 Vm=5.26	Vm_{std}	5.00
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 29.9% *	Mf	.701
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.743
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.63
Static pressure in stack, absolute, in. Hg -5.8" (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.42
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps\times Ms}}$ ΔP=.63 ΔP=(.75) Ts=(344) Ts=350	Vs	(3,775) 3,473
Total sample time, minutes	θ	21
Nozzle diameter, inches	Dn	.176
$\frac{1{,}039\ (350(344) + 460)(5.00)}{(3473)(21)(28.42)(.701)(.176^2)}$ (3,775)	% I	(85.4) 93.5

* CALCULATED FROM THIS RUN

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Idea Cement Co Run No. ESP-I-2-3
Sample Location ESP INLET Sample Date 5/5/81
Sample Box No. ______ Recovery Date ______
Sample Type HCSS Cleanup Person ______

Filter No. B ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE | SILICA GEL

	1	2	3	4	5	Silica Gel	
Impinger Sequence	1	2	3	4	5		
Impinger Type a/							
Impinger Solution							
Final Volume (wt) b/	42					475.6	
Initial Volume (wt) b/	0					472.3	
Net Volume (wt) b/	42					3.3	
Sample No.(s)							

Silica Gel Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 45.3

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 48921-03

Source Identification ESP INLET

Test Run Number ESP-I-2-3

Pollutant(s) in Sample HESS

Task	Date	Time	Personnel	Remarks
Sampling	5/5/81	1610-1631		
Probe Technician			FRITZ HOFFMEISTER	
Meter Technician			Tom WALKER	
Other			MARK HANSEN	
Transport of Train to Cleanup Site				
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen HCSS

RUN ESP-I-3-3

MRI Project Number 48921-03
Field Dates
Plant IDEAL CEMENT Co
Sampling Location INLET
Sampling Date 5/5/81

FIELD CREW

Crew Chief MARK HANSEN

Testing Engineer 1 Tom WALKER
2
3

Engr. Technician 1 FRITZ HOFFMEISTER
2 MARK HANSEN
3

Lab Technician 1 JOEL PAVELONIS
2 DICK COBB
3

Process Engineer 1
2

Other 1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal Cement Co Date 5/5/81
Sampling Location ESP Inlet Initial TW
Test No. ESP - I - 3 - 3

Velocity head at sampling location, in. H_2O	ΔPs	.93
Stack temperature at sample point, °F	Ts	373
Barometric pressure, in. Hg	Pb	28.84
Static pressure in stack, in. Hg (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.41
Percent moisture in gas stream by volume	% H_2O	31
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.69
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md *	30.91
Molecular wt. stack gas, lb/lb-mole $\underset{30.91}{(Md)}\ \underset{.69}{(Mf)} + 18(1 - \underset{.69}{Mf})$	Ms	26.91
Stack velocity, fpm $5{,}128.8\ \underset{.84}{(Cp)}\ \left(\sqrt{\underset{.93}{\Delta Ps}}\right) \sqrt{\frac{\overset{373}{Ts} + 460}{\underset{28.41}{Ps} \times \underset{26.91}{Ms}}}$	Vs	4336.77
Calculated nozzle diameter, in. $24\sqrt{\frac{\overset{.58}{Fs}/\overset{4336.77}{Vs}}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min .58	D_{n_c}	.157
Actual nozzle diameter, in.	D_{n_a}	.157
Assumed meter temperature, °F	Tm	72
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $\underset{.58}{Fs}\left(\frac{\overset{72}{Tm}+460}{\underset{373}{Ts}+460}\right)\left(\frac{\overset{28.41}{Ps}}{\underset{28.84}{Pb}}\right)(Mf)\ .69$	Fm	.25

* FROM 5/4/81 (pm) DATA AT OUTLET
(copy from original)

WATERPROOF PAPER

50ml

FIELD DATA - ANDERSEN

PLANT Ideal Cement Co
DATE 5/5/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE HC35
RUN NUMBER ESP-I-3-3
OPERATOR Tom Walker
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.84
STATIC PRESSURE, (P_s) -5.8
Filter Set 35

Leak CK: Inital at 15" Hg, CFM 0.0
Final at ____ Hg, CFM ____

SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .25
Probe Tip Diameter .157
CO_2 ____
O_2 ____
CO ____
N_2 ____
% H_2O 31

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	GAS METER READING (V_m), ft^3 Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1000	646.70										
3	3	1003	647.45	647.47	.88	.20	.20	365	62	62	2	—	60
	6	1006	648.20	648.21	.92		.19	360	62	62	2		61
	9	1009	648.95	648.94	.90		.19	365	64	62	2		61
	12	1012	649.70	649.69	.88		.20	370	65	63	2		62
	15	1015	650.45	650.46	.89		.20	360	67	63	2		66
	18	1018	651.20	651.21	.87		.20	370	67	63	2		68
	21	1021	651.95	651.94	.92		.19	360	68	64	2		68
			V_M=5.24		AVG ΔP=.89		AVG ΔH= ~~.20~~ .196	AVG T_S=364	AVG T_m= ~~64~~		63.9		

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant IDEAL CEMENT Co Date 5/5/81
Sampling Location ESP INLET Initial TW
Test Number ESP-I-3-3

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(364) 373
Meter volume (std), $\frac{17.64\overset{5.24}{(Vm)}\left(Pb+\frac{\Delta H_{avg}^{.20}}{13.6}\right)}{\underset{64}{Tm+460}}$	Vm_{std}	5.09
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 32.2 ACTUAL MOISTURE CALCULATED ON THIS RUN	Mf	
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md * / *'	31.74 / 30.91
Molecular wt. stack gas, lb/lb-mole $\underset{31.74}{(Md)}\ \underset{.68}{(Mf)} + 18(1 - \underset{.68}{Mf})$	Ms	26.78
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.41
Stack velocity, fpm $5{,}128.8\ \underset{.84}{(Cp)}\left(\underset{.93}{\sqrt{\Delta Ps}}_{avg}\right)\sqrt{\frac{\overset{373}{Ts+460}}{\underset{28.41\ \ 26.78}{Ps \times Ms}}}$ (ΔPs) = (.89) ΔPs = .93	Vs	(4,230) 4347.29
Total sample time, minutes	θ	21
Nozzle diameter, inches	Dn	.157
$\frac{1{,}039\ (373 + 460)(5.09)}{(4347.29)(21)(28.41)(.68)(.157^2)}$	% I	(103.0) 101.3

*' SEE ANDERSON SAMPLING CALCULATIONS OF THIS RUN

* USE THIS IN THESE CALCULATIONS

(copy from original)

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant IDEAL CEMENT Co Run No. ESP-I-3-3
Sample Location ESP INLET Sample Date 5/5/81
Sample Box No. ______ Recovery Date ______
Sample Type HCSS Cleanup Person ______

Filter No. 35
Sample No. ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	50					471.3
Initial Volume (wt) b/	0					470.0
Net Volume (wt) b/	50					1.3
Sample No.(s)						Silica Gel Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 51.3

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892L-03

Source Identification ESP-I-3-3

Test Run Number

Pollutant(s) in Sample PARTICULATE HCSS

Task	Date	Time	Personnel	Remarks
Sampling	5/5/81	1000-1021		
Probe Technician			Fritz Hoffmeister	
Meter Technician			Tom Walker	
Other			Mark Hansen	
Transport of Train to Cleanup Site				
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen HCSS

RUN ESP-I-4-3

MRI Project Number 48921-03
Field Dates
Plant IDEAL CEMENT CO
Sampling Location ESP INLET
Sampling Date 5/6/81

FIELD CREW

Crew Chief		MARK HANSEN
Testing Engineer	1	TOM WALKER
	2	
	3	
Engr. Technician	1	FRITZ HOFFMEISTER
	2	JOEL PAVELONIS
	3	
Lab Technician	1	JOEL PAVELONIS
	2	DAN OLSON
	3	
Process Engineer	1	FRITZ HOFFMEISTER
	2	
Other	1	
	2	

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant IDEAL CEMENT CO Date 5/6/81
Sampling Location ESP INLET Initial TW
Test No. ESP-I-4-3

Velocity head at sampling location, in. H_2O From Previous Method 5	ΔPs	.84
Stack temperature at sample point, °F	Ts	350
Barometric pressure, in. Hg	Pb	28.88
Static pressure in stack, in. Hg (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.45
Percent moisture in gas stream by volume	% H_2O	30
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.7
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md *	31.74
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 31.74 .7 .7	Ms	27.62
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$ Cp = .84, ΔPs = .84, Ts = 350, Ps = 28.45, Ms = 27.62	Vs	4008.9
Calculated nozzle diameter, in. Fs = .55 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min (Fs = .55, Vs = 4008.9)	D_{n_c}	.159
Actual nozzle diameter, in.	D_{n_a}	.157
Assumed meter temperature, °F	Tm	65
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$ Fs = .55, Tm = 65, Ts = 350, Ps = 28.45, Pb = 28.88, Mf = .7	Fm	.25

* FROM 5/5/81 INLET FYRITE

(copy from original)

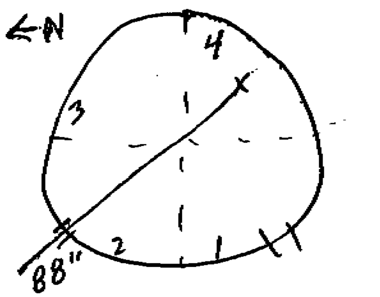
53ml

FIELD DATA - ANDERSEN HCSS

PLANT IDEAL Cement Co
DATE 5/6/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE HCSS
RUN NUMBER ESP-I-4-3
OPERATOR Tom Walker
AMBIENT TEMPERATURE 65
BAROMETRIC PRESSURE 28.88
STATIC PRESSURE, (P_s) -5.8
Filter Set 21

Leak CK: Inital at 15" Hg, CFM .005
Final at ____ Hg, CFM ____

←N



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .25
Probe Tip Diameter .157
CO_2 ____
O_2 ____
CO ____
N_2 ____
% H_2O 30

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1210	691.60										
4	3	1213	692.35	692.37	1.0	.20	.20	355	62	62	2	—	65
	6	1216	693.10	693.12	.94		.20	360	63	62	2		65
	9	1219	693.85	693.87	1.1		.20	360	64	62	2		65
	12	1222	694.60	694.67	1.1		.23	370	65	63	2		65
	15	1225	695.35	695.47	1.0		.23	360	66	63	2		65
	18	1228	696.10	696.26	1.1		.22	370	67	63	2		65
	21	1231	696.85	696.47	1.0		.22	365	67	63	2		65
				697.07									
			Vm=5.47		AVG ΔPs=1.03	AVG ΔH=.214			AVG Tm=63.7				
								AVG Ts=362.9					

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Cement Co   Date 5/6/81
Sampling Location ESP INLET   Initial TW
Test Number ESP-I-4-3

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(363) 350
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ Vm: 5.47, Pb: 28.88, ΔH: .21, Tm: 64; ΔH = .21 Pb = 28.88 Vm = 5.47 Tm = 64	Vm_{std}	5.32
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ % H_2O = 31.5	Mf	.685
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.74
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 31.74 .685 .685	Ms	27.41
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.45
Stack velocity, fpm 5,128.8 (Cp) $\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ Cp: .84, ΔPs: 1.0, Ts: 363, Ps: 28.45, Ms: 27.41; (ΔPs) = (1.0) ΔPs = .84	Vs	(4425.88) 4024.22
Total sample time, minutes	θ	21
Nozzle diameter, inches	Dn	.157
$\frac{1{,}039\ (363 + 460)(5.32)}{(4425.88)(21)(28.45)(.685)(.157^2)}$	% I	(101.89) 110.29

* SEE ANDERSON SAMPLING CALCULATIONS THIS RUN

( ) = ACTUAL CONDITIONS EXPERIENCED During Run

(copy from original)

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant: IDEAL CEMENT Co — Run No.: ESP-I-4-3
Sample Location: ESP-INLET — Sample Date: 5/6/81
Sample Box No.: ____ — Recovery Date: ____
Sample Type: HCSS — Cleanup Person: ____

Filter No.: 21 ____ ____
Sample No.: ____ ____ ____
Sample Material Description: ____

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL	
Impinger Type a/							
Impinger Solution							
Final Volume (wt) b/	53					459.0	
Initial Volume (wt) b/	0					459.9	
Net Volume (wt) b/	53					-0.9	
Sample No.(s)						Silica Gel Color	

Combined impinger contents, Sample No. ____
Liquid Level Marked ____ Container(s) Sealed ____
Description of Impinger Solution ____
Total Moisture, gm 52.1

a/ S = Greenburg-Smith standard, M = Modified, O = Other ____
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ____ Liquid Level Marked ____ Sealed ____
Dry Catch: Sample No. ____ Description ____ Sealed ____
Impinger Rinse: Sample No. ____ Liquid Level Marked ____ Sealed ____
Acetone Blank: Sample No. ____ Liquid Level Marked ____ Sealed ____
Water Blank: Sample No. ____ Liquid Level Marked ____
Filter Blank: Sample No. ____ Sealed ____

Sample Disposition ____
Carrier ____ Date Shipped: ____
Remarks: ____

Date of laboratory custody ____ Seal(s) broken by ____
Personnel accepting custody ____ Date broken ____
Remarks: ____

SAMPLE HANDLING LOG

Project Number 4892L-03

Source Identification ESP-INLET

Test Run Number ESP-I-4-3

Pollutant(s) in Sample HCSS

Task	Date	Time	Personnel	Remarks
Sampling	5/6/81	1210-1231		
Probe Technician			Fritz Hoffmeister	
Meter Technician			Tom Walker	
Other				
Transport of Train to Cleanup Site				
~~Train~~ Disassembly	5-6-81		Jose Parelo	
~~Train~~ Cleanout	5-6-81		Joel Pavlonis	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen HCSS

RUN ESP-I-1-4

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/4/81

FIELD CREW

Crew Chief M. Hansen

Testing Engineer 1 T. Walker
2
3

Engr. Technician 1 F. Hoffmeister
2
3

Lab Technician 1 J. Pavelonis
2 G. Cobb
3 D. Olson

Process Engineer 1 F. Hoffmeister
2

Other 1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal   Date 5/4/81
Sampling Location ESP Inlet   Initial TW
Test No. ESP -I-1-4

Velocity head at sampling location, in. H_2O	ΔPs	.81
Stack temperature at sample point, °F	Ts	378
Barometric pressure, in. Hg	Pb	28.72
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O) -5.8	Ps	28.29
Percent moisture in gas stream by volume	% H_2O	27.7
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.723
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.15
Molecular wt. stack gas, lb/lb-mole $\underset{31.15}{(Md)}\ \underset{.723}{(Mf)} + 18(1 - \underset{.723}{Mf})$	Ms	27.51
Stack velocity, fpm $5{,}128.8\ \underset{.84}{(Cp)}\ \left(\sqrt{\underset{.81}{\Delta Ps}}\right) \sqrt{\frac{\overset{378}{Ts} + 460}{\underset{28.29}{Ps} \times \underset{27.51}{Ms}}}$	Vs	4023.44
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$ 4023.44, where Fs = 0.5 to 0.75 ft^3/min .58	D_{n_c}	.163
Actual nozzle diameter, in.	D_{n_a}	.157
Assumed meter temperature, °F	Tm	75
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $Fs\left(\frac{\overset{75}{Tm}+460}{\underset{378}{Ts}+460}\right)\left(\frac{Ps}{Pb}\right)^{28.29}_{28.72}(Mf)\ .723$	Fm	.264

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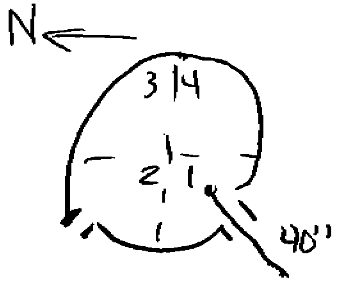
WATERPROOF PAPER
& SKOAL PROFF

23ml

FIELD DATA - ANDERSEN

PLANT Ideal Cement
DATE 5/4/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE HC33 Particle Size
RUN NUMBER ESP-I-1-4
OPERATOR Tom Waller
AMBIENT TEMPERATURE 75
BAROMETRIC PRESSURE 28.72
STATIC PRESSURE, (P_s) -3.8
Filter Set 34

Leak CK: Inital at 15" Hg, CFM .005
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .264
Probe Tip Diameter .157
CO_2 ____
O_2 ____
CO ____
N_2 ____
% H_2O 27.7

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3 627.42 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1943											
1	3	1946	628.20	628.20	.62	.21	.21	375	72	72	1	—	69
	6	1949	628.98	628.98	.76	↓	.21	376	73	72	1		69
	9	1952	629.76	629.76	.73		.21	375	75	73	2		69
	12	1955	630.54	630.54	.74		.21	375	76	73	2		69
	15	1958	631.32	631.32	.68		.21	375	78	74	2		69
			V_m=3.90		AVG ΔP_s=.706		ΔH=.21						
								T_s=374		T_m=~~74~~	~~93.8~~ 73.8		

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP Inlet
Test Number ESP-I-1-4

Date 5/4/81
Initial TW

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	378 (374)
Meter volume (std), $\dfrac{17.64(Vm)\left(Pb+\dfrac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ 3.9, 28.72, .21, 74; ΔH = .21, Pb = 28.72, Vm = 3.9, Tm + 460 = 534	Vm_{std}	3.70
Mole fraction dry gas, $\dfrac{100-\%\ H_2O}{100}$ *	Mf	.723
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.51
Static pressure in stack, absolute, in. Hg -5.8 (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.29
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\dfrac{Ts+460}{Ps \times Ms}}$ .84, .81, 378, 28.72; ΔP = .81, ΔP = (.71), Cp = .84	Vs	4023 (3758)
Total sample time, minutes	θ	15
Nozzle diameter, inches	Dn	.157
$\dfrac{1{,}039\ (378\ (374) + 460)(3.7)}{(4023\ (3758))(15)(28.29)(.723)(.157^2)}$	% I	105.9 (112.8)

* Will assume 27.7 because of doubt in Silica gel weight on this run
( ) actual

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PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I-1-4

Sample Location ESP-Inlet Sample Date 5/4/81

Sample Box No. Recovery Date 5/4/81

Sample Type HCSS Particle Size Cleanup Person D. Olson

Filter No. 34

Sample No.

Sample Material Description

MOISTURE AND/OR SAMPLE						SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	23					*449.3
Initial Volume (wt) b/	0					453.2
Net Volume (wt) b/	23					-3.9
Sample No.(s)						Silica Gel Color

Combined impinger contents, Sample No.

Liquid Level Marked Container(s) Sealed

Description of Impinger Solution

Total Moisture, gm 19.1

a/ S = Greenburg-Smith standard, M = Modified, O = Other

b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition

Carrier Date Shipped:

Remarks:

Date of laboratory custody Seal(s) broken by

Personnel accepting custody Date broken

Remarks: *USED MOISTURE FROM MASS RUN (27.7%) From ESP-I-1-2

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-1-4

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/4/81	1943-1958		
Probe Technician			M. Hansen	
Meter Technician			T. Walker	
Other			F. Hoffmeister	
Transport of Train to Cleanup Site	5/4/81	2015	M. Hansen F. Hoffmeister	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-2-4

MRI Project Number 4892h-03
Field Dates 5
Plant Ideal
Sampling Location ESP- Inlet
Sampling Date 5-5-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 Walker
2
3

Engr. Technician 1
2
3

Lab Technician 1 Pavelonis
2 Cobb
3 Olson

Process Engineer 1 Hoffmeister
2

Other 1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal　　　　Date 5-5-81

Sampling Location ESP-Inlet　　　　Initial G.C.

Test No. ESP-I-2-4

Velocity head at sampling location, in. H_2O	ΔPs	.75
Stack temperature at sample point, °F	Ts	345
Barometric pressure, in. Hg	Pb	28.82
Static pressure in stack, in. Hg (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.39
Percent moisture in gas stream by volume	% H_2O	30
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.70
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md *	30.91
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 30.91 .7 .7	Ms	27.03
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$ (Cp .84, ΔPs .75, Ts 345, Ps 28.39, Ms 27.03)	Vs	3821.36
Calculated nozzle diameter, in. $F_s = .55$ $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min (Fs .55, Vs 3821.36)	D_{n_c}	.162
Actual nozzle diameter, in.	D_{n_a}	.176
Assumed meter temperature, °F	Tm	78
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $Fs\left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$ (Fs .55, Tm 78, Ts 345, Ps 28.39, Pb 28.82, Mf .7)	Fm	.25

* Data taken from 5/4/81 (pm) at outlet

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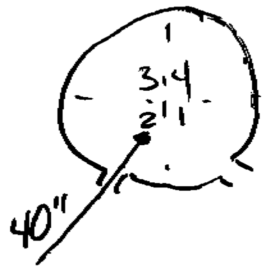
WATERPROOF PAPER

40-1

FIELD DATA - ANDERSEN HCSS

PLANT Ideal Cement Co
DATE 5/5/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE HCSS
RUN NUMBER ESP-I-2-4
OPERATOR Tom Walker
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.82
STATIC PRESSURE, (P_s) -5.8
Filter Set 30

Leak CK: Inital at 15" Hg, CFM .00
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .25
Probe Tip Diameter .176
CO_2
O_2
CO
N_2
% H_2O

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³ 671.41 Desired	GAS METER READING Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1742											
2	3	1745 ~~1743~~	672.16	672.17	.72	.120	.120	360	73	73	2	—	74
	6	1748 ~~1746~~	672.91	672.92	.71	↓	.20	360	74	73	2		74
	9	1751 ~~1749~~	673.66	673.67	.75		.20	365	74	74	2		74
	12	1754 ~~1752~~	674.41	674.42	.72		.20	360	75	74	2		74
	15	1757 ~~1755~~	675.16	675.18	.72		.20	355	76	74	2		74
	18	1800 ~~1758~~	675.91	675.91	.68		.19	360	76	74	2		74
	21	1803 ~~1801~~	676.66	676.67	.70		.20	355	77	74	2		74
			5.26 V_m = ~~5.26~~	Avg ΔP_s = .71		Avg ΔH = .20			Avg T_m = 74.4				
								Avg T_s = 359.3					

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant: Ideal
Sampling Location: ESP Inlet
Test Number: ESP-I-2-4

Date: 5/5/81
Initial: T.W.

Isokinetic equation:

$$\% \ I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(359) 345
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $Vm = 5.26$ $\Delta H = .20$ $T_m = 74$ $Pb = 28.82$	Vm_{std}	5.01
Mole fraction dry gas, $\frac{100-\% \ H_2O}{100}$ 27.56 = % H_2O	Mf	.72
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28) From 5/5/81 inlet data	Md	31.74
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.89
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) -5.8	Ps	28.39
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ $\Delta P_s = .75$ $(\Delta P_s) = (.71)$ $T_s = 345$ $T_s = (359)$	Vs	(3691.98) 3767.98
Total sample time, minutes	θ	21
Nozzle diameter, inches	Dn	.176
$\frac{1{,}039\ (345 + 460)(5.01)}{(3767.98)(21)(28.39)(.72)(.176^2)}$	% I	(86.84) 83.77

( ) = actual for this run

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PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I-2-4
Sample Location ESP- Inlet Sample Date 5-5-81
Sample Box No. ______ Recovery Date 5-5-81
Sample Type HCSS Cleanup Person Cobb/Olson/Paulerin

Filter No. 30
Sample No. ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE						SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	40					472.5
Initial Volume (wt) b/	0					472.0
Net Volume (wt) b/	40					.5
Sample No.(s)						Silica Gel
						Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 40.5

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4894-03

Source Identification ESP-Inlet

Test Run Number ESP-I-2-4

Pollutant(s) in Sample Particle Sizing

Task	Date	Time	Personnel	Remarks
Sampling	5-5-81	1742-1803		
Probe Technician			~~Walker~~ Hansen	
Meter Technician			Walker	
Other			Hoffmeister	
Transport of Train to Cleanup Site			Hansen/Walker	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen HCSS

RUN ESP-I-3-4

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Inlet
Sampling Date 5/5/81

FIELD CREW

Crew Chief M. Hansen

Testing Engineer 1 T. Walker
2
3

Engr. Technician 1 F. Hoffmeister
2 M. Hansen
3

Lab Technician 1 J. Pavelonis
2 G. Cobb
3 D. Olson

Process Engineer 1 F. Hoffmeister
2

Other 1
2

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal Date 5/5/81
Sampling Location ESP Inlet Initial T.W.
Test No. ESP-I-3-4

Velocity head at sampling location, in. H_2O From previous run	ΔPs	.89
Stack temperature at sample point, °F From previous run	Ts	364
Barometric pressure, in. Hg	Pb	28.88
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.45
Percent moisture in gas stream by volume	% H_2O	32
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$ 32	Mf	.68
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md *	30.91
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 30.91 .68 .68	Ms	26.78
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$ .84 .89 364 28.45 26.78	Vs	4226.76
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min .57 .57 4226.76	D_{n_c}	.157
Actual nozzle diameter, in.	D_{n_a}	.157
Assumed meter temperature, °F	Tm	65
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs\left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$ .57 65 364 28.45 28.88 .68	Fm	.24

* from 5/4/81 (pm) Data at outlet

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WATERPROOF PAPER

48ml

FIELD DATA - ANDERSEN HCSS

PLANT: IDEAL CEMENT
DATE: 5/5/81
SAMPLING LOCATION: ESP INLET
SAMPLE TYPE: HCSS
RUN NUMBER: ESP-I-3-4
OPERATOR: Tom WALKER
AMBIENT TEMPERATURE: 65
BAROMETRIC PRESSURE: 28.88
STATIC PRESSURE, (P_s): -.58
Filter Set: 14

Leak CK: Inital at 15" Hg, CFM 0.0
Final at ____ Hg, CFM ____

SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Calculated ACFM (desired): .24
Probe Tip Diameter: .157
CO_2:
O_2:
CO:
N_2:
% H_2O: 32

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 652.15 Desired	Actual	VELOCITY HEAD (Δp_s), in H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	6	1142											
3	3	1145	652.87	652.88	.82	.19	.19	340	61	61	2	✓	60
	6	1148	653.59	653.63	.83		.19	350	62	61	2		62
	9	1151	654.31	654.32	.83		.17	340	63	61	2		64
	12	1154	655.03	655.03	.85		.18	345	64	62	2		64
	15	1157	655.75	655.75	.85		.19	345	65	62	2		64
	18	1200	656.47	656.49	.84		.19	355	66	63	2		64
	21	1203	657.19	657.21	.82		.18	345	67	63	2		64

$V_m = 5.06$ AVG $\Delta P_s = .83$ AVG $\Delta H = .184$ AVG $T_m = 63$

AVG $T_s = 346$

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Idoal Date 5/5/81
Sampling Location ESP Inlet Initial T.W.
Test Number ESP-I-3-4

Isokinetic equation:

$$\% \ I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(346) 364
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ 5.06 1.18 63	Vm_{std}	4.93
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 32.1 *	Mf	.675
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md *2	30.91
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 30.91 .675 .675	Ms	26.71
Static pressure in stack, absolute, in. Hg -5.8 (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.45
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ .84 .89 364 28.45 26.71 ΔP = .89 ΔP = (.83) Ts = (346)	Vs	(4042) 4232.29
Total sample time, minutes	θ	21
Nozzle diameter, inches	Dn	.157
$\frac{1{,}039\ (364 + 460)(4.93)}{(4232.29)(21)(28.45)(.675)(.157^2)}$	% I	(102.8) 100.33

* Actual moisture from this run

*2 see Anderson sampling calculations this run

( ) actual ΔPS ; Ts obtained from run

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PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal
Sample Location ESP Inlet
Sample Box No.
Sample Type HCSS Particle Size

Run No. ESP-I-3-4
Sample Date 5/5/81
Recovery Date
Cleanup Person

Filter No. 14
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

	1	2	3	4	5	SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	48					472.3
Initial Volume (wt) b/	0					471.3
Net Volume (wt) b/	48					1.0
Sample No.(s)						

Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked
Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 49

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier
Date Shipped:
Remarks:

Date of laboratory custody
Personnel accepting custody
Seal(s) broken by
Date broken
Remarks:

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-3-4

Pollutant(s) in Sample Particulate HCSS

Task	Date	Time	Personnel	Remarks
Sampling	5/5/81	1142-1203		
Probe Technician			Fritz Hoffmeister	
Meter Technician			Tom Walker	
Other			Mark Hansen	
Transport of Train to Cleanup Site				
~~Train~~ Disassembly	5-5-81		Joel Paulconis	
~~Train~~ Cleanout	5-5-81		Joel Paulconis	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen HCSS

RUN ESP-I-44

MRI Project Number 4892L-03
Field Dates
Plant IDEAL CEMENT CO
Sampling Location ESP - INLET
Sampling Date 5/6/81

FIELD CREW

Crew Chief		MARK HANSEN
Testing Engineer	1	TOM WALKER
	2	
	3	
Engr. Technician	1	FRITZ HOFFMEISTER
	2	MARK HANSEN
	3	
Lab Technician	1	JOEL PAVELONIS
	2	DAN OLSON
	3	
Process Engineer	1	FRITZ HOFFMEISTER
	2	
Other	1	
	2	

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant IDEAL CEMENT CO Date 5/6/81
Sampling Location ESP INLET Initial TW
Test No. ESP - I - 4 - 4

Velocity head at sampling location, in. H_2O	ΔPs	.92
Stack temperature at sample point, °F	Ts	360
Barometric pressure, in. Hg	Pb	28.84
Static pressure in stack, in. Hg (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.41
Percent moisture in gas stream by volume	% H_2O	30
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.70
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md *	31.74
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 31.74 .7 .7	Ms	27.62
Stack velocity, fpm $5{,}128.8\ (\underset{.84}{Cp}) \left(\sqrt{\underset{.92}{\Delta Ps}}\right) \sqrt{\frac{\overset{360}{Ts} + 460}{\underset{28.41}{Ps} \times \underset{27.62}{Ms}}}$	Vs	4224.24
Calculated nozzle diameter, in. $F_s = .56$ $24\sqrt{\frac{Fs/Vs}{\pi}}$ (.56, 4224.24), where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.156
Actual nozzle diameter, in.	D_{n_a}	.157
Assumed meter temperature, °F	Tm	65
Isokinetic sample rate, stack conditions, ft^3/min Vs (0.00694) $(\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $\overset{.56}{Fs} \left(\frac{\overset{65}{Tm}+460}{\underset{360}{Ts}+460}\right) \left(\frac{\overset{28.41}{Ps}}{\underset{28.84}{Pb}}\right) (\overset{.7}{Mf})$	Fm	.25

* FROM 5/5/81 INLET FYRITE

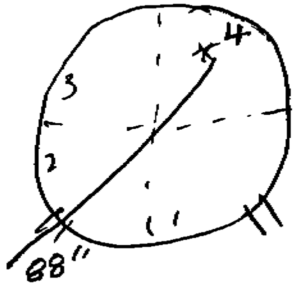
(copy from original)

29ml

FIELD DATA - ANDERSEN HESS

PLANT Ideal Cement Co
DATE 5/6/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE HCSS
RUN NUMBER ESP-I-4-4
OPERATOR Tom Walker
AMBIENT TEMPERATURE 65
BAROMETRIC PRESSURE 28.84
STATIC PRESSURE, (P_s) -5.8
Filter Set 22

Leak CK: Inital at 15" Hg, CFM .01
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .25
Probe Tip Diameter .157
CO_2
O_2
CO
N_2
% H_2O

Console No. 3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1425	697.20										
4	3	1428	697.95	697.97	1.0	.20	.20	385	65	64	1	–	60
	6	1431	698.70	698.71	1.0		.20	385	66	65	1		60
	9	1434	699.45	699.47	1.0		.21	385	67	65	1		64
	12	1437	700.20	700.23	1.0		.20	380	69	65	2		64
	15	1440	700.95	700.99	.99		.20	375	70	65	2		64
	18	1443	701.70	701.77	1.0		.20	380	70	66	2		64
			Vm=4.57		AVG Δp=1.0	AVG ΔH=.20		Ts=382	Tm=66.4				

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Cement Co   Date 5/6/81
Sampling Location ESP Inlet   Initial TW
Test Number ESP-I-44

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(382) 360
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ 4.57 (28.84 .2) 66 Vm = 4.57 ΔH = .20 Pb = 28.84 Tm = 66	Vm_{std}	4.42
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 24% = H_2O	Mf	.76
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md *	31.74
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) 31.74 .76 .76	Ms	28.44
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.41
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ .84 1.0 382 28.41 28.44 (ΔP_s) = (1.0) ΔP_s = .92	Vs	(4397.95) 4162.9
Total sample time, minutes	θ	18
Nozzle diameter, inches	Dn	.157
$\frac{1{,}039\,(\underline{382} + 460)(\underline{4.42})}{(4397.95)(\underline{18})(\underline{28.41})(\underline{.76})(\underline{.157}^2)}$	% I	(91.78) 94.42

* See Anderson Sampling Calculations this run

(copy from original)

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Cement Co — Run No. ESP-I-4-4
Sample Location ESP INLET — Sample Date 5/6/81
Sample Box No. ______ — Recovery Date ______
Sample Type HCSS — Cleanup Person ______

Filter No. 22
Sample No. ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	29					459.5
Initial Volume (wt) b/	0					459.0
Net Volume (wt) b/	29					.5
Sample No.(s)						

Silica Gel Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 29.5

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______ Liquid Level Marked ______ Sealed ______
Impinger Rinse: Sample No. ______ Liquid Level Marked ______ Sealed ______
Water Blank: Sample No. ______ Liquid Level Marked ______
Dry Catch: Sample No. ______ Description ______ Sealed ______
Acetone Blank: Sample No. ______ Liquid Level Marked ______ Sealed ______
Filter Blank: Sample No. ______ Sealed ______
Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 48921-03

Source Identification ESP INLET

Test Run Number ESP-I-4-4

Pollutant(s) in Sample HCSS

Task	Date	Time	Personnel	Remarks
Sampling	5/6/81	1425-1443		
Probe Technician			FRITZ HOFFMEISTER	
Meter Technician			Tom WALKER	
Other			MARK HANSEN	
Transport of Train to Cleanup Site	5/6/81	1455	M. Hansen F. Hoffmeister	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

I-2 Electrostatic Precipitator Outlet

I-2-1 Total Mass (EPA Method 17)

MIDWEST RESEARCH INSTITUTE

RUN ESP-0-1-18(c)

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-6-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 United
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

MRI - Form PO (10/72)

NOMOGRAPH DATA

PLANT Ideal

DATE 5-6-81

SAMPLING LOCATION ESP Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	90
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	30
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.87
STATIC PRESSURE IN STACK, in. Hg (P_m ±0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.40
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.98
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	310
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	Δ. =.07
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	0.63	
CALCULATED NOZZLE DIAMETER, in.	0.48	
ACTUAL NOZZLE DIAMETER, in.	0.44	
REFERENCE Δp, in. H_2O	0.115	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal — Date 5-6-81

Sampling Location ESP Outlet — Initial Ca

Test Number ESP-O-1-18(C)

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

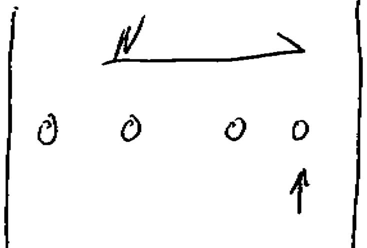
ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	90
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	10
Mole fraction dry gas	Mf	.7
Nozzle diameter, inches	Dn	.44
Barometric pressure, inches Hg	Pb	28.87
$\frac{5.168\ (90 + 460)\ (10)\ (.7)\ (.84)\ (.44^2)}{\sqrt{28.87}}$	K	602.2

FIELD DATA

PLANT Ideal
DATE 5-6-81
SAMPLING LOCATION ESP-Outlet
SAMPLE TYPE
RUN NUMBER ESP-0-1-1-~~B~~(C)
OPERATOR White
AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 28.87
STATIC PRESSURE, (P_s) -6.4" H_2O
FILTER NUMBER (s) 11



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. .44
ASSUMED MOISTURE, % 30%
SAMPLE BOX NUMBER
METER BOX NUMBER 9
METER $\Delta H_@$ 1.84
C FACTOR .63
PROBE HEATER SETTING —
HEATER BOX SETTING —
REFERENCE Δp .11

Leak CK: Initial at 15" Hg, CFM .002
Final at Hg, CFM

READ AND RECORD ALL DATA EVERY 10 MINUTES

$$VM = 602.2 \times \sqrt{\frac{Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1323	617.135										
	10	1333	623.16	623.20	.08	1.35	1.35	340	80	80	12		58
	20	1343	630.24	630.00	.011	1.90	1.60	335	85	80	13		50
	30	1353	636.97	636.92	.10	1.65	1.70	340	95	85	14		50
	40	1403	644.05	644.19	.11	1.80	1.90	335	100	84	17		58
	50	1413	651.47	651.55	.12	2.0	1.9	330	102	88	20		59
OFF	60	1423	658.51	658.54	.11	1.9	1.7	345	110	90	19		63
1433 ↓	70	1433	665.24	665.35	.10	1.65	1.6	340	110	92	22		63
	~~80~~			665.643	~~.11~~								
	~~90~~												
	~~100~~												
	~~110~~												
	~~120~~												
								Ts=337.9	Tm=	91.5			
		Vm =	48.508			ΔH=1.68							
					ΔP=.104								

COMMENTS: Couldn't maintain flow.

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal

Sampling Location ESP Outlet

Test Number ESP-O-1-18 (C)

Date 5-6-81

Initial CL

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	337.9
Meter volume (std), $\dfrac{17.64(Vm)\left(Pb+\dfrac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = 1.68$ $Pb = 28.87$ $Tm = 91.5$ $Vm = 48.508$	Vm_{std}	44.98
Mole fraction dry gas, $\dfrac{100-\%\ H_2O}{100}$ 30.8% collected this run	Mf	.692
Molecular wt. dry stack gas, lb/lb-mole $(\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 + \%CO \times 0.28)$	Md	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.03
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.40
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\dfrac{Ts+460}{Ps \times Ms}}$ $\Delta P = .104$	Vs	1,416
Total sample time, minutes	θ	70
Nozzle diameter, inches	Dn	.440
$\dfrac{1{,}039\,(337.9+460)(44.98)}{(1{,}416)(70)(28.40)(.692)(.440^2)}$	% I	98.9

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant: Ideal
Sample Location: ESP Outlet
Sample Box No.:
Sample Type:

Run No.: ESP-0-1-1B(C)
Sample Date: 5-6-81
Recovery Date:
Cleanup Person:

Filter No.: 11
Sample No.:
Sample Material Description:

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL	
Impinger Type a/							
Impinger Solution							
Final Volume (wt) b/	13	0	0	397		795.3	
Initial Volume (wt) b/	0	0	0			781.1	
Net Volume (wt) b/	13	0	0	397		14.2	
Sample No.(s)						Silica Gel	
						Color	

Combined impinger contents, Sample No.
Liquid Level Marked Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 424.2

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed
Impinger Rinse: Sample No.
Liquid Level Marked
Sealed
Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed
Acetone Blank: Sample No.
Liquid Level Marked
Sealed
Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier Date Shipped:
Remarks:

Date of laboratory custody Seal(s) broken by
Personnel accepting custody Date broken
Remarks:

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP Outlet

Test Run Number ESP-O-[redacted]-1B(C)

Pollutant(s) in Sample ______

Task	Date	Time	Personnel	Remarks
Sampling	5-6-81	1323-1433	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site				
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-0-2-1

MRI Project Number 4892-L-03
Field Dates 5-1-81
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-1-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 Whited
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

NOMOGRAPH DATA

PLANT IDEAL

DATE 5-1-81

SAMPLING LOCATION ESP Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\,avg.}$	100 ~~100~~ ~~85~~
PERCENT MOISTURE IN GAS STREAM BY VOLUME assumed from ESP-I-3-1	% H_2O	18.9
BAROMETRIC PRESSURE AT METER, in. Hg 0830	P_m	28.92
STATIC PRESSURE IN STACK, in. Hg -6.4" H_2O ($P_m \pm 0.074$ STACK GAUGE PRESSURE in in. H_2O)	P_s	28.45
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	0.98
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	360
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.12
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	~~0.82~~ 0.79	
CALCULATED NOZZLE DIAMETER, in.	~~0.405~~ 0.41	
ACTUAL NOZZLE DIAMETER, in.	0.377	
REFERENCE Δp, in. H_2O	0.165	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal
Sampling Location ESP-O-2-1
Test Number ESP Outlet

Date 5-1-81
Initial CW

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	100
Pitot coefficient	Cp	0.84
Sampling time interval, minutes	θi	5
Mole fraction dry gas	Mf	0.81
Nozzle diameter, inches	Dn	.377
Barometric pressure, inches Hg	Pb	28.92
$\frac{5.168\ (100 + 460)\ (.84)\ (5)\ (.81)\ (.377^2)}{\sqrt{28.92}}$	K	260.21

FIELD DATA

PLANT Ideal
DATE 5-1-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Particulate
RUN NUMBER ESP-0-2-1
OPERATOR United
AMBIENT TEMPERATURE 68
BAROMETRIC PRESSURE 28.92
STATIC PRESSURE, (P_s) -6.4 "H_2O
FILTER NUMBER (s) 3

N →

4 3 2 1
O O O O
↑
Sample Point

SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. .377"
ASSUMED MOISTURE, % 18.9
SAMPLE BOX NUMBER 2 —
METER BOX NUMBER 2
METER $\Delta H_@$ 1.84
C FACTOR 0.82
PROBE HEATER SETTING —
HEATER BOX SETTING —
REFERENCE Δp 0.165

Leak CK: Initial at 15" Hg, CFM 0.000
Final at Hg, CFM

READ AND RECORD ALL DATA EVERY 5 MINUTES

$$VM = 260 \times \sqrt{\frac{Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 541.622 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0925											
	5	0930	544.495	544.60	0.10	1.1	1.2	365	68	68	5		
	10	0935	547.37	547.30	0.10	1.1	1.0	360	69	69	5		
	15		549.94	549.82	0.08	0.92	0.92	360	72	69	5		
	20	0945	552.51	552.41	0.08	0.92	1.0	360	75	69			
	25	0950	555.08	555.15	0.08	0.92	1.0	360	76	69			
	30	0955	557.31	557.38	0.06	0.79	0.79	360	77	68			
	35	0	559.54	—	0.06	0.79	0.78	360	79	70			
	40	1005	561.77	561.85	0.06	0.79	0.79	360	79	70			
	45	1010	564.20	564.1	0.07	0.82	~~0.80~~	350	79	72			
	50	1015	566.62	566.51	0.07	0.82	0.9	350	80	72			
	55	1020	569.22	569.39	0.08	0.92	0.99	350	80	74			
	60	1025	571.65	571.48	0.07	0.82	0.75	350	82	74			
	65	1030	574.08	573.72	0.07	0.82	0.85	355	81	74			
	70	1035	576.33	576.15	0.06	.79	.85	350	83	75			
	75	1040	578.76	578.74	0.07	0.82	0.90	345	83	75			
	80	1045	581.20	581.10	0.07	0.82	0.85	340	83	75			
	85	1050	583.64	583.77	0.07	0.82	0.88	340	85	79			
	90	1055	586.08	586.15	0.07	0.82	0.82	340	84	79			
	95	1100	588.14	588.10	0.05	0.56	0.50	340	84	79			
	100	1105	589.74	589.69	0.03	0.35	0.35	340	82	78			
	105		591.59	591.71	0.04	0.45	0.52*	340	82	80			
	110	1115	593.85	593.88	0.06	0.70	0.66	340	82	80			

COMMENTS:

*.52

EPA (Dur) 235
1 72

TRAVERSE POINT NUMBER	SAMPLING TIME min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3 Desired (593.85)	GAS METER READING (V_m), ft^3 Actual (593.88)	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	115	1120	595.92	596.05	0.05	0.55	0.55	340	83	79			
	120	1125	598.18	598.12	0.06	0.68	0.68	345	84	79			
	125	1130	600.25	600.13	0.05	.55	0.55	345	87	79			
	130	1135	602.68	602.50	0.07	.80	0.80	345	88	79			
	135	1140	605.11	605.02	0.07	.80	.85	350	89	79			
	140	1145	607.36	607.59	0.06	0.68	0.75	350	100	80	10		
	145	1150	609.61	609.8	0.06	0.68	0.64	345	110	87	7		
	150	1155	611.67	611.70	0.05	0.55	0.51	355	110	90	7		
	155	1200	613.72	613.70	0.05	0.55	0.54	355	110	90	7		
	160	1205	615.55	615.60	0.04	0.45	0.46	355	111	91	7		
	165	1210	617.59	617.55	0.05	0.55	0.53	355	110	90	7		
	170	1215	619.65	619.54	0.05	0.55	0.55	345	110	92	7		
	175	1220	621.91	.81	0.06	0.68	0.70	340	109	91			
	180	1225	623.97	623.403	0.05	0.55	0.60	340	110	91	8		
				V_m =	ΔP_s =		ΔH =	T_s		T_m			
				81.781	0.063		.744	349.4		82.9			

Run Number ESP-0-2-1 Date 5-1-81 Sampling Location ESP Outlet

Comments:

EPA (Dur) 236
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal   Date 5-1-81
Sampling Location ESP Outlet   Initial CL
Test Number ESP-O-2-1

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	349.4
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = .744 Pb = 28.92 Tm = 82.9 Vm = 81.781	Vm_{std}	76.99
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 23.7% ~~Assumed from Inlet data~~	Mf	~~.81~~ .763
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	30.72
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~28.30~~ 27.71
Static pressure in stack, absolute, in. Hg −6.4"H₂O (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.45
Stack velocity, fpm ΔPs = ~~.0~~.063 = .251 Cp = .84 $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	~~1084~~ 1,096
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.377
$\frac{1{,}039\ (349.4 + 460)(76.99)}{(\cancel{1084})(180)(28.45)(\cancel{.81})(.377^2)}$	% I	~~101.3~~ 106.4

1,096   .763

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal
Sample Location ESP Outlet
Sample Box No. —
Sample Type Particulate

Run No. ESP-0-2-1
Sample Date 5-1-81
Recovery Date
Cleanup Person

Filter No. 3
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

	1	2	3	4	5	SILICA GEL
Impinger Sequence						
Impinger Type[a]						
Impinger Solution						
Final Volume (wt)[b]	432					525.8
Initial Volume (wt)[b]	0					446.8
Net Volume (wt)[b]	432					79.0
Sample No.(s)						Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked　　Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 511

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed
Impinger Rinse: Sample No.
Liquid Level Marked
Sealed
Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed
Acetone Blank: Sample No.
Liquid Level Marked
Sealed
Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier　　Date Shipped:
Remarks:

Date of laboratory custody　　Seal(s) broken by
Personnel accepting custody　　Date broken
Remarks:

SAMPLE HANDLING LOG

Project Number 4892-L-02

Source Identification ESP Outlet

Test Run Number ESP-O-2-1

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5-1-81	0825 1225	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site	5-1-81	1230	Cobb	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-O-3-1

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP-Outlet
Sampling Date 5-2-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 Whited
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

MRI - Form PO (10/72)

NOMOGRAPH DATA

PLANT Ideal

DATE 5-2-81

SAMPLING LOCATION ESP Outlet Port #3

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	~~8~~ 108
PERCENT MOISTURE IN GAS STREAM BY VOLUME assumed from inlet data	% H_2O	18%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.91
STATIC PRESSURE IN STACK, in. Hg -6.4" H_2O (P_m ±0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.44
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	0.98
AVERAGE STACK TEMPERATURE, °F assumed from previous data	$T_{s\,avg.}$	355
AVERAGE VELOCITY HEAD, in. H_2O read at time of calculations	$\Delta p_{avg.}$	~~0.15~~ .24 0.15 ~~0.25~~
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR		0.83
CALCULATED NOZZLE DIAMETER, in.		~~0.398~~ .340
ACTUAL NOZZLE DIAMETER, in.		0.377
REFERENCE Δp, in. H_2O		0.16

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal Date 5-2-81
Sampling Location ESP Outlet Initial CW
Test Number ESP-0-3-1

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

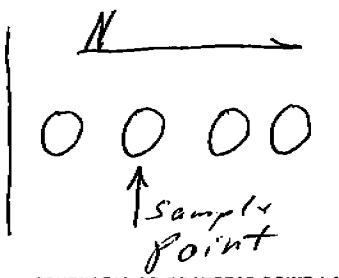
ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	108
Pitot coefficient	Cp	0.84
Sampling time interval, minutes	θi	10
Mole fraction dry gas	Mf	~~.83~~ .82
Nozzle diameter, inches	Dn	.377
Barometric pressure, inches Hg	Pb	28.91 ~~28.90~~
$\frac{5.168\ (108 + 460)\ (.84)\ (10)\ (.82)\ (.377^2)}{\sqrt{28.90}}$	K	527.95

FIELD DATA

PLANT Ideal
DATE 5-2-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Dust
RUN NUMBER ESP-0-3-1
OPERATOR Whited
AMBIENT TEMPERATURE
BAROMETRIC PRESSURE 28.91
STATIC PRESSURE, (P_s) -6.4" H_2O
FILTER NUMBER (s) 4



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. .377
ASSUMED MOISTURE, % 18
SAMPLE BOX NUMBER —
METER BOX NUMBER 5
METER $\Delta H_@$ 1.84
C FACTOR .83
PROBE HEATER SETTING —
HEATER BOX SETTING —
REFERENCE Δp 0.16

$VM = 527.95 \times \sqrt{\frac{Ps}{Ts + 460}}$

Leak CK: Initial at 15" Hg, CFM 0.000
Final at Hg, CFM ____

READ AND RECORD ALL DATA EVERY 10 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	GAS METER READING (V_m), ft^3 Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0930		163.555									
	10	0940	170.762	170.42	.15	1.8	2.8	345	80	80	7		
	20	0950	178.46	178.23	.17	1.9	2.0	340	85	77			
	30	1000	186.16	186.20	.17	1.9	2.2	345	87	78	5		70
	40	1010	193.37	193.48	.15	1.8	1.8	345	92	80	9		70
	50	1020	200.58	200.57	0.15	1.8	1.6	345	92	82	9		
	60	1030	207.52	207.53	0.14	1.6	1.6	350	92	83	9		75
	70	1040	214.48	—	0.14	1.6	1.6	345	93	84	12		75
	80	1050	221.42	221.32	0.14	1.6	1.6	350	94	85	15		
	90	1100	228.65	—	0.15	1.8	1.9	340	95	85	18		
	100	1110	235.86	~~235.400~~	.14	1.6	1.6	340	96	86	20		
	110	~~1120~~	END	235.410									
	120	~~1130~~											
	130	~~1140~~											
	140	~~1150~~											
	150	~~1200~~											
	160	~~1210~~											
	170	~~1220~~											
	180	1230											
				V_m	ΔP_s		ΔH	T_s		T_m			
				71.855	0.15		1.77	344.5		86.3			

COMMENTS:

EPA (Dur) 235
4/77

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Date 5-2-81
Sampling Location ESP Outlet Initial OL
Test Number ESP-O-3-1

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	344.5
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = 1.77 Vm 71.855 Tm 86.3 Pb = 28.91	Vm_{std}	~~67.355~~ 67.38
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ ~~(5.29)~~ collected 25.3% ~~24.4~~	Mf	~~.76~~ .747
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	30.72
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~27.67~~ 27.50
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) Ps = -6.4	Ps	~~28.43~~ 28.44
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ $\sqrt{\Delta Ps}$ = .3873 Cp = .84	Vs	~~1667.4~~ 1,692
Total sample time, minutes	θ	100
Nozzle diameter, inches	Dn	.377
$\frac{1{,}039\ (344.5 + 460)(\cancel{67.355}\ 67.38)}{(\cancel{1667})(100)(\cancel{28.43})(\cancel{.76})(.377^2)}$	% I	~~108.6~~ 110.2

1,692 28.44 .747

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-0-3-1
Sample Location ESP Outlet Sample Date 5-2-81
Sample Box No. ______ Recovery Date ______
Sample Type Dust Cleanup Person ______

Filter No. 4 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL
Impinger Type[a]						
Impinger Solution						
Final Volume (wt)[b]	403					543.5
Initial Volume (wt)[b]	0					463.9
Net Volume (wt)[b]	403					79.6
Sample No.(s)						Silica Gel
						Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 482.6

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4882-L-03

Source Identification ESP Outlet

Test Run Number ESP-0-3-1

Pollutant(s) in Sample Dust

Task	Date	Time	Personnel	Remarks
Sampling	5-2-81	0930 To 1110	Whited	
Probe Technician		"	Whited	
Meter Technician		"	Whited	
Other				
Transport of Train to Cleanup Site		1130	Cobb	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-0-4-1

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-2-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 Whited
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

NOMOGRAPH DATA

PLANT Ideal

DATE 5-2-81

SAMPLING LOCATION ESP- Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	95
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	.23
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.83
STATIC PRESSURE IN STACK, in. Hg -6.4 (P_m±0.074STACK GAUGE PRESSURE in in. H_2O)	P_s	28.36
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.98
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	355
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	~~.42~~ .40
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	0.76	
CALCULATED NOZZLE DIAMETER, in.	.305	
ACTUAL NOZZLE DIAMETER, in.	~~.317~~ .304	
REFERENCE Δp, in. H_2O	.4	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ided Date 5-2-81

Sampling Location ESP OutLet Initial CC

Test Number ESP- O-4-1

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

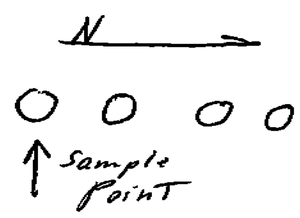
ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	95
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	10
Mole fraction dry gas	Mf	.76
Nozzle diameter, inches	Dn	~~.377~~ .304
Barometric pressure, inches Hg	Pb	28.83
$\dfrac{5.168\ (95 + 460)\ (.84)\ (10)\ (.76)\ (\cancel{.307}\ .304^2)}{\sqrt{28.83}}$	K	315.16

FIELD DATA

PLANT Ideal
DATE 5-2-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Dust
RUN NUMBER ESP-0-4-1
OPERATOR Uhl+il
AMBIENT TEMPERATURE 85
BAROMETRIC PRESSURE 28.83
STATIC PRESSURE, (P_s) -6.4" H_2O
FILTER NUMBER (s) 5



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. .304 #12
ASSUMED MOISTURE, % 23%
SAMPLE BOX NUMBER —
METER BOX NUMBER 5
METER $\Delta H_@$ 1.84
C FACTOR ~~.78~~ .76
PROBE HEATER SETTING —
HEATER BOX SETTING —
REFERENCE Δp .4

Leak CK: Initial at 15" Hg, CFM 0.000
Final at Hg, CFM

READ AND RECORD ALL DATA EVERY 10 MINUTES

$VM = 315.16 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1538	237.813										
	10	1548	244.88	245.69	.40	1.8	1.9	330	85	85	5½		100
	20	1558	251.82	252.80	.38	1.7	2.1	320	97	87	7		
	30	1608	258.64	259.81	.37	1.8	1.8	335	98	88	6½		
	40	1618	265.53	266.54	.38	1.8	1.6	335	98	88	6½		
	50	1628	272.42	272.45	.38	1.8	1.4	~~345~~	99	90	5		
	60	1638	279.62	279.81	.42	2.0	2.1	330	102	91	8		
	70	1648	286.78	286.92	.41	2.0	1.8	330	109	94	7		
Down	80	1658	293.76	293.72	.39	1.9	1.5	335	109	95	7		
↓	90	1708	301.01	301.04	.42	2.0	1.8	335	106	95	7		
↑ on	100	1730	308.27	308.39	.43	2.0	2.0	345	108	95	9		
1' 33 Sec	110	1740	315.38	315.00	.41	1.9	1.6	345	109	95	11		
For Silica	120	1750	322.60	322.64	.42	2.0	2.1	345	109	96	15		
Gell	130	1800	329.60	329.77	.40	1.8	1.8	350	114	97	14		
	140	1810	336.43	336.61	.38	1.8	1.6	348	114	98	13		
	150	1820	343.30	—	.38	1.8	1.5	340	112	98	12		
	160	1830	350.41	350.37	.41	1.9	1.8	335	112	98	14½		
	170	1840	357.61	357.83	.42	2.0	2.0	345	113	98	16		
	180	1850	364.46	364.565	.38	1.8	1.6	340	113	98	14		
			END										
			V_m =	126.75	.399	ΔH =	1.78	T_s=338	T_m=	99.8			

COMMENTS:

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant *Ideal* | Date *5-2-81*
Sampling Location *ESP Outlet* | Initial *[illegible]* MDH
Test Number *ESP-O-4-1*

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	338
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ Tm = 99.8 Pb = 28.83 ΔH = 1.78 Vm = 126.75	Vm_{std}	115.67
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 27.7% ~~Based on moisture data from previous run~~	Mf	.723
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	~~31.15~~ 31.15 ~~30.72~~
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.51
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.36
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP = .399	Vs	2,752
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.304
$\frac{1{,}039\,(338 + 460)(115.67)}{(2{,}752)(180)(28.36)(.723)(.304^2)}$	% I	102.2

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal　　Run No. ESP-0-4-1
Sample Location ESP Outlet　　Sample Date 5-2-81
Sample Box No. ______　　Recovery Date ______
Sample Type ______　　Cleanup Person ______

Filter No. 5
Sample No. ______
Sample Material Description ______

	MOISTURE AND/OR SAMPLE					SILICA GEL	
Impinger Sequence	1 condenser	2	3	4	5		
Impinger Type a/						used two S.G cartridges	
Impinger Solution							
Final Volume (wt) b/	413	436				496.8	520.2
Initial Volume (wt) b/	0	0				470.1	454.1
Net Volume (wt) b/	413	436				26.7	66.1
Sample No.(s)						Silica Gel	
Combined impinger contents, Sample No.			~~849~~			Color	

Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm ~~42.8 + 436 =~~ 92.8 + 849 = 941.8g

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP Outlet

Test Run Number ESP-0-4-1

Pollutant(s) in Sample Dust

Task	Date	Time	Personnel	Remarks
Sampling	5-2-81	1538-1850	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site	5/2/81	1855	E. Whited	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-O-1-2

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-4-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 Whited
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

NOMOGRAPH DATA

PLANT Ideal

DATE 5-4-81

SAMPLING LOCATION ESP Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	105
PERCENT MOISTURE IN GAS STREAM BY VOLUME assumed Average Moisture	% H_2O	27%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.67
STATIC PRESSURE IN STACK, in. Hg −6.4" H_2O ($P_m \pm 0.074$ STACK GAUGE PRESSURE in in. H_2O)	P_s	28.20
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	0.98
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	360
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.11
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	0.68	
CALCULATED NOZZLE DIAMETER, in.	0.435	
ACTUAL NOZZLE DIAMETER, in.	0.440	
REFERENCE Δp, in. H_2O	0.108	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant *Ideal* Date *5-4-81*
Sampling Location *ESP Outlet* Initial *CL*
Test Number *ESP-0-1-2*

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

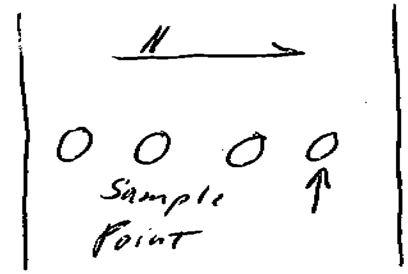
Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	*105*
Pitot coefficient	Cp	*.84*
Sampling time interval, minutes	θi	*10*
Mole fraction dry gas	Mf	*.73*
Nozzle diameter, inches	Dn	*.440*
Barometric pressure, inches Hg	Pb	*28.67*
$\frac{5.168\ (105 + 460)\ (.84)\ (10)\ (.73)\ (.44^2)}{\sqrt{28.67}}$	K	*647.39*

WATERPROOF PAPER

FIELD DATA

PLANT Ideal
DATE 5-4-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE E Dust Mass
RUN NUMBER ESP-0-1-2
OPERATOR Whited
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.67
STATIC PRESSURE (P_s) -6.4" H_2O
FILTER NUMBER(s) 6



Schematic of Traverse Point Layout

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. 0.44
ASSUMED MOISTURE, % 27%
SAMPLE BOX NUMBER —
METER BOX NUMBER 9
TEMPERATURE ~~METER~~ NO. 105
METER ΔH@ 1.84
METER CORRECTION
C FACTOR 0.68
REFERENCE Δp 0.108

LEAK CK: Initial at 15" Hg, CFM 0.00
Final at ____ Hg, CFM ____

Read and Record All Data Every 10 Minutes

$VM = 647.388 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0840		237.520									
Down 0902	10	0850	244.67	242.1	.1	0.70	1.70	360	72	72	3		60
	20	0900	249.73	247.17	0.05	.85	1.0	360	75	73	5		65
	30	1113	256.10	261.3	0.08	1.4	1.8	365	81	74	6		70
on 1104	40	1123	263.69	267.3	0.11	1.9	1.5	340	90	82	10		90
(1143	50	1133	270.92	272.8	.1	1.8	1.4	340	95	85	10		90
off)	60	1143	278.23	278.93	.1	1.8	1.4	340	100	88	11		95
	moisture measurement												
1146 on	70	1156	285.10	285.14	.09	1.5	1.4	340	95	990	13		90
	80	1206	292.33	292.22	.00	1.8	1.8	340	104	95	15 1/2		90
	90	1216	298.78	298.60	.08	1.4	1.45	345	110	95	14 1/4		95
off)	10	1226	305.62	305.32	.09	1.5	1.6	345	114	100	16		95
(1227 1235 on)	110	~~1243~~	312.47	313.04	.12	2.1	2.3	345	110	100	15		95
	120	1253	320.40	320.00	.12	2.1	1.8	340	119	104	15		100
1255 off	1257 on	moisture		measu-	vmit .09	~~1.5~~	~~1.6~~	~~345~~	~~120~~	~~104~~	~~15~~		~~102~~
	130	1305	327.24	327.00	.09	1.5	1.6	345	120	104	15		102
off 1328	140	1315	334.11	333.80	.09	1.5	1.6	340	120	105	15		104
	150	1325	340.16	339.90	.07	1.2	1.3	340	120	105	16		104
on 1327	160	1337	347.03	346.79	.09	1.5	1.6	340	120	110	17		65
1338 off	170		354.27	351.752	.10	1.8	1.8	345	120	110	21		95
1341 on	~~180~~												
	off 1347												
			Vm =	114.232	ΔP: .095	ΔH =	1.59	Ts: ~~326~~ 345	Tm =	98.8			

COMMENTS:

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Date 5-4-81
Sampling Location ESP Outlet Initial CW
Test Number ESP-O-2-2

Isokinetic equation:

$$\% \ I = \frac{1,039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	345 ~~326~~
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H avg}{13.6}\right)}{Tm+460}$ ΔH = 1.59 Pb = 28.67 Vm = 114.232 Tm + 460 = 558.8 ~~553.3~~	Vm_{std}	~~104.81~~ 103.81
Mole fraction dry gas, $\frac{100-\% \ H_2O}{100}$ % H_2O = 23.3	Mf	~~.77~~ .767
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	30.91
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.99
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) -6.4	Ps	28.2
Stack velocity, fpm $5,128.8 \ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps x Ms}}$ ΔP = .1095 Cp = .84	Vs	~~1291~~ 1343
Total sample time, minutes	θ	~~180~~ 170
Nozzle diameter, inches	Dn	.44
$\frac{1,039 \ (345 \ \cancel{326} + 460)(103.81)}{(\cancel{1291} \ 1343)(28.2)(\cancel{180} \ 170)(\cancel{.769} \ .767)(.44^2)}$	% I	~~87.6~~ 88.8 90.8

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal
Run No. ESP-0-2-1
Sample Location ESP OUTLET
Sample Date
Sample Box No.
Recovery Date
Sample Type
Cleanup Person

Filter No. 6
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

	1	2	3	4	5
Impinger Sequence	1	2	3	4	5
Impinger Type[a/]					
Impinger Solution					
Final Volume (wt)[b/]	247	219	110	28	
Initial Volume (wt)[b/]	0	0	0		
Net Volume (wt)[b/]	247	219	110	28	
Sample No.(s)					

Combined impinger contents, Sample No.
Liquid Level Marked
Container(s) Sealed

SILICA GEL

485.4	459.5	464.2
447.3	451.0	446.5
38.1	8.5	17.7

Silica Gel Color 64.3

Description of Impinger Solution
Total Moisture, gm 668.3

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier
Date Shipped:
Remarks:

Date of laboratory custody
Seal(s) broken by
Personnel accepting custody
Date broken
Remarks:

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Outlet

Test Run Number ESP-O-1-2

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5-4-81	0840 to 1347	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site				
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-O-Z-2 B METHOD 17

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP OUTLET
Sampling Date 5-6-81

FIELD CREW

Crew Chief		Hansen
Testing Engineer	1	Whited
	2	
	3	
Engr. Technician	1	
	2	
	3	
Lab Technician	1	
	2	
	3	
Process Engineer	1	
	2	
Other	1	
	2	

NOMOGRAPH DATA

PLANT Ideal

DATE 5-6-81

SAMPLING LOCATION ESP OuTLet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	100 ~~330~~
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	27
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.87
STATIC PRESSURE IN STACK, in. Hg (P_m ± 0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.90
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.98
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	315 ~~330~~
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.1
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	.70	
CALCULATED NOZZLE DIAMETER, in.	.42	
ACTUAL NOZZLE DIAMETER, in. #27	~~377~~ .440	
REFERENCE Δp, in. H_2O	0.1	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal

Sampling Location ESP-Outlet

Test Number ESP-0-2-2+B

Date 5-8-81

Initial CL

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

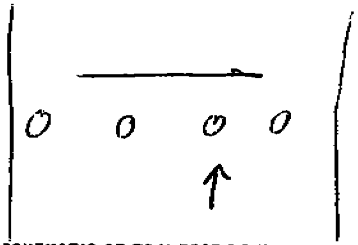
ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	100
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	10
Mole fraction dry gas	Mf	.77
Nozzle diameter, inches	Dn	.44
Barometric pressure, inches Hg	Pb	28.87
$\frac{5.168\ (100 + 460)\ (.84)\ (10)\ (.77)\ (.44^2)}{\sqrt{28.87}}$	K	674.47

FIELD DATA

PLANT Ideal
DATE 5-6-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE
RUN NUMBER ESP-0-2-2 B
OPERATOR White
AMBIENT TEMPERATURE 58
BAROMETRIC PRESSURE 28.87
STATIC PRESSURE, (P_s) -6.4
FILTER NUMBER (s) 10



SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. .44
ASSUMED MOISTURE, % 27
SAMPLE BOX NUMBER 9
METER BOX NUMBER 9
METER $\Delta H_@$ 1.84
C FACTOR .70
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp .1

Leak CK: Initial at 15" Hg, CFM 0.003
Final at Hg, CFM

READ AND RECORD ALL DATA EVERY 10 MINUTES

$VM = 674.47 \times \sqrt{\frac{Ps}{Ts + 460}}$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0905		513.973									
	10	0905	521.63	521.57	.10	1.9	1.8	315	58	58	14		49
	20	0925	528.55	528.02	.08	1.5	1.5	300	72	60	13½		50
	30	935	535.25	534.98	.08	1.5	1.7	305	79	65	13½		50
	40	0745	542.28	542.29	.09	1.7	2.0	310	85	67	13½		52
	50	0955	548.70	548.65	.07	1.35	1.3	310	90	72	12		55
	60	1005	555.32	555.38	.08	1.5	1.5	312	85	75	12		55
	70	1015	562.35	562.30	.09	1.7	1.7	310	90	85	15		55
	80	1025	569.00	569.10	.08	1.5	1.5	305	100	90	14		60
	90	1035	76.05	576.10	.09	1.75	1.70	305	100	84	15		60
	100	1045	582.68	582.82	.08	1.5	1.5	310	110	92	14		
	110	1055	589.31	589.23	.08	1.5	1.3	310	110	90	13		58
	120	1005	596.31	596.27	.09	1.75	1.7	315	110	90	15		58
	130	1115	603.34	603.28	.09	1.75	1.75	310	110	101	16		55
	140	1125	610.37	610.37	.09	1.75	1.75	310	110	101	16½		
	~~150~~ 149	1135	617.76	617.030	.10	1.9	1.85	315	110	97			
	~~160~~	1145											
	~~170~~	1155											
	~~180~~	1005											
						ΔH=	1.64	$\bar{T}_s$= 309.5		T_m = 88.3			
					ΔP= .086								
			Vm =	103.057									

COMMENTS:

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal

Date 5-6-81

Sampling Location ESP - Outlet

Initial ~~eo~~ MOH

Test Number ESP-0-2-2-B

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	309.5
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH=1.64 Pb=28.87 Vm=103.057 Tm=88.3	Vm_{std}	96.12
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 30.6% from This run	Mf	.694
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2$ + $\%CO \times 0.28$)	Md *	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.06
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.40
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP=.086	Vs	1,264
Total sample time, minutes	θ	149
Nozzle diameter, inches	Dn	.440
$\frac{1{,}039\,(309.5 + 460)(96.12)}{(1{,}264)(149)(28.40)(.694)(.440^2)}$	% I	106.9

* Md from 5/5/81 at 1830 at outlet

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal

Sample Location ESP - Outlet

Sample Box No. ______

Sample Type ______

Run No. ESP-0-2-2B

Sample Date 5-6-81

Recovery Date ______

Cleanup Person ______

Filter No. 10

Sample No. ______

Sample Material Description ______

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	375	75	0	420		794.8
Initial Volume (wt) b/	0	0	0	0		765.8
Net Volume (wt) b/	375	75		420		29.0
Sample No.(s)						

Silica Gel Color ______

Combined impinger contents, Sample No. ______

Liquid Level Marked ______ Container(s) Sealed ______

Description of Impinger Solution ______

Total Moisture, gm 899

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______

b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______

Carrier ______ Date Shipped: ______

Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______

Personnel accepting custody ______ Date broken ______

Remarks: METHOD 17

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP Outlet

Test Run Number ESP-0-2-2-B

Pollutant(s) in Sample ____________

Task	Date	Time	Personnel	Remarks
Sampling	5-6-81	0905- ~~1005~~ 1135	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site	5/6/81	1140	M. Hansen	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-0-3-2

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-5-81

FIELD CREW

Crew Chief Hansen

Testing Engineer
1 Whited
2
3

Engr. Technician
1
2
3

Lab Technician
1
2
3

Process Engineer
1
2

Other
1
2

MRI - Form PO (10/72)

NOMOGRAPH DATA

PLANT Ideal

DATE 5-5-81

SAMPLING LOCATION ESP- Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84	
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	~~110~~ 90	
PERCENT MOISTURE IN GAS STREAM BY VOLUME assume from method 17, ESP-0-2-2	% H_2O	~~23~~	38%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.82	
STATIC PRESSURE IN STACK, in. Hg -6.4" ($P_m \pm 0.074$ STACK GAUGE PRESSURE in in. H_2O)	P_s	28.35	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.98	
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	~~345~~	~~[illegible]~~ 315 actual at time of test
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	~~.40~~	.15
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$		
C FACTOR	~~.76~~ .52		
CALCULATED NOZZLE DIAMETER, in.	.305/~~.310~~.425		
ACTUAL NOZZLE DIAMETER, in.	.304		
REFERENCE Δp, in. H_2O	~~.304~~ .56		

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant *Ideal* Date *5-5-81*

Sampling Location *ESP Outlet* Initial *CO*

Test Number *ESP-O-3-2*

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

% H2O Meth. 17 ESP-0-2

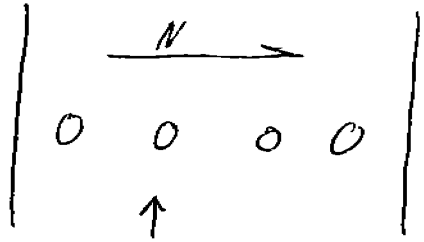
Assumed average meter temperature, °F	Tm_{avg}	~~110~~	90
Pitot coefficient	Cp	.84	
Sampling time interval, minutes	θi	10	
Mole fraction dry gas ~~28%~~ *assumed ESP-0-2-2*	Mf	~~.72~~	.62
Nozzle diameter, inches	Dn	~~.304~~	.304 ~~.287~~
Barometric pressure, inches Hg	Pb	28.82	
$\frac{5.168\ (\cancel{110}\ 90 + 460)\ (.84)\ (10)\ (\cancel{.72}\ .62)\ (.304^2)}{\sqrt{28.82}}$	K	~~322.8~~	~~775.3~~ 254.83

WATERPROOF PAPER

FIELD DATA

Method 17

PLANT Ideal
DATE 5-5-81
SAMPLING LOCATION ESP-Outlet
SAMPLE TYPE
RUN NUMBER ESP-O-7-2
OPERATOR Whited
AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 28.82
STATIC PRESSURE (P_s) -6.1 "H2O
FILTER NUMBER(s) 8



Schematic of Traverse Point Layout
Read and Record All Data
Every 10 Minutes

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. .304
ASSUMED MOISTURE, % ~~23~~ 38%
SAMPLE BOX NUMBER -
METER BOX NUMBER 5
TEMPERATURE METER NO.
METER ΔH@ 1.89
METER CORRECTION
C FACTOR .76
REFERENCE Δp ~~.040~~ .156

LEAK CK: Initial at 15" Hg, CFM .000
Final at 6" Hg, CFM 0.000

$$VM = \frac{\cancel{327.88}\ 273.27\ 254.8}{} \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0855		512.600									
	10	0905	517.16	517.20	1.5	.75	.75	320	80	80	7.0		70
	20	0915	521.50	521.72	.14	.70	.70	340	84	82	6.0		70
	30	0925	[illegible]	—	.14	.7	.68	330	88	82	6		[illegible]
	40	0935	530.81	530.83	.18	.85	.85	330	89	83	7		62
	50	0945	535.77	—	.18	.85	.85	325	89	84	7		
	60	0955	540.77	41.10	.18	.85	.72	315	90	85	7		
	70	1005	545.45	545.90	.17	.80	~~.80~~	315	90	60	8.5		
	80	1015	550.26	550.87	.18	.87	.80	320	90	85	7		58
	90	1025	554.42	545.03	.18	.58	.55	315	92	85	6		58
	100	1035	558.90	559.13	.19	.63	.57	315	94	87	6		55
	110	1045	562.75	563.20	.17	.62	.57	315	94	88	6		
	120	1055	566.80	567.12	.17	.62	.55	315	94	88			
	130	1105	570.84	571.03	.17	.62	.54	313	92	88	6		
	~~140~~	/	574.89	/	~~.14~~	~~.48~~	~~.40~~	~~315~~	~~92~~	~~88~~	~~6~~	/	53
	150	1115	574.59	579.03	.17	.62	.55	315	92	88	6		53
	160	1125	578.44	578.85	.15	.48	.44	315	92	88	6		53
	170	1135	582.10	582.47	.16	.50	.47	307	91	88	6		55
	180	1145	585.42	585.790	.13	.42	.37	305	91	88	6		53
Σ	170 minutes												
				73.18	.165		.647	318		87.7			

COMMENTS:

¥.78

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant: Ideal
Sampling Location: ESP Outlet
Test Number: ESP-O-3-2
Date: 5-5-81
Initial: CV

Isokinetic equation:

$$\% I = \frac{1,039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	318
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = .647$ $Pb = 28.82$ $Tm = 87.7$ $Vm = 73.18$	Vm_{std}	68.04
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 29.3% Calculated From This Run ≈ .7	Mf	~~.7~~ ~~.62~~ .707
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	30.90
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~27.03~~ 27.12
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.35
Stack velocity, fpm $5,128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ $\Delta P = .165$	Vs	~~1763~~ 1,760
Total sample time, minutes	θ	170
Nozzle diameter, inches	Dn	.304
$\frac{1,039\ (318 + 460)(68.04)}{(\cancel{1763}\ 1760)(170)(28.35)(\cancel{.62}\ .707)(.304^2)}$	% I	~~99.07~~ 99.2

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal
Run No. ESP-0-3-2
Sample Location ESP Outlet
Sample Date 5-5-81
Sample Box No. ____
Recovery Date ____
Sample Type ____
Cleanup Person ____

Filter No. 8
Sample No. ____
Sample Material Description ____

MOISTURE AND/OR SAMPLE 1st Condenser

						SILICA GEL	
Impinger Sequence	1	2	3	4	5		
Impinger Type a/							
Impinger Solution							
Final Volume (wt) b/	240	153	439			820.6	
Initial Volume (wt) b/	100	100	0			804.6	
Net Volume (wt) b/	140	3	439			16.0	
Sample No.(s)						Silica Gel	
Combined impinger contents, Sample No.						Color	

Liquid Level Marked ____ Container(s) Sealed ____
Description of Impinger Solution ____
Total Moisture, gm 598

a/ S = Greenburg-Smith standard, M = Modified, O = Other ____
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ____
Liquid Level Marked ____
Sealed ____
Impinger Rinse: Sample No. ____
Liquid Level Marked ____
Sealed ____
Water Blank: Sample No. ____
Liquid Level Marked ____

Dry Catch: Sample No. ____
Description ____
Sealed ____
Acetone Blank: Sample No. ____
Liquid Level Marked ____
Sealed ____
Filter Blank: Sample No. ____
Sealed ____

Sample Disposition ____
Carrier ____ Date Shipped: ____
Remarks: ____

Date of laboratory custody ____ Seal(s) broken by ____
Personnel accepting custody ____ Date broken ____
Remarks: ____

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP Outlet

Test Run Number ESP-O-3-2

Pollutant(s) in Sample ____________

Task	Date	Time	Personnel	Remarks
Sampling	5-5-81	0855 To 1145	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		1200	Whited	
Train Disassembly	5-5-81		J Pawlowski	
Train Cleanout	5-5-81		J Pawlowski	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-O-4-2

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP-Ou~~t~~tet
Sampling Date 5-5-81

FIELD CREW

Crew Chief Hausen

Testing Engineer
1 Whited
2
3

Engr. Technician
1
2
3

Lab Technician
1
2
3

Process Engineer
1
2

Other
1
2

NOMOGRAPH DATA

PLANT Ideal

DATE 5-5-81

SAMPLING LOCATION ESP - OUTLET

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\,avg.}$	95
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	30
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.88
STATIC PRESSURE IN STACK, in. Hg (P_m ±0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.41
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.98
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	325
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.40
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	0.65	
CALCULATED NOZZLE DIAMETER, in.	.315	
ACTUAL NOZZLE DIAMETER, in.	.304	
REFERENCE Δp, in. H_2O	.44	

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal Date 5-5-81
Sampling Location ESP-Outlet Initial CL
Test Number ESP-0-4-2

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where:
$$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

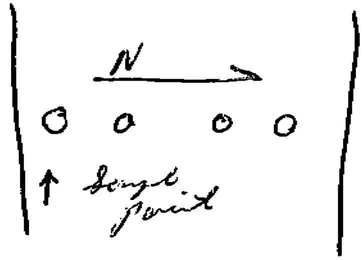
Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	95
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	10
Mole fraction dry gas	Mf	.70
Nozzle diameter, inches	Dn	.304
Barometric pressure, inches Hg	Pb	28.88
$\frac{5.168\ (95 + 460)\ (.84)\ (10)\ (.7)\ (.304^2)}{\sqrt{28.88}}$	K	290.0

WATERPROOF PAPER

FIELD DATA

PLANT Ideal
DATE 5-5-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE
RUN NUMBER ESP0-4-2
OPERATOR Whitfield
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.88
STATIC PRESSURE (P_s) -6.4
FILTER NUMBER(s) 9



Schematic of Traverse Point Layout

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. .304
ASSUMED MOISTURE, % 30
SAMPLE BOX NUMBER
METER BOX NUMBER 5
TEMPERATURE METER NO. Unit 2
METER ΔH@ 1.84
METER CORRECTION
C FACTOR .65
REFERENCE Δp .44

LEAK CK: Initial at 15" Hg, CFM 0.005
Final at 11 Hg, CFM 0.005

Read and Record All Data Every 10 Minutes

$VM = 290.03 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 585.815		VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
			Desired	Actual		DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	0	1526											
	10	1536	592.04	592.44	.35	1.5	1.5	300	83	83	7		70
	20	1546	598.26	597.11	.35	1.5	1.2	300	100	90	6		65
	30	1556	604.55	604.18	.36	1.5	1.4	305	105	90	9		
	40	1606	610.73	610.66	.35	1.4	1.4	305	119	98	9		55
	50	1606	617.02	617.29	.36	1.5	1.5	305	122	102	10		60
	60	1626	623.18	623.46	.35	1.5	1.3	315	120	100	9		62
	70	1636	629.69	629.88	.36	1.55	1.3	305	120	105	9		
	80	1646	636.21	635.95	.36	1.55	1.4	305	116	110	8		
	90	1656	642.53	642.22	.35	1.5	1.45	330	113	111	9		64
	100	1706	648.77	648.60	.33	1.4	1.4	307	113	112	9		64
	110	1716	655.10	655.02	.34	1.4	1.4	305	113	112	9		69
	120	1726	661.53	661.46	.34	1.4	1.4	302	115	112	10		65
	130	1736	667.77	667.85	.33	1.4	1.4	305	118	112	10		67
	140	1746	673.91	674.13	.33	1.4	1.35	330	119	113	11		
	150	1756	680.10	680.28	.32	1.4	1.2	318	119	117	11		69
	160	1806	686.37	686.30	.34	1.4	1.2	320	119	118	10		71
	170	1816	692.51	692.41	.33	1.4	1.3	330	119	114	10		74
	180	1826	698.72	698.702	.34	1.4	1.35	335	118	110	10		74
				112.887	.344		1.352	312.89		109.97			

COMMENTS:

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Date 5-5-81
Sampling Location ESP Outlet Initial ec
Test Number ESP-0-4-2

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	312.9	
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = 1.35 Vm = 112.887 Tm = 109.97 Pb = 28.88	Vm_{std}	101.25	
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 27.6% Calculated	Mf	.72	
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.05	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~27.33~~	27.40
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.41	
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔPs = .344	Vs	~~1604~~ ~~2515~~	2,518
Total sample time, minutes	θ	180	
Nozzle diameter, inches	Dn	.304	
$\frac{1{,}039\,(312.9 + 460)(101.25)}{(\cancel{1604})(180)(28.41)(.72)(.304^2)}$ ~~2515~~ 2,518	% I	~~95~~ 94.9	

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant: Toleal

Sample Location: ESP Outlet

Sample Box No.

Sample Type

Run No.: ~~5-5-81~~ ESP-O-4-2

Sample Date: 5-5-81

Recovery Date

Cleanup Person

Filter No.: 9

Sample No.

Sample Material Description

MOISTURE AND/OR SAMPLE

	1	2	Condenser 3	4	5	SILICA GEL	
Impinger Sequence	1	2	3	4	5		
Impinger Type a/							
Impinger Solution							
Final Volume (wt) b/	380	79	325			815.8	
Initial Volume (wt) b/	0	0	0			780	
Net Volume (wt) b/	380	79	325			35.8	
Sample No.(s)	~~300~~	'					

Combined impinger contents, Sample No.

Silica Gel Color

Liquid Level Marked

Container(s) Sealed

Description of Impinger Solution

Total Moisture, gm: 819.8

a/ S = Greenburg-Smith standard, M = Modified, O = Other

b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition

Carrier

Date Shipped:

Remarks:

Date of laboratory custody

Personnel accepting custody

Seal(s) broken by

Date broken

Remarks:

SAMPLE HANDLING LOG

Project Number 4892-L-~~03~~

Source Identification ESP OUTLET

Test Run Number ESP-0-4-2

Pollutant(s) in Sample ______

Task	Date	Time	Personnel	Remarks
Sampling	5-5-81	1526 To 1826	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		1845	Whited	
Train Disassembly	5-5-81		J. Pavlovis	
Train Cleanout	5-5-81		J. Pavlovis	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

I-2-2 EPA Method 3 - Gas Analysis for Carbon Dioxide, Oxygen, Excess Air, and Dry Molecular Weight

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Ideal Cement
DATE 4-28-81
SAMPLING TIME (24-hr CLOCK) 1500 hours
SAMPLING LOCATION ESP Outlet North kiln
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Grab
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 85%
OPERATOR Whited

COMMENTS: gas sample taken at 4½' inside duct, at port number 3

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	14½%		15½%		15		15.0 %	44/100	6.6
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	8		8		8.		8.0%	32/100	2.56
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							77%	28/100	21.56
								TOTAL	30.72

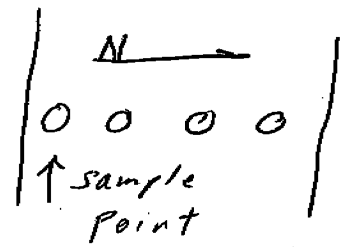
I-239

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Ideal
DATE 5-2-81
SAMPLING TIME (24-hr CLOCK) 2120 hours
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Grab
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 85 °F
OPERATOR Whited

COMMENTS:



RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	17		18		18		17.67	44/100	7.77
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	9.0		8.0		8.0		8.33	32/100	~~2.66~~ 2.67
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							74	28/100	20.72
								TOTAL	~~31.75~~ 31.16

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Ideal Cement Co.
DATE 5/4/81
SAMPLING TIME (24-hr CLOCK) 2141
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) GRAB
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 80°F
OPERATOR E. Whited

COMMENTS: Gas sample taken from ESP Outlet Port No. 4, at 4'6" into duct.

GAS \ RUN	1 ACTUAL READING	1 NET	2 ACTUAL READING	2 NET	3 ACTUAL READING	3 NET	AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
CO_2	17		16.5		16.5		16.67	44/100	7.33
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	7		5		5.5		5.83	32/100	1.87
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							77.5	28/100	21.70
								TOTAL	30.90

(Copied from original)

I-241

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Ideal

DATE 5-5-81

SAMPLING TIME (24-hr CLOCK) 1830

SAMPLING LOCATION ESP Outlet

SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS, GRAB) Grab

ANALYTICAL METHOD Fyrite

AMBIENT TEMPERATURE 60 °F

OPERATOR Whited

COMMENTS: Sample was pulled from 4'6" inside port #4.

RUN / GAS	1 ACTUAL READING	1 NET	2 ACTUAL READING	2 NET	3 ACTUAL READING	3 NET	AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
CO_2	17%		17½%		16½		17%	44/100	7.48
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	9%		8%		8%		8.33	32/100	~~2.66~~ 2.67
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)								28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							74.67	28/100	20.91
								TOTAL	~~31.05~~ 31.06

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Ideal
DATE 5/6/81
SAMPLING TIME (24-hr CLOCK) 2100
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) GRAB
ANALYTICAL METHOD Fyrite
AMBIENT TEMPERATURE 60°F
OPERATOR E. Whited

COMMENTS: Sample taken at quadrant #2 at 4'6" into the flue.

GAS \ RUN	1 ACTUAL READING	1 NET	2 ACTUAL READING	2 NET	3 ACTUAL READING	3 NET	AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
CO_2							19.0	44/100	8.36
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)							8.0	32/100	2.56
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)							0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							73.0	28/100	20.44
								TOTAL	31.36

EPA (Dur) 230
4/72

I-2-3 Particle Sizing - Andersen Mark III Impactor with 15 μm Preseparator

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP O-1-1 (C)

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5/6/81

FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	E. Whited
	2	
	3	
Engr. Technician	1	
	2	
	3	
Lab Technician	1	J. Pavelonis
	2	D. Olson
	3	
Process Engineer	1	F. Hoffmeister
	2	
Other	1	
	2	

ANDERSEN SAMPLING CALCULATIONS

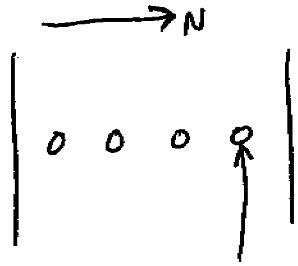
Plant Ideal Date 5/6/81
Sampling Location ESP Outlet Initial MDH
Test No. ESP-O-1-1 (C)

Velocity head at sampling location, in. H_2O	ΔPs	.11
Stack temperature at sample point, °F	Ts	~~340~~ ~~330~~ 340
Barometric pressure, in. Hg	Pb	28.82
Static pressure in stack, in. Hg −6.4 (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.35
Percent moisture in gas stream by volume Assumed From ESP-O-H-C on 5/6/81	% H_2O	30.8
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.692
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.03
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	1,460
Calculated nozzle diameter, in. Fs = .54 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.260
Actual nozzle diameter, in. 6-7.0	D_{n_a}	.275
Assumed meter temperature, °F	Tm	90
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	.253

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5/6/81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Particulate Mk III
RUN NUMBER ESP-O-1-1(C)
OPERATOR E. White
AMBIENT TEMPERATURE 65°F
BAROMETRIC PRESSURE 28.82
STATIC PRESSURE, (P_s) -6.4
Filter Set 12

Leak CK: Inital at 15" Hg, CFM 0.000
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Meter Box 9

Calculated ACFM (desired) ~~.275~~ .253
Probe Tip Diameter .275
CO_2 17%
O_2 8.33%
CO 0
N_2 74.67
% H_2O 30.8 assumed

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 666.000 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1635											
	10	1645	668.53	668.35	.09		.18	325	75	75	4		70
	20	1655	671.06	670.95	.10		.19	325	79	78	4		58
	30	1705	673.59	673.25	.08		.18	325	80	80	4		52
	40	1715	676.12	675.92	.09	.18	.20	325	89	80			
	50	1725	678.65	678.45	.08		.19	325	90	85			52
	60	1735	681.18	681.09	.09		.20	330	92	86	4		52
	70	1745	683.71	683.70	.10		.19	325	92	88	4		52
	80	1755	686.24	686.30	.09		.18	315	96	90	4		55
	90	1805	688.77	688.80	.11		.18	320	96	91			55
	100	1815	691.30	691.20	.10		.18	315	90	90	4		55
	110	1825	693.73	—	.10		.18	310	85	80	4		
	120	1835	696.16	696.16	.11		.18	310	88	84	4		52
	130	1845	698.59	698.59	.10		.17	310	99	90	4		55
	140	1855	701.02	700.96	.10		.17	310	99	92	4		55
	150	1905	703.45	703.41	.09		.17	312	102	90	4		52
	160	1915	708.88	707.90	.11		.17	305	102	93	4		52
	170	1925	711.41	710.20	.10		.20	305	100	94	5		52
	180	1935	713.99	712.059	.12		.21	305	100	94	5		52
						ΔH=	.184		T_m =	~~89.6~~			
			Vm =	46.059	ΔP=.098					89.3			
							Ts=	316.5					

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Date 5/6/81
Sampling Location ESP Outlet Initial MDH
Test Number ESP-O-1-1(C)

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(316.5) 340
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = .184 Pm = 28.82 Vm = 46.059 Tm = 89.6	Vm_{std}	42.625
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 29.7% collected this run	Mf	.703
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.17
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.35
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP = .11 ΔP = (.097) Ts = 340 Ts = (316.5)	Vs	(1,347) 1,456
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.275
$\frac{1{,}039\,(340\ (316.5) + 460)(42.625)}{(1{,}456)(180)(28.35)(.703)(.275^2)}$	% I	(94.1) 89.7

(1,347)

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal
Run No. ESP-O-1-1 (C)
Sample Location ESP Outlet
Sample Date 5/6/81
Sample Box No. ______
Recovery Date ______
Sample Type Particle Size Andersen MK III
Cleanup Person ______

Filter No. 12 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

	1	2	3	4	5	SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type a/						
Impinger Solution						
Final Volume (wt) b/	369	30				785.7
Initial Volume (wt) b/	0					774.6
Net Volume (wt) b/	369	30				11.1
Sample No.(s)						Silica Gel

Combined impinger contents, Sample No. ______ Color ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 383.1

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Dry Catch: Sample No. ______
Description ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______
Filter Blank: Sample No. ______
Sealed ______
Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Outlet

Test Run Number ESP-O-1-1(C)

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/6/81	1635-1935	E. Whited	
Probe Technician				
Meter Technician			E. Whited	
Other				
Transport of Train to Cleanup Site				
Train Disassembly	5/6/81		J Pavlonis	
Train Cleanout	5/6/81		Joel Pavlonis	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-02-1(B)

MRI Project Number 4892-L-07
Field Dates
Plant Ideal
Sampling Location ESP OUTLET
Sampling Date 5-6-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 White
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal
Sampling Location ESP Outlet
Test No. ESP-O-2-1 D

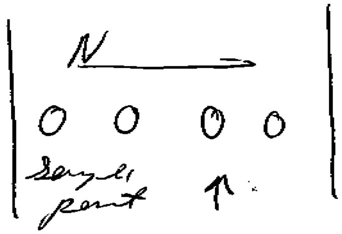
Date 5-6-81
Initial PC

Velocity head at sampling location, in. H_2O	ΔPs	.09
Stack temperature at sample point, °F	Ts	310
Barometric pressure, in. Hg	Pb	28.87
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.40
Percent moisture in gas stream by volume	% H_2O	30.27
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.697
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.10
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	1293
Calculated nozzle diameter, in. Fs = 0.505 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	0.268
Actual nozzle diameter, in. 60-7.0	D_{n_a}	.273
Assumed meter temperature, °F	Tm	90
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$	Fm	0.246

FIELD DATA - ANDERSEN

PLANT Illed
DATE 5-6-81
SAMPLING LOCATION ESP-OUTLET
SAMPLE TYPE
RUN NUMBER ESP-0-2-1B
OPERATOR White
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.87
STATIC PRESSURE, (P_s) -8.4" H_2O
Filter Set 11

Leak CK: Inital at 15" Hg, CFM 0.001
Final at 04.0 Hg, CFM 0.000



SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Calculated ACFM (desired) .246
Probe Tip Diameter .273
CO_2
O_2
CO
N_2
% H_2O 30%

Console No. 5

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 746.701 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1300											
	10	1310	749.16	748.44	0.08	.17	.17	330	80	80			
	20	1320	751.62	751.21	.09		.20	330	80	81	4		55
	30	1330	754.08	754.32	.09		.24	325	85	80	4		
	40	1340	756.54	757.02	.09		.18	330	86	82	4		55
	50	1350	759.00	759.21	.08		.16	335	88	85	4		57
	60	1400	761.53	761.58	.10		.15	335	88	88	4		60
	70	1410	764.06	764.08	.08		.16	330	90	88	4		60
	80	1420	766.59	766.47	.07		.16	330	90	90	4		62
	90	1430	769.12	768.96	.10		.17	335	90	90	4		62
	100	1440	771.65	771.55	.08		.17	337	90	90	4		60
	110	1450	774.18	773.99	.09		.18	334	94	92	4		
	120	1500	776.71	776.66	.09		.20	335	92	90	4		
	130	1510	779.24	779.20	.08		.19	333	92	90	4		58
	140	1520	781.77	—	.08		.18	330	92	92	4		60
	150	1530	784.30	784.10	.07		.18	325	92	90	4		
	160	1540	786.83	786.58	.05		.18	320	92	90	4		60
	170	1550	789.36	788.80	.08		.18	330	92	90	4		60
	180	1600	791.89	790.962	.07		.17	320	92	90	4		60
					ΔP =								
			Vm =	44.261	0.082	ΔH	.179	~~333.90~~		~~90.85~~			
							Ts =	330.2	Tm =	88.5			

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP OUTLET
Test Number ~~ESP-O-2-1B~~
ESP-O-2-1-B

Date 5-6-81
Initial MDH

Isokinetic equation:

$$\% \text{ I} = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(330.2) 310
Meter volume (std), $\dfrac{17.64(Vm)\left(Pb+\dfrac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = .179 Pb = 28.87 Tm = 88.5 Vm = 44.261	Vm_{std}	41.11
Mole fraction dry gas, $\dfrac{100-\%\ H_2O}{100}$ 28.4% collected This run	Mf	.716
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.34
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.40
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\dfrac{Ts+460}{Ps \times Ms}}$ ΔP = .09 ΔP = (.082) Ts = 310 Ts = (330.2)	Vs	1,287 (1,245)
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.273
$\dfrac{1{,}039\ (310\ (330.2) + 460)(41.11)}{(1{,}287)(180)(28.40)(.716)(.273^2)}$ (1,245)	% I	(99.4) 93.7

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-O-2-1B
Sample Location ESP Outlet Sample Date 5-6-81
Sample Box No. ______ Recovery Date ______
Sample Type ______ Cleanup Person ______

Filter No. 11
Sample No. ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE						SILICA GEL
Impinger Sequence	1	2	3	~~4~~	5	
Impinger Type[a]						
Impinger Solution						
Final Volume (wt)[b]	305	34				786.6
Initial Volume (wt)[b]	0	0				779.5
Net Volume (wt)[b]	305	34				7.1
Sample No.(s)						Silica Gel Color

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 346.1

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-2-03

Source Identification ESP-Outlet

Test Run Number ESP-0-2-1 B

Pollutant(s) in Sample ____

Task	Date	Time	Personnel	Remarks
Sampling	5-6-81	1300 to 1600	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		1615	Whited	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-0-3-1

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP-0-3-1
Sampling Date 5-2-81

FIELD CREW

Crew Chief Hansen

Testing Engineer
1 Whited
2
3

Engr. Technician
1
2
3

Lab Technician
1
2
3

Process Engineer
1
2

Other
1
2

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal Date 5-2-81
Sampling Location ESP Outlet Initial CW
Test No. ESP-O-3-1

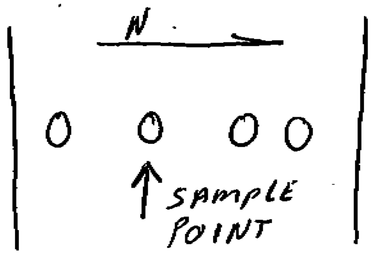
5-3-81

Velocity head at sampling location, in. H_2O	ΔPs	.25
Stack temperature at sample point, °F	Ts	350
Barometric pressure, in. Hg	Pb	28.83
Static pressure in stack, in. Hg -6.4 (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.36
Percent moisture in gas stream by volume assumed from Inlet data from previous run	% H_2O	23
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.77
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	30.72
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.79
Stack velocity, fpm $\sqrt{\Delta P} = .5$ $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	~~2092~~ 2184
Calculated nozzle diameter, in. $Fs = 0.549$ $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.2145
Actual nozzle diameter, in.	D_{n_a}	0.235
Assumed meter temperature, °F	Tm	95
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs\left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$ $\left(\frac{95+460}{350+460}\right)\left(\frac{28.36}{28.83}\right)(.77)(.549)$	Fm	0.284

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5-2-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Dust
RUN NUMBER ESP-O-3-1
OPERATOR Whited
AMBIENT TEMPERATURE 85
BAROMETRIC PRESSURE 28.83
STATIC PRESSURE, (P_s) -6.4" H_2O
Filter Set 5

Leak CK: Inital at 15" Hg, CFM 0.000
Final at 15" Hg, CFM 0.000



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .284 or 2.84/10min
Probe Tip Diameter .235
CO_2
O_2
CO 30.72
N_2
% H_2O 23

Console No. 9

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	GAS METER READING (V_m), ft^3 Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1642		186.400									
	10	1643	189.24	188.93	.25	2.3	.22	335	88	92	2		
	20	1653	192.08	191.62	.26		.23	335	90	90	2		
	30	1703	194.92	194.85	.25		.29	335	93	91	2		
Down	40	1713	157.76	197.68	.25		.26	340	95	90	2		
	50	1723	200.60	200.52	.25		.26	340	98	92	2		
on	60	1733	203.44	203.65	.24		.26	340	98	92	2		
	70	1743	206.28	206.28	.25		.24	340	100	96	2		
	80	1753	209.12	209.15	.23		.25	340	100	99	2		
	90	1803	211.96	212.03	.23		.25	335	100	99	2		
	100	1813	214.80	214.89	.22		.245	340	100	99			
	110	1823	217.64	217.75	.23		.24	340	100	99	2		
	120	1833	220.48	220.50	.23		.22	340	101	100	2		
	130	1843	223.32	223.37	.23		.24	345	101	100	2		
	140	1853	226.16	226.26	.25		.245	335	101	100	2		
	150	1903	229.00	229.00	.23		.22	350	102	100	2		
	160	1913	231.84	231.90	.25		.23	355	102	100	2		
	170	1923	234.68	234.64	.24		.225	345	102	100	2		
	180	1933	237.52	237.462	.22		.225	355	102	100	2		
	END												
		Vm =	51.062		~~.2394~~	ΔH =	.242	~~340.3~~	Tm =	97.56			
					.24			341.4					

Silica Gel Change - 30 or 45 sec.

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant *Ideal* Date *5-2-81*
Sampling Location *ESP OUTLET* Initial *CU*
Test Number *ESP-0-3-1*

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

		Read	*Projected*
Average stack temperature, °F	Ts_{avg}	(340.3) ~~340.3~~	350
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ *ΔH .242 Pb 28.83 51.062-Vm Tm = 97.56*	Vm_{std}	46.60	~~46.8~~
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ *27.7% (5/2/81) ESP-0-2-1 Based on water data taken from previous Run*	Mf	~~.77~~ ~~.77~~	.723
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	~~30.72~~ 30.72	~~31.15~~ 31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms *27.51*	~~27.54~~	~~27.20~~ ~~27.79~~
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	~~27.77~~ ~~28.36~~	28.36
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{PsxMs}}$ *ΔP assumed .25 ΔP = .25 ΔP = (.2394) Ts = (340.3)*	Vs	~~2180~~ 2184 2,195	~~2145~~ (2,135)
Total sample time, minutes	θ	~~180~~	180
Nozzle diameter, inches	Dn	~~.235~~ .235	
$\frac{1{,}039\ (\underline{350}\ (340.3) + 460)(\cancel{46.8}\ 46.60)}{(\cancel{2145}\ \cancel{2180})(\underline{180})(\underline{28.36}\ \cancel{27.79})(\underline{.723}\ \cancel{.77})(\cancel{.235}^2)}$	% I	~~85~~ ~~84.8~~	~~92.1~~

2,195

(2,135)

87.7% (89.0)

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal   Run No. ESP-0-3-1
Sample Location ESP Outlet   Sample Date 5-2-81
Sample Box No. ________   Recovery Date ________
Sample Type ________   Cleanup Person ________

Filter No. 5 ________ ________
Sample No. ________ ________ ________
Sample Material Description ________

MOISTURE AND/OR SAMPLE						SILICA GEL
Impinger Sequence	1	2	3	4	5	Moisture assumed
Impinger Type a/						same as Method 17
Impinger Solution						ESP-0-4-1
Final Volume (wt) b/						
Initial Volume (wt) b/						
Net Volume (wt) b/						
Sample No.(s)						Silica Gel
Combined impinger contents, Sample No.						Color ________

Liquid Level Marked ________ Container(s) Sealed ________
Description of Impinger Solution ________
Total Moisture, gm ________

a/ S = Greenburg-Smith standard, M = Modified, O = Other ________
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ________
Liquid Level Marked ________
Sealed ________
Impinger Rinse: Sample No. ________
Liquid Level Marked ________
Sealed ________
Water Blank: Sample No. ________
Liquid Level Marked ________

Dry Catch: Sample No. ________
Description ________
Sealed ________
Acetone Blank: Sample No. ________
Liquid Level Marked ________
Sealed ________
Filter Blank: Sample No. ________
Sealed ________

Sample Disposition ________
Carrier ________ Date Shipped: ________
Remarks: ________

Date of laboratory custody ________ Seal(s) broken by ________
Personnel accepting custody ________ Date broken ________
Remarks: ________

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP Outlet

Test Run Number ESP-0-3-1

Pollutant(s) in Sample Dust

Task	Date	Time	Personnel	Remarks
Sampling	5-2-81	1642 To 1933	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		1945	Whited	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-0-4-1

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-4-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 Whited
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal
Sampling Location ESP Outlet
Test No. ESP-0-4-1

Date 5-4-81
Initial ev

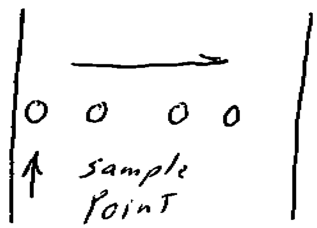
Velocity head at sampling location, in. H_2O ΔPs Taken just prior to test	ΔPs	0.42
Stack temperature at sample point, °F Ts taken just prior to test	Ts	360
Barometric pressure, in. Hg	Pb	28.67
Static pressure in stack, in. Hg — 6.4" H_2O (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.20
Percent moisture in gas stream by volume mass Assumed from previous Run ESP-0-4-1	% H_2O	27%
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.73
Molecular wt. dry stack gas, lb/lb-mole Assumed from mass Run ESP-0-4-1 (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	28.53
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\underset{.648}{\sqrt{\Delta Ps}}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	2818
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min Fs = 0.5605	D_{n_c}	0.191
Actual nozzle diameter, in. ~~60~~ - 5.0 61 - 5.0	D_{n_a}	.195
Assumed meter temperature, °F	Tm	105
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$ .56 $\frac{105+460}{360+460}$ .98 .73	Fm	~~[illegible]~~ .276

WATERPROOF PAPER

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5-4-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE
RUN NUMBER ESP-0-4-1
OPERATOR White
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.67
STATIC PRESSURE, (P_s) -6.4" H_2O
Filter Set 6

Leak CK: Inital at 15" Hg, CFM 0.00
Final at 5 Hg, CFM 0.00



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Meter Box 5
Calculated ACFM (desired) .276
Probe Tip Diameter .195
CO_2 16.7
O_2 5.8
CO 0
N_2 77.5
% H_2O 27%

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1108		369.600									
	10	1118	372.36	372.26	.38	.21	.21	340	83	83	1		100
	20	1128	375.12	375.07	.37	.215	.215	340	83	85	1		100
	30	1138	377.88	377.73	.38	.22	.215	340	85	85	1		100
	40	1148	380.64	380.62	.37	.215	.215	340	86	86	1		100
	50	1158	383.40	383.31	.37	.215	.215	340	87	86	1		100
	60	1208	386.16	386.18	.39	.22	.22	345	87	87	1		100
(1208 off) 1218 on			moisture measurement										
1231 off	70	1220	388.92	388.88	.38	.21	.21	335	92	88	1		100
123	80	1232	391.68	391.72	.36		.215	345	95	94	1		102
	90	1242	394.44	394.45	.37		.21	345	104	97	1		98
	100	1252	397.20	397.21	.39		.21	340	105	100	1		102
	110	1302	399.96	399.99	.40		.21	345	105	102	1		103
	120	1313	402.72	402.77	.38		.20	340	108	105	1		103
off 1317 / on 1314													
	130	1324	405.48	405.49	.39		.21	345	106	105	1		103
	140	1334	408.24	408.33	.40		.21	340	108	108			105
	150	1344	411.00	411.10	.41		.20	340	109	109	1		108
	160	1357	413.76	413.84	.39		.20	340	110	110	1		112
	170	1404	416.52	416.49	.39		.19	335	110	110	1		110
	180	1414	419.28	419.266	.39		.20	340	109	110	1		115
			V_m =	49.666	ΔP = .42 (.38)		ΔH = .21	T_s = 360 (341)	T_m =	97.8			

COMMENTS: ( ) actual

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant *Ideal* Date *5-4-81*
Sampling Location *ESP Outlet* Initial *CU*
Test Number *ESP-0-4-1*

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	360 (341)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ — $\Delta H = .21$, $Pb = 28.67$, $Vm = 49.666$, $Tm+460 = 557.8$	Vm_{std}	45.05
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ — $\%\ H_2O = 29.7$	Mf	.70
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	30.91
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.04
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) — -6.4	Ps	28.2
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ — $\Delta P = .42$, $\Delta P = (.38)$, $Cp = .84$	Vs	2895 (2722)
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.195
$\frac{1{,}039\ (\underline{360\ (341)} + 460)(\underline{45.05})}{(\underline{2895\ (2722)})(\underline{180})(\underline{28.2})(\underline{.7})(\underline{.195}^2)}$	% I	98.1 (101.9)

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant: Ideal
Run No.: ESP-0-4-1
Sample Location: ESP-OUTLET
Sample Date: 5-4-81
Sample Box No. ______
Recovery Date ______
Sample Type ______
Cleanup Person ______

Filter No.: 6
Sample No. ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5
Impinger Type[a]					
Impinger Solution					
Final Volume (wt)[b]	124	133	128		
Initial Volume (wt)[b]	0	0	0		
Net Volume (wt)[b]	124	133	128		
Sample No.(s)					

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm: 404.3

SILICA GEL

467.2	[illegible]
447.9	[illegible]
19.3	[illegible]

Silica Gel
Color ______

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______

Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______

Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______

Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP OUTLET

Test Run Number ESP-O-4-1

Pollutant(s) in Sample ____________

Task	Date	Time	Personnel	Remarks
Sampling	5-4-81	1108 TO 1414	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		1420	Whited	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-O-1-2

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-4-81

FIELD CREW

Crew Chief		Hansen
Testing Engineer	1	Whitell
	2	
	3	
Engr. Technician	1	
	2	
	3	
Lab Technician	1	
	2	
	3	
Process Engineer	1	
	2	
Other	1	
	2	

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant *Ideal* Date *5-4-81*
Sampling Location *ESP - Outlet* Initial *CW*
Test No. *ESP-0-1-2*

Velocity head at sampling location, in. H_2O	ΔPs	*Δ=.1*
Stack temperature at sample point, °F	Ts	*340*
Barometric pressure, in. Hg	Pb	*28.72*
Static pressure in stack, in. Hg (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	*28.25*
Percent moisture in gas stream by volume *assumed from method 17, ESP-0-1-2*	% H_2O	*23.3*
Mole fraction, dry gas $\frac{100 - \%\ H_2O}{100}$ *method 17* *moisture taken from ESP-0-1-2*	Mf	*.77*
Molecular wt. dry stack gas, lb/lb-mole *assumed from ESP-0-4-1* (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	*31.15*
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	*28.19*
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	*1365*
Calculated nozzle diameter, in. *Fs=0.5384* $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	*.269*
Actual nozzle diameter, in.	D_{n_a}	*.273*
Assumed meter temperature, °F	Tm	*100*
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs\left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$	Fm	*0.284*

WATERPROOF PAPER

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5-4-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE
RUN NUMBER ESP O-~~1~~-2
OPERATOR White
AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 28.72
STATIC PRESSURE, (P_s) -6.4
Filter Set 7

Leak CK: Inital at 15" Hg, CFM 0.00
Final at ____ Hg, CFM ____

SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Meterbox 9
Calculated ACFM (desired) .284
Probe Tip Diameter .273
CO_2 16.7
O_2 5.8
CO 0
N_2 77.5
% H_2O 23.3

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1723		354.50									
	10	1733	357.34	—	~~320~~.13	.21	.21	320	83	83			95
	20	1743	360.18	—	.15		.19	315	88	89			95
	30	1753	363.02	362.40	.15		.20	315	92	92			95
	40	1803	365.86	365.46	.13		.29	325	92	90			95
	50	1813	368.70	—	.10		.29	320	94	90			100
	60	1823	371.54	371.55	.10		.21	320	100	95			100
	off 1823												
1829	70 on	1829	374.35	374.23	.11		.21	315	100	100		120 ml H_2O Drained	100
	80	1849	377.22	376.92	.13		.24	315	100	100		ofs	100
	90	1859	380.06	379.78	.10		.24	325	105	100			
	100	1909	382.90	382.62	.11		.24	325	105	105			100
off	110	1919	385.74	385.42	.10	.23	~~.22~~	325	108	105			100
1932	120	1929	388.58	388.32	.10	.23	~~.22~~	325	110	107			100
1936	130	1946	391.42	391.22	.10		.24	325	110	108		141 ml H_2O	95
on	140	1956	394.26	394.22	.09		.25	325	110	107			100
	150	2006	397.10	396.97	.10		.21	335	110	107			105
	160	2016	399.94	399.83	.12		.21	325	110	107			105
	170	2026	402.78	402.69	.10		.22	—	110	107			105
	180	2036	405.62	405.495	.11		.23	—	111	107		133 ml H_2O	105
			V_m =	50.995	ΔP = .1 (.11)	ΔH	= .23	T_s = 340 (321.6)	T_m =	101.1			

COMMENTS: ( ) actual

EPA (Dur) 235
4 72

I-273

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP Outlet
Test Number ESP-O-1-2
Date 5-4-81
Initial CL

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	340 (321.6
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = .23$ $Pb = 28.72$ $Vm = 50.995$ $Tm+460 = 561$	Vm_{std}	46.08
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ $\%\ H_2O = 34.5$	Mf	.655
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	30.91
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~26.28~~ 26.46
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O) -6.4	Ps	28.25
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ $\Delta P = .1$ $= (.11)$ $C_p = .84$	Vs	1409 (1461)
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.273
$\frac{1{,}039\ (\underset{(321.6)}{340} + 460)(46.08)}{(1409)(180)(28.25)(.655)(.273^2)}$ (1461)	% I	109.5 (103.2)

( ) actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal
Sample Location ESP - Outlet
Sample Box No. ______
Sample Type ______

Run No. ESP-0-2-1
Sample Date 5-4-81
Recovery Date ______
Cleanup Person ______

Filter No. 7
Sample No. ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5
Impinger Type a/					
Impinger Solution					
Final Volume (wt) b/	120	141	133		
Initial Volume (wt) b/	0	0	0		
Net Volume (wt) b/	120	141	133		
Sample No.(s)					

SILICA GEL

579.8	469.8
465.3	463.5
114.5	6.3

Silica Gel Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 514.8

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number ~~54~~ 4892-L-03

Source Identification ESP Outlet

Test Run Number ESP-0-1-2

Pollutant(s) in Sample ______

Task	Date	Time	Personnel	Remarks
Sampling	5-4-81	1723 To 2036	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		2045	Whited	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-0-2-2-(B)

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5/6/81

FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	E. Whited
	2	
	3	
Engr. Technician	1	
	2	
	3	
Lab Technician	1	J. Paveloni's
	2	D. Olson
	3	
Process Engineer	1	F. Hoffmeister
	2	
Other	1	
	2	

ANDERSEN SAMPLING CALCULATIONS

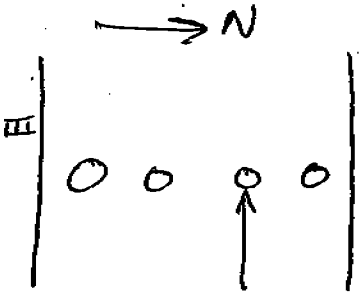
Plant Ideal Date 5/6/81
Sampling Location ESP Outlet Initial MDH
Test No. ESP-O-2-2 (B)

Velocity head at sampling location, in. H_2O	ΔPs	.08
Stack temperature at sample point, °F	Ts	330
Barometric pressure, in. Hg	Pb	28.81
Static pressure in stack, in. Hg -6.4 (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.34
assumed from ESP-O-2-1(B) on 5/6/81 Percent moisture in gas stream by volume	% H_2O	28.4
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.716
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.34
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	1,230
Calculated nozzle diameter, in. Fs = .53 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.281
Actual nozzle diameter, in. 60-7.0	D_{n_a}	.273
Assumed meter temperature, °F	Tm	85
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	.258

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5/6/81
SAMPLING LOCATION ESP outlet
SAMPLE TYPE Particle Size Andersen MK III
RUN NUMBER ESP-O-2-2 (B)
OPERATOR B. Whited
AMBIENT TEMPERATURE 65°F
BAROMETRIC PRESSURE 28.81
STATIC PRESSURE, (P_s) -6.4"
Filter Set 13

Leak CK: Inital at 15" Hg, CFM 0.001
Final at 7" Hg, CFM 0.000



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired)	.258	
Probe Tip Diameter	.273	
CO_2	17%	19%
O_2	8.33	8.0%
CO	0	0.%
N_2	74.67	73%
% H_2O	28.4	

Console No. 5

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	GAS METER READING (V_m), ft^3 Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\,in})$, °F	DRY GAS METER TEMPERATURE OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1743	791.100										
	10	1753	793.68	793.34	.09	.18	.18	305	78	78	5		70
	20	1803	796.26	796.16	.08		.21	300	78	80	5		70
	30	1813	798.84	798.80	.07		.21	305	82	80	5		
	40	1823	801.42	801.40	.07		.20	300	80	81	5		58
	50	1833	804.00	803.98	.07		.20	300	81	84	5		
	60	1843	806.42	806.13	.07		.16	305	95	88	4		
	70	1853	808.92	809.02	.10		.24	295	100	93	6		58
	80	1903	811.42	811.70	.07		.22	300	105	95	6		58
	90	1913	813.92	814.27	.09		.19	300	102	98	5		
	100	1923	816.42	816.58	.08		.16	300	100	98	5		60
	110	1933	818.92	819.10	~~.09~~ .09		.15	300	100	97	5		60
	120	1943	821.42	821.42	.09		.16	300	97	95	5		60
	130	1953	823.92	823.80	.07		.16	300	97	96	5		61
	140	2003	825.96	826.15	.08		.16	300	96	96	5		61
	150	2013	828.24	828.40	.08		.16	300	90	95	5		60
	160	2023	830.52	830.90	.08		.15	300	90	92	5		58
	170	2033	832.80	833.10	.09		.15	300	90	893	5		58
	180	2043	835.08	835.361	.07		.15	300	89	92	5		
				ΔP=	.08								
			Vm =	44.261		ΔH =	.178						
									T_M =	91.1			
							TS =	300.6					

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP Outlet
Test Number ESP-0-2-2 (B)

Date 5/6/81
Initial MDH

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	(300.6) 330
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ Vm = 44.261 Pb = 28.81 Tm = 91.1 ΔH = .178	Vm_{std}	40.83
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 28.96% collected this run.	Mf	.7104
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	31.36
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.49
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.34
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP = .08 ΔP = (.08) Ts = 330 Ts = (300.6)	Vs	(1,204) 1,227
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.273
$\frac{1{,}039\,(330(300.6) + 460)(40.83)}{(1{,}227)(180)(28.34)(.7104)(.273^2)}$ (1,204)	% I	(99.2) 101.1

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant: Ideal
Run No.: ESP-0-2-2-(B)
Sample Location: ESP Outlet
Sample Date: 5/6/81
Sample Box No.
Recovery Date
Sample Type: Andersen Particle Size (MK III)
Cleanup Person

Filter No.: 13
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

	1	2	3	4	5	SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type[a]						
Impinger Solution						
Final Volume (wt)[b]	341					757.5
Initial Volume (wt)[b]	0					744.8
Net Volume (wt)[b]	341					12.7
Sample No.(s)						Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked
Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm: 353.7

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed
Impinger Rinse: Sample No.
Liquid Level Marked
Sealed
Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed
Acetone Blank: Sample No.
Liquid Level Marked
Sealed
Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier
Date Shipped:
Remarks:

Date of laboratory custody
Seal(s) broken by
Personnel accepting custody
Date broken
Remarks:

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Outlet

Test Run Number ESP-0-2-2(B)

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/6/81	1743-2043	E. Whited	
Probe Technician				
Meter Technician			E. Whited	
Other				
Transport of Train to Cleanup Site				
Train Disassembly	5-7-81		J. Pavlovic	
Train Cleanout	5-7-81		J. Pavlovic	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-O-3-2

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-5-81

FIELD CREW

Crew Chief Hansen

Testing Engineer
1 Whited
2
3

Engr. Technician
1
2
3

Lab Technician
1
2
3

Process Engineer
1
2

Other
1
2

ANDERSEN SAMPLING CALCULATIONS

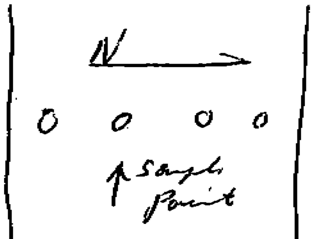
Plant *Ideal* Date *5-5-81*
Sampling Location *ESP Outlet* Initial *CV*
Test No. *ESP-O-3-2*

Velocity head at sampling location, in. H_2O	ΔPs	*.17*
Stack temperature at sample point, °F	Ts	*315*
Barometric pressure, in. Hg	Pb	*28.88*
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	*28.41*
Percent moisture in gas stream by volume *Based on method 17 ESP-O-3-2*	% H_2O	*30*
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	*.70*
Based on fyrite taken at ESP-O-3-2 Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	*30.90*
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	*27.03*
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$ *ΔP*	Vs	*1784*
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min *Fs = 0.511*	D_{n_c}	*.229*
Actual nozzle diameter, in. *60-6.0*	D_{n_a}	*.235*
Assumed meter temperature, °F	Tm	*88*
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$	Fm	*.249* ~~*.496*~~

WATERPROOF PAPER

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5-5-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE
RUN NUMBER ESP-O-3-2
OPERATOR White
AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 28.88
STATIC PRESSURE, (P_s) -6.4" H2O
Filter Set 9



SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Meter Box - 9
Calculated ACFM (desired) .2490
Probe Tip Diameter ~~.304~~ .235
CO_2
O_2
CO
N_2
% H_2O 30

Leak CK: Inital at 15" Hg, CFM 0.005 /60sec
Final at 4" Hg, CFM 0.001

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 469.000 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1447											
	10	1457	471.49	471.63	.16	~~.27~~	.21	305	70	70	3		65
	20	1502	473.98	474.22	.14		.20	305	71	70	3		60
	30	1517	476.47	476.72	.16		.20	305	71	70	3		60
	40	1527	478.96	479.24	.14		.18	305	71	70			
	50	1537	481.45	481.95	.16		.25	310	80	81	3		65
	60	1547	483.94	484.60	.17		.26	305	82	80	3		58
	70	1552	486.43	487.4	.17	.19 →	~~.20~~	305	82	80	3		58
	80	1607	488.92	488.75	.15		.19	305	85	82	3		55
	90	1617	491.41	492.09	.14		.17	300	84	82	3		
	100	1627	493.90	494.13	.15		.15	305	80	82	3		57
	110	1637	496.39	496.69	.13		.19	305	82	83	3		57
	120	1647	498.88	499.15	.14		.18	310	82	83	3		58
	130	1657	501.37	501.60	.14		.17	315	80	82	3		58
	140	1707	503.86	504.05	.14		.17	313	80	82	3		58
	150	1717	506.35	506.44	.14		.16	305	80	82	3		58
	160	1727	508.84	508.84	.13		.17	305	80	82	3½		58
	170	1737	511.33	511.32	.17		.18	315	80	82	3½		58
	180	1747	513.82	513.789	.15		.18	330	80	82	3½		60
							ΔH:	T_s =		T_m =			
				44.789	.149		~~.183~~	308.22		79.03			
							.189						

COMMENTS:

EPA (Dur) 235
4-72

ISOKINETIC PERFORMANCE WORKSHEET

Plant *Ideal*

Sampling Location *ESP Outlet*

Test Number *ESP-O-3-2*

Date *5-5-81*

Initial *CG*

Isokinetic equation:

$$\% I = \frac{1,039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	315 (308.2)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH .183 Pb = 28.88 Vm = 44.783 Tm = 79.03	Vm_{std}	42.35
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 29.2%	Mf	.71
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.26
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.41
Stack velocity, fpm $5,128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ Δp = (.149) Δp = .17 Ts = 315 Ts = (308.2)	Vs	(1656) 1,777
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.235
$\frac{1,039\ ((308.2)^{315} + 460)(42.35)}{((1656))(180)(28.41)(.71)(.235^2)}$	% I	(101.8) 95.7

(   ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-0-3-2
Sample Location ESP-Outlet Sample Date 5-5-81
Sample Box No. ____ Recovery Date ____
Sample Type - Cleanup Person ____

Filter No. 9
Sample No. ____
Sample Material Description ____

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5
Impinger Type[a]					
Impinger Solution					
Final Volume (wt)[b]	326	35	2		
Initial Volume (wt)[b]	0	0	0		
Net Volume (wt)[b]	326	35	2		
Sample No.(s)					

SILICA GEL

770.6
762.4
8.2
Silica Gel Color ____

Combined impinger contents, Sample No. ____
Liquid Level Marked ____ Container(s) Sealed ____
Description of Impinger Solution ____
Total Moisture, gm 371.2

a/ S = Greenburg-Smith standard, M = Modified, O = Other ____
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ____ Liquid Level Marked ____ Sealed ____
Dry Catch: Sample No. ____ Description ____ Sealed ____
Impinger Rinse: Sample No. ____ Liquid Level Marked ____ Sealed ____
Acetone Blank: Sample No. ____ Liquid Level Marked ____ Sealed ____
Water Blank: Sample No. ____ Liquid Level Marked ____
Filter Blank: Sample No. ____ Sealed ____
Sample Disposition ____
Carrier ____ Date Shipped: ____
Remarks: ____

Date of laboratory custody ____ Seal(s) broken by ____
Personnel accepting custody ____ Date broken ____
Remarks: ____

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP Outlet

Test Run Number ESP-0-3-2

Pollutant(s) in Sample ________

Task	Date	Time	Personnel	Remarks
Sampling	5-5-81	1447 - 1747	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site				
~~Train~~ Disassembly	5-5-81		J. Pawlowski	
~~Train~~ Cleanout	5-5-81		J. Pawlowski	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-0-4-2

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP OUTLET
Sampling Date 5-6-81

FIELD CREW

Crew Chief Hansen

Testing Engineer
1 Whited
2
3

Engr. Technician
1
2
3

Lab Technician
1
2
3

Process Engineer
1
2

Other
1
2

ANDERSEN SAMPLING CALCULATIONS

Plant *Ideal* Date *5-6-81*
Sampling Location *ESP Outlet* Initial *CW*
Test No. *ESP-0-4-2*

Velocity head at sampling location, in. H_2O	ΔPs	*.35*
Stack temperature at sample point, °F	Ts	*330*
Barometric pressure, in. Hg	Pb	*28.87*
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	*28.40*
Percent moisture in gas stream by volume	% H_2O	*27.6*
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	*.724*
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	*31.05*
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	*27.45*
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	*2566*
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$ *$F_s = 0.5274$*, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	*0.194*
Actual nozzle diameter, in. *60, -5.0*	D_{n_a}	*.195*
Assumed meter temperature, °F	Tm	*100*
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	*0.265*

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5-6-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE
RUN NUMBER ESP-O-4-2
OPERATOR United
AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 28.87
STATIC PRESSURE, (P_s) -6.4
Filter Set 10

Leak CK: Inital at 15" Hg, CFM 0.005
Final at 5" Hg, CFM 0.000

N →

O O O O

↑ sample point

SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Meter Box 5
Calculated ACFM (desired) .265
Probe Tip Diameter .195
CO_2
O_2
CO
N_2
% H_2O 27.6

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0830		699.450									
	10	0840	702.1	701.60	.37	.18	.18	325	62	63	1		58
	20	0850	704.75	704.19	.37		.20	315	65	65	1		58
	30	0900	707.40	707.04	.37		.24	315	70	67	1		48
	40	9000	710.05	709.95	.39		.26	315	68	72	1		48
	50	9020	712.70	712.93	.37		.26	315	78	70	1		50
	60	930	715.35	715.35	.35		.16	315	80	75	3		52
	70	940	718.00	717.81	.35		.175	315	82	80	3		55
	80	950	720.65	720.39	.36		.18	320	84	80	4		55
	90	1000	723.30	723.04	.37		.21	325	85	82	4½		55
	100	1010	725.95	725.90	.37		.22	315	80	85	5		53
	110	1020	728.60	728.51	.35	.19	[illegible]	310	82	86	5		57
	120	1030	731.25	731.18	.35		.19	320	92	88	5		58
	130	1040	733.90	733.75	.36		.19	315	96	90	5		58
	140	1050	736.55	736.12	.36		.16	315	98	94	5		58
	150	1100	739.20	738.64	.35		.17	310	102	96	4		58
	160	1110	741.85	740.20	.37		.17	315	100	95	4		58
	170	1120	744.50	743.63	.35	.19	~~.18~~	315	100	97	4		58
	180	1130	747.15	746.275	.34	.19	[illegible]	315	100	98	4		58
			Vm =	46.825	ΔP=.36			Ts=316.1	Tm =	83.5			
						ΔH=	.196						

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant *Ideal* Date *5-6-81*

Sampling Location *ESP OUTLET* Initial *Cw*

Test Number *ESP-O-4-2*

Isokinetic equation:

$$\% \text{ I} = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	330 (316)
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = .196$ $Pb = 28.87$ $Vm = 46.825$ $Tm = 83.5$	Vm_{std}	43.90
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 28.4% this run.	Mf	.716
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	31.05
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.34
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.40
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ $\Delta P = .35$ $\Delta P = (.36)$ $Ts = 330$ $Ts = (316)$	Vs	(2,584) 2,571
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.195
$\frac{1{,}039\,(330\,(316) + 460)(43.90)}{(2{,}571)(180)(28.40)(.716)(.195^2)}$ (2,584)	% I	(98.4) 100.7

(   ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-0-4-2
Sample Location ESP Outlet Sample Date 5-6-81
Sample Box No. ______ Recovery Date ______
Sample Type ______ Cleanup Person ______

Filter No. 10 ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5	SILICA GEL
Impinger Type[a]						
Impinger Solution						
Final Volume (wt)[b]	352	0	0			779.5
Initial Volume (wt)[b]	0	0	0			762.4
Net Volume (wt)[b]	352	0	0			17.1
Sample No.(s)						Silica Gel Color ______

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 369.1

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP OutLeT

Test Run Number ESP-0-4-2

Pollutant(s) in Sample Particulate.

Task	Date	Time	Personnel	Remarks
Sampling	5/6/81	0830 - 1130	E. Whited	
Probe Technician			E. Whited	
Meter Technician				
Other				
Transport of Train to Cleanup Site	5/6/81	1140	M. Hansen	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

APPENDIX J

SUSPECT AND BAD RUNS

J-1 Electrostatic Precipitator Inlet

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-I-1-3 (A) * overloaded Impactor

MRI Project Number 4892-L(03)
Field Dates
Plant Ideal
Sampling Location ESP-Inlet
Sampling Date 5/4/81

FIELD CREW

Crew Chief M. Hansen

Testing Engineer
1 T. Walker
2
3

Engr. Technician
1 F. Hoffmeister
2
3

Lab Technician
1 J. Pavelonis
2 G. Cobb
3 D. Olson

Process Engineer
1 F. Hoffmeister
2

Other
1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal Date 5/4/81
Sampling Location ESP Inlet Initial DW
Test No. ESP-I-1-3 (A)

Velocity head at sampling location, in. H_2O	ΔPs	.50
Stack temperature at sample point, °F	Ts	366
Barometric pressure, in. Hg	Pb	28.72
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.29
Percent moisture in gas stream by volume	% H_2O	30
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.7
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.21
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	3155.65
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.182
Actual nozzle diameter, in.	D_{n_a}	.177
Assumed meter temperature, °F	Tm	74
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	.254

WATERPROOF PAPER
46mil

FIELD DATA - ANDERSEN

PLANT Ideal Cement Co
DATE 5/4/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE HCSS PARTICLE SIZE
RUN NUMBER ESP-I-1-3(A)
OPERATOR Tom Walker
AMBIENT TEMPERATURE 70
BAROMETRIC PRESSURE 28.72
STATIC PRESSURE, (P_s) -5.6
Filter Set 36

Leak CK: Inital at 15" Hg, CFM .015
Final at ____ Hg, CFM ____

N

SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .254
Probe Tip Diameter .177
CO_2 17.67
O_2 8.33
CO ____
N_2 74
% H_2O .30

TRAVERSE POINT NUMBER	SAMPLING TIME min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1800	621.22										
1	3	1803	621.98	622.01	.84	.20	.20	375	70	70	1	—	67
	6	1806	622.74	622.74	.78		.19	380	73	71	1		68
	9	1809	623.51	623.46	.83		.20	380	73	71	2		68
	12	1812	624.27	624.25	.84		.21	380	75	72	2		68
	15	1815	625.03	625.05	.85		.21	375	77	72	2		69
	18	1818	625.79	625.81	.83		.21	380	79	73	2		70
	21	1821	626.55	626.57	.82		.21	370	81	74	2		70
	24	1824	627.32	627.35	.70		.20	380	82	75	2		70
			V_m=6.11		Avg Δp_s=.81		Avg ΔH=.20	T_s=378	Avg T_m=74.2				

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal

Date 5/4/81

Sampling Location ESP Inlet

Initial DW

Test Number ESP-I-1-3 (A)

Isokinetic equation:

$$\% I = \frac{1,039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	366
Meter volume (std), $\dfrac{17.64(Vm)\left(Pb+\dfrac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$	Vm_{std}	5.80
Mole fraction dry gas, $\dfrac{100-\%\ H_2O}{100}$	Mf	.723
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	31.15
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.51
Static pressure in stack, absolute, in. Hg (Pb) $\pm$ (0.074 x stack gage pressure, in H_2O)	Ps	28.29
Stack velocity, fpm $5,128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\dfrac{Ts+460}{Ps \times Ms}}$	Vs	(4,023.44) 3138.40
Total sample time, minutes	θ	24
Nozzle diameter, inches	Dn	.177
$\dfrac{1,039\,(366^{(378)} + 460)(5.80)}{(3138.4)(24)(28.29)(.723)(.177^2)}$ (4,023.44)	% I	(81.61) 103.13

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-I-1-3(A)
Sample Location ESP Inlet Sample Date 5/4/81
Sample Box No. ______ Recovery Date ______
Sample Type HCSS Particle Size Cleanup Person ______

Filter No. 36
Sample No. ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE						SILICA GEL	
Impinger Sequence	1	2	3	4	5		
Impinger Type[a]							
Impinger Solution							
Final Volume (wt)[b]	46.0					453.2	
Initial Volume (wt)[b]	0					451.9	
Net Volume (wt)[b]	46.0					1.3	
Sample No.(s)						Silica Gel Color	

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm 47.3

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Dry Catch: Sample No. ______
Description ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______
Filter Blank: Sample No. ______
Sealed ______
Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L(03)

Source Identification ESP Inlet

Test Run Number ESP-I-1-3(A)

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	5/4/81	1800-1824		
Probe Technician			Fritz Hoffmeister	
Meter Technician			Tom Walker	
Other			Mark Hansen	
Transport of Train to Cleanup Site				
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

J-2 Electrostatic Precipitator Outlet

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-0-1-1 (A)

MRI Project Number 4892
Field Dates 4-30-81
Plant Ideal Cement
Sampling Location ESP Outlet
Sampling Date 4-30-81

Nom. ISO.

FIELD CREW

Crew Chief E. M. Hansen

Testing Engineer 1 Ed White
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal Cement Date 4-30-81
Sampling Location ESP Outlet Initial C/W
Test No. ESP-O-1-1 (A)

Velocity head at sampling location, in. H_2O	ΔPs	~~0.266~~	0.10
Stack temperature at sample point, °F	Ts	370	
Barometric pressure, in. Hg	Pb	28.84 ~~27.06~~	
Static pressure in stack, in. Hg $H_2O" = -6.4$ (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	~~28.27~~ ~~28.59~~	28.37
Percent moisture in gas stream by volume	% H_2O	27	
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.73	
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	30.72	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.29	
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	~~2305~~ ~~1751~~	1,411 ~~1448~~
Calculated nozzle diameter, in. Fs = .57 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min Fs = 370 - 32 x 5 = ÷ 9 = + 273 x .4 + 63 = 247.3 - 132.5 x .0049787 = FS	D_{n_c}	~~0.213~~ ~~0.246~~	.272
Actual nozzle diameter, in.	D_{n_a}	.235	
Assumed meter temperature, °F	Tm	110	
X Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	—	
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	~~.284~~ .281	

$Fs = (247.3 - 132.5)(0.0049787)$

$Fs = 0.572$

FIELD DATA - ANDERSEN

PLANT Ideal Cement
DATE 4-30-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Particulate
RUN NUMBER ESP-0-1-1(A)
OPERATOR E White
AMBIENT TEMPERATURE 80°F
BAROMETRIC PRESSURE 28.84
STATIC PRESSURE, (P_s) -6.4" H_2O
Filter Set 1

Leak CK: Inital at 15" Hg, CFM 0.000
Final at 0000 Hg, CFM ______

N →

4 3 2 1

O O O O

Sample point ↑

SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Calculated ACFM (desired) 0.281
Probe Tip Diameter 0.235
CO_2
O_2 30.72
CO
N_2
% H_2O 27%

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ 464.082 ~~463.456~~ Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1653											
	5	1658	465.482	465.20	0.10		.15	355	95	95		~~70~~	70
	10	1703	466.88	466.21		0.16	~~0.15~~	355	100	95			
	15	1708	468.28	—			.20	355	102	100			
	20	1713	469.68	469.52		~~0.15~~	0.20	355	110	100			70
	25	1718	471.08	471.04			0.22	355	109	103			20
	30	1723	472.48	472.37			0.19	355	110	107			70
	35	1728	473.88	473.60			0.22	355	110	107			70
	40	1733	475.28	—			0.28	355	110	107			70
	45	1738	476.68	476.57			0.24	355	110	107			
	50	1743	478.08	478.02			0.26	355	111	109			70
	55	1748	479.48	479.45			0.25	355	111	109			70
	60	1753	480.88	480.75			0.24	355	111	111			70
	65	1758	482.28	482.20			0.25	360	111	111			70
	70	1803	483.68	483.60			0.26	363	112	111			70
	75	1808	485.08	485.05			0.27	355	112	112			70
	80	1813	486.48	—			0.26	355	112	112			70
	85	1818	487.88	487.83			0.25	355	112	112			70
	90	1823	489.28	489.25			0.25	355	112	112			70
	95	1828	490.68	490.66			0.26	355	111	112			70
	100	1833	492.08	492.07			0.25	355	111	112			70
	105	1838	493.48	493.47			0.25	355	111	112			70
	110	1843	494.88	494.85			0.24	355	111	111			70
	115	1848	496.28	496.29			0.25	355	111	111			70
COMMENTS:	120	1853	497.68	492.650			0.24	355	111	111			70

~~33.579~~ = V_m = 33.568

ΔH = .2345 | T_s = 355.5 T_m = 108.6

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant: Ideal
Date: 4-30-81
Sampling Location: ESP Outlet
Initial:
Test Number: ESP-0-1-1(A)

Isokinetic equation:

$$\% I = \frac{1,039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	~~355~~	370
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = 0.2345 Pb = 28.84 Tm = 108.6 Vm = 33.568	Vm_{std}	~~30.135~~ ~~30.05~~	30.03
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$	Mf	.81	
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	30.72	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf) -6.4"	Ms	28.30	
Static pressure in stack, absolute, in. Hg -6.4" H_2O (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	~~28.75~~ 28.37	
Stack velocity, fpm 5,128.8 (Cp)$(\sqrt{\Delta Ps_{avg}})\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ~~ΔP = Vt = 0.316~~ Cp = .84 ΔP = .1	Vs	~~1370~~ 1,385	(1,398) 1,411
Total sample time, minutes	θ	120	
Nozzle diameter, inches	Dn	.235	
$\frac{1,039\ (\cancel{355}\ 370 + 460)(\cancel{30.05})}{(1370)(120)(28.45)(.81)(.235^2)}$	% I	~~121~~	

$$\frac{1,039(370+460)(30.03)}{(1,385)(120)(28.37)(.81)(.235^2)}$$

% I 122.8

117.5

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Cement
Sample Location ESP Outlet
Sample Box No. ______
Sample Type Particulate

Run No. ESP-0-1-1 (A)
Sample Date 4-30-81
Recovery Date ______
Cleanup Person ______

Filter No. ______ ______ ______
Sample No. ______ ______ ______
Sample Material Description ______

MOISTURE AND/OR SAMPLE

Impinger Sequence	1	2	3	4	5
Impinger Type a/					
Impinger Solution					
Final Volume (wt) b/		24			
Initial Volume (wt) b/		0			
Net Volume (wt) b/	0	0			
Sample No.(s)					

Combined impinger contents, Sample No. ______
Liquid Level Marked ______ Container(s) Sealed ______
Description of Impinger Solution ______
Total Moisture, gm ______

SILICA GEL

Not Taken

Silica Gel Color ______

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Impinger Rinse: Sample No. ______
Liquid Level Marked ______
Sealed ______
Water Blank: Sample No. ______
Liquid Level Marked ______

Dry Catch: Sample No. ______
Description ______
Sealed ______
Acetone Blank: Sample No. ______
Liquid Level Marked ______
Sealed ______
Filter Blank: Sample No. ______
Sealed ______

Sample Disposition ______
Carrier ______ Date Shipped: ______
Remarks: ______

Date of laboratory custody ______ Seal(s) broken by ______
Personnel accepting custody ______ Date broken ______
Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L.03

Source Identification ESP Outlet

Test Run Number ESP-O-1-1(A)

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	~~5~~ 3 4-30-81	1653 To 1853	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site	4/30/81	1855	Whited	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-O-1-1-D

Non Isokinetic

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP OUTLET
Sampling Date 5-1-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 White
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

ANDERSEN SAMPLING CALCULATIONS

Plant Ideal — Date 5-1-81

Sampling Location ESP Outlet — Initial CU

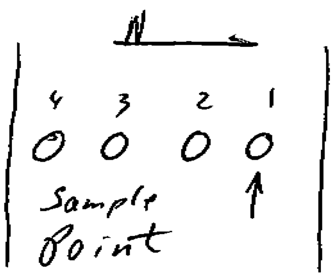
Test No. ESP-O-1-1 (B)

Velocity head at sampling location, in. H_2O	ΔPs	0.10
Stack temperature at sample point, °F	Ts	360
Barometric pressure, in. Hg	Pb	28.92
Static pressure in stack, in. Hg −6.4" H_2O (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.45
Percent moisture in gas stream by volume assumed from ESP-I-3-1	% H_2O	19
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	0.81
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	30.72
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	28.30
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	1375 ~~556~~
Calculated nozzle diameter, in. 245.088 - 132.5 x 0.00049787 = FS $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min FS = 0.560	D_{n_c}	0.273
Actual nozzle diameter, in.	D_{n_a}	0.235
Assumed meter temperature, °F	Tm	100
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$	Fm	0.304

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5-1-81
SAMPLING LOCATION ESP OUTLET
SAMPLE TYPE OUT
RUN NUMBER ESP-O-1-1(B)
OPERATOR White
AMBIENT TEMPERATURE 67
BAROMETRIC PRESSURE 28.92
STATIC PRESSURE, (P_s) -6.4
Filter Set 3

Leak CK: Inital at 15" Hg, CFM 0.000
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Calculated ACFM (desired) .304 = 3.04/min
Probe Tip Diameter 0.235
CO_2
O_2 30.72
CO
N_2
% H_2O 18%

TRAVERSE POINT NUMBER	SAMPLING TIME, min (0)	CLOCK TIME (24-hr CLOCK) (1122)	GAS METER READING (V_m), ft³ (68.100) Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\ in})$, °F	OUTLET $(T_{m\ out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	10	1132	71.14	71.12	0.1	.25	.25	340	70	70			
	20	1142	74.18	73.82	0.12		.29	355	74	72			
	30	1152	77.22	76.87	0.12	.27 →	.27	350	67	70			
	40	1202	80.26	79.78	0.11		.29	355	78	75			
	50	1212	83.30	83.37	0.12		.31	355	80	78			
	60	1222	86.34	—	0.12	.38 →	.38	350	80	78			
	70	1232	89.38	89.61	0.10		.38	350	81	78			
	80	1242	92.42	92.68	0.10		.34	350	81	78			
	90	1252	95.46	95.40	0.12	.25	~~.25~~	355	81	79			
	100	1302	98.50	98.23	0.10		.24	355	81	79			
	110	1312	101.54	101.20	0.10		.27	355	81	79			
	120	1322	104.58	104.31	0.12		.31	355	81	79			
	130	1332	107.62	107.53	0.10		.33	355	82	79			
	140	1342	110.66	10.74	0.11		.33	355	83	80			
	150	1352	109.70	113.98	0.11		.31	350	83	80			
	160	1402	116.74	116.85	0.10		.30	350	83	82			
	170	1412	119.78	119.58	0.12		.25	350	90	84			
	180	1422	122.82	122.701	0.11		.25	345	85	82			
				122.701									
								T_s =					
			V_m =	54.601	.11	ΔH	.295	351.67		79			

COMMENTS:

EPA (Dur) 235
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP Outlet
Test Number ESP-0-1-1(B)

Date 5-1-81
Initial CU

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	360 ~~351.67~~
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = .295$ Pb=28.92 $V_m = 54.601$ $T_m = 79$	Vm_{std}	~~51.716~~ ~~49.74~~ 51.72
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ 23.7% Moisture collected from ESP-0-2-1	Mf	~~.81~~ .763
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	30.72
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~28.90~~ 27.71
Static pressure in stack, absolute, in. Hg -6.4" H_2O (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.45
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	~~1443~~ ~~1375~~ (1,450) 1,389
Total sample time, minutes	θ	180
Nozzle diameter, inches	Dn	.235
$\frac{1{,}039\ (360 + 460)(51.72)}{(\cancel{1375})(180)(28.45)(\cancel{.81})(.235^2)}$ 1,389 .763	% I	~~139.9~~ 147.02

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Run No. ESP-0-1-1(B)
Sample Location ESP Outlet Sample Date 5-1-81
Sample Box No. — Recovery Date
Sample Type Dust Cleanup Person

Filter No. 3
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE | SILICA GEL

	1	2	3	4	5
Impinger Sequence	1	2	3	4	5
Impinger Type[a]					
Impinger Solution					
Final Volume (wt)[b]	NOT	TAKEN		Assumed	
Initial Volume (wt)[b]		MASS	TRAIN	MOISTURE	
Net Volume (wt)[b]					
Sample No.(s)					

Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Dry Catch: Sample No.
Description
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier Date Shipped:
Remarks:

Date of laboratory custody Seal(s) broken by
Personnel accepting custody Date broken
Remarks:

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP OutLeT

Test Run Number ESP-0-1-1(13)

Pollutant(s) in Sample DusT

Task	Date	Time	Personnel	Remarks
Sampling	5-1-81	1122 To 1422	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		1430	~~Whited~~ Cobb	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP- 0-2-1 (A)

NON-ISO.

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date ~~5-1-81~~ 5-2-81

FIELD CREW

Crew Chief Hansen

Testing Engineer
1 Whited
2
3

Engr. Technician
1
2
3

Lab Technician
1
2
3

Process Engineer
1
2

Other
1
2

ANDERSEN SAMPLING CALCULATIONS

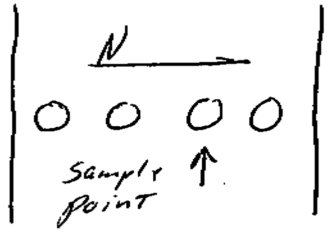
Plant Ideal Date 5-2-81
Sampling Location ESP Outlet Initial CV
Test No. ESP-0-2-1(A)

Velocity head at sampling location, in. H_2O Velocity taken at time of test	ΔPs	[illegible]	.15
Stack temperature at sample point, °F	Ts	355	
Barometric pressure, in. Hg	Pb	28.90	
Static pressure in stack, in. Hg −6.4 "H_2O (Pb) ± (0.074 x gage pressure, in. H_2O)	Ps	28.43	
4/30/81 assumed -18.9% from inlet ESP-I-3? Percent moisture in gas stream by volume	% H_2O	~~[illegible]~~ 18.9	
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.811 ~~.87~~ ~~.876~~	
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	30.72	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~27.67~~ ~~28.30~~	28.32
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$ Cp = 0.84 $\sqrt{\Delta Ps}$ = ~~[illegible]~~ .387	Vs	~~1183~~ ~~[illegible]~~ 1698	
Calculated nozzle diameter, in. Fs = 0.555 $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.245 ~~[illegible]~~ ~~[illegible]~~	
Actual nozzle diameter, in.	D_{n_a}	0.235	
Assumed meter temperature, °F	Tm	~~[illegible]~~ 90	
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs		
Calculated meter flow rate, ft^3/min $Fs\left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$ $\left(\frac{90+460}{355+460}\right)(.555)\left(\frac{28.43}{28.90}\right)(.81)$	Fm	0.299	

FIELD DATA - ANDERSEN

PLANT Ideal
DATE 5-2-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Dust
RUN NUMBER ESP-0-2-1(A)
OPERATOR White
AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 28.90
STATIC PRESSURE, (P_s) -6.4" H_2O
Filter Set 4

Leak CK: Inital at 15" Hg, CFM 0.000
Final at ____ Hg, CFM ____



SCHEMATIC OF TRAVERSE POINT LAYOUT
with Dimensions

Meter box 9
Calculated ACFM (desired) 0.299 or 2.99/10 min
Probe Tip Diameter 0.235
CO_2
O_2 30.72
CO
N_2
% H_2O 18.9%

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	GAS METER READING Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\ in})$, °F	DRY GAS METER TEMPERATURE OUTLET $(T_{m\ out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0935		128.000									
2	10	0945	130.99	130.73	.04	.26	.26	340	78	78			
	20	0955	133.98	133.45	0.05	.26	.28	340	83	79	3		75
	30	1005	136.97	136.40	0.04	.34	.30	345	87	81	3		
	40	1015	139.96	139.60	0.040	.34	.34	345	92	84	3		60
	50	1025	142.95	142.92	0.040	.34	.36	355	101	89	3		60
	60	1035	145.94	145.92	0.040	.26	.26	345	110	93	3		70
↓ Down	70	1045	148.93	149.10	0.080	.	.26	345	120	98	3		
↑ On	80	1055	151.92	—	.04	—	.26	347	109	99	3		70
	~~90~~	~~1116 1105~~	~~154.91~~	~~156.0~~	~~.04~~	~~—~~	~~.20~~	~~—~~	~~—~~	~~—~~	~~—~~		—
	~~100~~	~~1126 1115~~	~~157.90~~	~~158.96~~	~~.07~~		~~.20~~	~~355~~	~~89~~	~~90~~	~~0~~		
	110	1136 ~~1125~~	160.89										
	120	1146 ~~1135~~	163.88										
	130	1156 ~~1145~~	166.87										
	140	1206 ~~1155~~	169.86										
	150	1216 ~~1205~~	172.85										
	160	1226 ~~1215~~	175.84										
	170	1236 ~~1225~~	178.83										
	180	1246 ~~1235~~	181.820										
	/		STOP										

Instrument had to be serviced during the run. It was returned to service several minutes later.

COMMENTS:

(continued)

EPA (Dur) 235
4 72

Andersen III

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	GAS METER READING (V_m), ft^3 Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m_{in}})$, °F	DRY GAS METER TEMPERATURE OUTLET $(T_{m_{out}})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	Continued												
	90	1128	156.78	156.08	.08		.26	350	88	90			
	100	1138	162.77	158.90	.08		.26	355	89	92	3	3	70
	110	1148	162.76	162.13	.08		.35	355	94	92	3		
	120	1158	165.75	165.43	.09		.34	355	96	92	3		
	130	1208	168.74	168.68	.09		.27	355	100	93	3		
	140	1218	171.73	171.69	.08		.26	355	100	94	3		
	150	1228	174.72	174.35	.08		.26	355	100	94	3		
	160	1238	177.71	177.40	.08		.29	355	101	94	3		
	170	1248	180.70	180.66	.09		.33	360	104	98	3		
	180	1258	183.69	183.66	0.09		.27	360	104	99	3		
	~~190~~ END												
			~~Vm= 48.65~~ Vm= 48.68		.075	ΔH=	.292	351.2	Tm=	94.3			

Run Number ESP-O-2-1(A)   Date 5-2-81   Sampling Location ESP Outlet

Comments:

EPA (Dur) 236
4 72

ISOKINETIC PERFORMANCE WORKSHEET

Plant *Ideal* Date *5-2-81*
Sampling Location *ESP Outlet* Initial *CW*
Test Number *ESP-O-2-1 (A)*

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	~~351.2~~	(351.2) 355
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = .292 Pb = 28.90 Vm - 48.68 Tm - 94.3	Vm_{std}	44.80	
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ assumed from ESP-O-3-1 5/2/81 collected 25.3%	Mf	~~.76~~ .747	
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	30.72	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~27.67~~ 27.50	
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.43	
Stack velocity, fpm $5{,}128.8\,(Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ~~[illegible]~~ ΔP=.15 ΔP = (.075) Ts = 351.2)	Vs	~~1199~~ ~~1678~~ 1,704	(1,202)
Total sample time, minutes	θ	180	
Nozzle diameter, inches	Dn	.235	
1,039 (~~351.2~~ 355 (351.2) + 460)(44.8) / (~~1199~~ ~~1678~~ 1,704 (1,202))(180)(28.43)(~~.76~~ .747)(.235 ²)	% I	(148.8) ~~104~~ 105.5	

( ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal
Sample Location ESP Outlet
Sample Box No. —
Sample Type Dust

Run No. ESP-O-2-1 (A)
Sample Date 5-2-81
Recovery Date
Cleanup Person

Filter No.
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE Taken from ESP-O-3-1 method 12 on 5/2/81

SILICA GEL

Impinger Sequence	1	2	3	4	5
Impinger Type[a]					
Impinger Solution					
Final Volume (wt)[b]					
Initial Volume (wt)[b]	0				
Net Volume (wt)[b]					
Sample No.(s)					

Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked   Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier   Date Shipped:
Remarks:

Date of laboratory custody   Seal(s) broken by
Personnel accepting custody   Date broken
Remarks:

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP- Outlet

Test Run Number ESP- 0-2-1 (A)

Pollutant(s) in Sample Dust

Task	Date	Time	Personnel	Remarks
Sampling	5-2-81	0935 To 1258	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		1300	Whited	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

APPENDIX K

ACCEPTED RUNS BUT NOT USED IN CALCULATIONS

K-1 Electrostatic Precipitator Inlet

K-2 Electrostatic Precipitator Outlet

K-1 Electrostatic Precipitator Inlet

MIDWEST RESEARCH INSTITUTE

RUN ESP-I-3-1

No HCSS runs.

MRI Project Number 4892L-03
Field Dates
Plant IDEAL CEMENT CO.
Sampling Location ESP INLET
Sampling Date 4/30/81

FIELD CREW

Crew Chief	MARK HANSEN
Testing Engineer	1 TOM WALKER
	2
	3
Engr. Technician	1 MARK HANSEN
	2 DAN OLSON
	3
Lab Technician	1 JOEL PAVELONIS
	2
	3
Process Engineer	1 FRITZ HOFFMEISTER
	2
Other	1
	2.

NOMOGRAPH DATA

PLANT IDEAL CEMENT CO.

DATE 4/30/81

SAMPLING LOCATION ESP INLET

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	100
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	27
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.84 ~~29.06~~
STATIC PRESSURE IN STACK, in. Hg (P_m±0.074(STACK GAUGE PRESSURE in in. H_2O) •5.8	P_s	28.41 ~~28.63~~
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	1
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	393
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	1.4 AT B-5
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	—
C FACTOR		.68
CALCULATED NOZZLE DIAMETER, in.		.23
ACTUAL NOZZLE DIAMETER, in. #30		.247
REFERENCE Δp, in. H_2O		1.1

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant IDEAL CEMENT

Sampling Location ESP INLET

Test Number ESP I-3-1

Date 4/30/81

Initial DW

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

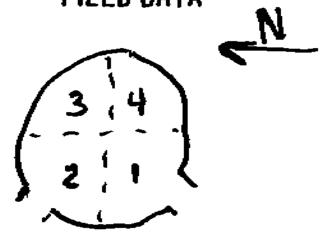
K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	100
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	3
Mole fraction dry gas	Mf	.73
Nozzle diameter, inches	Dn	~~.25~~ .247
Barometric pressure, inches Hg	Pb	28.84
$\frac{5.168\ (100 + 460)\ (.84)\ (3)\ (.73)\ (.247^2)}{\sqrt{28.84}}$ 5.37	K	60.48

FIELD DATA



PLANT Ideal Cement Co.
DATE 4/30/81
SAMPLING LOCATION ESP INLET
SAMPLE TYPE PARTICULATE
RUN NUMBER ESP-I-3-1
OPERATOR DW
AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 28.84
STATIC PRESSURE, (P_s) -5.8
FILTER NUMBER (s) 23

PROBE LENGTH AND TYPE 8' SS
NOZZLE I.D. .247
ASSUMED MOISTURE, % 27
SAMPLE BOX NUMBER 10
METER BOX NUMBER 3
METER $\Delta H_@$ 1.02
C FACTOR .68
PROBE HEATER SETTING
HEATER BOX SETTING
REFERENCE Δp 1.1

Leak CK: Initial at 15" Hg, CFM .01
Final at Hg, CFM .01

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY 3 MINUTES

$$VM = 60.48 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 502.33 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1650											
3	3	1653	504.30	504.35	.90	1.55	1.6	390	90	88	6	225	90
	6	1656	506.36	506.55	1.0	1.7	1.8	399	92	88	7	241	89
	9	1659	508.36	508.45	.92	1.55	1.4	380	96	89	6	260	89
	12	1702	510.34	510.32	.91	1.55	1.4	385	98	89	6	269	89
	15	1705	512.27	512.22	.87	1.5	1.45	394	100	90	5	280	89
			V_m = 9.89		Avg ΔP = .92	Avg ΔH 1.53		Avg T_s = 390	Avg T_m = 92				

COMMENTS.

18.9% moisture

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal Cement Co
Date 4/30/81
Sampling Location ~~ESP-I-3-1~~ ESP Inlet
Initial WLW
Test Number ESP-I-3-1

Isokinetic equation:

$$\% \ I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	390
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $\Delta H = 1.53$ $Pb = 28.84$ $Tm = 92$ $Vm = 9.89$	Vm_{std}	9.15
Mole fraction dry gas, $\frac{100-\% \ H_2O}{100}$ 18.9%	Mf	~~.73~~ .81
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28)	Md	~~31.58~~ 31.58
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~27.91~~ ~~28~~ 29.00
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	~~28.41~~ 28.41
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	~~4270.4~~ 4,197
Total sample time, minutes	θ	15
Nozzle diameter, inches	Dn	.247
$\frac{1{,}039\ (390 + 460)(9.15)}{(\cancel{4270.4})(15)(28.41)(\cancel{.73})(.247^2)}$ 4,197 .81	% I	~~99.52~~ 91.4

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant IDEAL CEMENT CO.
Sample Location ESP INLET
Sample Box No. 4
Sample Type PARTICULATE

Run No. ESP-I-3-1
Sample Date 4/30/81
Recovery Date
Cleanup Person

Filter No. ~~21~~ 23
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

						SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type[a/]	M	SG	M	M		
Impinger Solution	H_2O	H_2O	DRY	S.G.		
Final Volume (wt)[b/]	140	102	0			792.4
Initial Volume (wt)[b/]	100	100	0			789.3
Net Volume (wt)[b/]	40	2	0			3.1
Sample No.(s)						Silica Gel Color

Combined impinger contents, Sample No.
Liquid Level Marked Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 45.1

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed
Impinger Rinse: Sample No.
Liquid Level Marked
Sealed
Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed
Acetone Blank: Sample No.
Liquid Level Marked
Sealed
Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier Date Shipped:
Remarks:

Date of laboratory custody Seal(s) broken by
Personnel accepting custody Date broken
Remarks:

SAMPLE HANDLING LOG

Project Number 48921-03

Source Identification ~~ESP I-3-1~~ ESP Inlet

Test Run Number ESP-I-3-1

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	4/30/81	1650-1705		
Probe Technician			M. Hansen	
Meter Technician			T. Walker	
Other				
Transport of Train to Cleanup Site	4/30/81	1711		
Train Disassembly	4-30-81		J. Pavlovis	
Train Cleanout	4-30-81		J. Pavlovis	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

K-2 Electrostatic Precipitator Outlet

MIDWEST RESEARCH INSTITUTE

RUN ESP-0-1-1(A)

MRI Project Number 4892-L-03
Field Dates ______
Plant Ideal Cement
Sampling Location ESP- Outlet
Sampling Date 4-30-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 White
2 ______
3 ______

Engr. Technician 1 ______
2 ______
3 ______

Lab Technician 1 ______
2 ______
3 ______

Process Engineer 1 ______
2 ______

Other 1 ______
2 ______

NOMOGRAPH DATA

PLANT Ideal

DATE 4-30-81

SAMPLING LOCATION ESP Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	110
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	.27
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.84
STATIC PRESSURE IN STACK, in. Hg −6.4" H_2O ($P_m \pm 0.074$ STACK GAUGE PRESSURE in in. H_2O)	P_s	28.37
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	0.98
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	370
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	~~0.166~~ 0.15
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR		0.67
CALCULATED NOZZLE DIAMETER, in.		~~0.388~~ 0.40
ACTUAL NOZZLE DIAMETER, in. ~~60-1~~ #27		0.377
REFERENCE Δp, in. H_2O		~~[illegible]~~ ~~0.225~~ 0.210

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal
Sampling Location ESP Outlet
Test Number ESP-0-1-1(A)

Date 43081
Initial CTC

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	~~0.18~~ 110
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	5
Mole fraction dry gas	Mf	.73
Nozzle diameter, inches	Dn	0.377
Barometric pressure, inches Hg	Pb	28.84
$\frac{5.168\ (110 + 460)\ (.84)\ (5)\ (.73)\ (.377^2)}{\sqrt{28.84}}$	K	239.031

FIELD DATA

PLANT Ideal
DATE 4-30-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Particulate
RUN NUMBER ESP-O-1-1(A)
OPERATOR Whited
AMBIENT TEMPERATURE 85
BAROMETRIC PRESSURE 28.84
STATIC PRESSURE, (P_s) -6.4" H_2O
FILTER NUMBER (s) 1

N →

4 3 2 1

Sample

SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 48"
NOZZLE I.D. 0.377
ASSUMED MOISTURE, % 27%
SAMPLE BOX NUMBER NA
METER BOX NUMBER 2
METER $\Delta H_@$ 1.84
C FACTOR 0.69
PROBE HEATER SETTING —
HEATER BOX SETTING —
REFERENCE Δp ~~0.225~~ 0.210

Leak CK: Initial at 15" Hg, CFM 0.000
Final at Hg, CFM 0.000

READ AND RECORD ALL DATA EVERY 5 MINUTES

$VM = 239.031 \times \sqrt{\frac{Ps}{Ts + 460}}$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1441	444.001		0.18	1.5		376				NA	
	5	1446	446.64	446.67	0.1	0.95	0.97	360	85	90	4		60
	10	1451	449.29	449.35	0.1	0.95	0.95	355	90	90	4		60
	15	1456	451.93	451.90	0.1	0.95	0.93	355	96	90	4 3/4		60
	20	1501	454.58	—	0.1	0.95	0.95	355	101	95	4 3/4		60
	25	1506	457.36	457.20	0.11	1.05	1.05	355	108	97	4 3/4		60
	30	1511	460.27	460.29	0.12	1.15	1.30	350	108	97	4 3/4		60
	35	1516	463.17	463.177	0.12	1.15	1.20	355	104	98	4 3/4		60
						~~ΔH~~ 1.102							
			V_m = ~~19.169~~ 19.176		Δp_s=0.107		ΔH 1.05	T_s = 355	T_m =	~~96.6~~ 97			

COMMENTS:

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant *Ideal* — Date *4-30-81*

Sampling Location *ESP Outlet* — Initial *CTW*

Test Number *ESP-0-1-1 (A)*

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	*355*	
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ *ΔH = 1.05*, *Pb = 28.84*, ~~*Vm = 19.16*~~, *Tm = ~~98.6~~ 97*, *Vm = 19.176*	Vm_{std}	~~*22.2*~~ ~~*17.578*~~	*17.56* ~~*17.574*~~
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$ *assumed from Initial Stack Traverse data*	Mf	*0.73*	
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2$ x 0.44) + ($\%O_2$ x 0.32) + ($\%N_2$ + %CO x 0.28) *assumed from Initial Stack Traverse data*	Md	*30.72*	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	*27.29*	
Static pressure in stack, absolute, in. Hg *-6.4" H2O* (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	*28.37*	
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ *Cp = 0.84*, *ΔP = .107*	Vs	*1445*	
Total sample time, minutes	θ	~~*30*~~ *35*	
Nozzle diameter, inches	Dn	*0.377*	
$\frac{1{,}039\ (\underline{355} + 460)(\underline{\cancel{17.568}}\ \cancel{17.574}\ 17.56)}{(\underline{1445})(\underline{35})(\underline{28.37})(\underline{0.73})(\underline{0.377}^2)}$	% I	~~*116.58*~~ ~~*99.96*~~	*99.88*

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal Cement
Sample Location ESP Outlet
Sample Box No. 2
Sample Type Particulate

Run No. ESP-0-1-1(A)
Sample Date 4-30-81
Recovery Date
Cleanup Person

Filter No. 1
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

						SILICA GEL
Impinger Sequence	1	2	3	4	5	
Impinger Type[a]						
Impinger Solution						
Final Volume (wt)[b]	134					492.4
Initial Volume (wt)[b]	0					481.8
Net Volume (wt)[b]	134					10.6
Sample No.(s)						

Combined impinger contents, Sample No.
Silica Gel Color
Liquid Level Marked
Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm 144.6

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed
Impinger Rinse: Sample No.
Liquid Level Marked
Sealed
Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed
Acetone Blank: Sample No.
Liquid Level Marked
Sealed
Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier
Date Shipped:
Remarks:

Date of laboratory custody
Personnel accepting custody
Seal(s) broken by
Date broken
Remarks: METHOD 17

MIDWEST RESEARCH INSTITUTE

Run No. ESP-0-1-1 (A) PARTICULATE CLEAN-UP AND ANALYSIS

Date 4-30-81

FIELD ANALYSIS

Performed by ______

Impinger Sequence	1	2	3	4	5	6
Impinger Type*						
Final Volume**						
Initial Volume**						
Difference						

* S = Greenburg-Smith standard, M = modified, O = Other ______

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
		4					
		5					
		6					
		6					
		6					
		7					
		8					
		9					
		10					

Comments:

Codes:
1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 4812-L-03

Source Identification ESP Outlet

Test Run Number ESP-O-1-1(H)

Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	4-30-81	1440 to 1516		
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Gleanup Site		1530	Whited	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-O-1-1 B

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 4-30-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 Whitell
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

MRI - Form PO (10/72)

NOMOGRAPH DATA

PLANT Ideal

DATE 4-30-81

SAMPLING LOCATION ESP Outlet

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\,avg.}$	~~100~~ 110
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	18.9
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.74
STATIC PRESSURE IN STACK, in. Hg − 6.4" H_2O (P_m ±0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.27
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	0.98
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	355
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.14
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR		0.83
CALCULATED NOZZLE DIAMETER, in.		0.380
ACTUAL NOZZLE DIAMETER, in.		0.377
REFERENCE Δp, in. H_2O		0.16

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant Ideal
Sampling Location ESP Outlet
Test Number ESP-O-1-1 (B)

Date 4-30-81
Initial CW

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	110
Pitot coefficient	Cp	0.84
Sampling time interval, minutes	θi	5
Mole fraction dry gas	Mf	0.82
Nozzle diameter, inches	Dn	0.377
Barometric pressure, inches Hg	Pb	~~28.27~~ 29.74
$\frac{5.168\ (110 + 460)\ (.84)\ (5)\ (.82)\ (.377^2)}{\sqrt{\cancel{28.27}\ 29.74}}$	K	~~223.61~~ ~~271.194~~ 268.97

FIELD DATA

PLANT Ideal
DATE 4-30-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE Particulate
RUN NUMBER ESP-0-1-1-(B)
OPERATOR United
AMBIENT TEMPERATURE 85
BAROMETRIC PRESSURE ~~28.27~~ 28.74
STATIC PRESSURE, (P_s) 6.4" H_2O
FILTER NUMBER (s) 2

N

4 3 2 1
O O O O

Sample Point

SCHEMATIC OF TRAVERSE POINT LAYOUT

PROBE LENGTH AND TYPE 4½
NOZZLE I.D. 0.377
ASSUMED MOISTURE, % 18%
SAMPLE BOX NUMBER 2
METER BOX NUMBER — 2
METER $\Delta H_@$ 1.84
C FACTOR 0.83
PROBE HEATER SETTING —
HEATER BOX SETTING —
REFERENCE Δp 0.16

Leak CK: Initial at 15" Hg, CFM 000
Final at Hg, CFM 0.000

READ AND RECORD ALL DATA EVERY 5 MINUTES

$VM = \frac{\cancel{27.19}}{\cancel{23.36}} \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$

Vm = 268.97

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3 Desired	Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1942	497.882										
	5	1947	501.317	500.79	0.13	1.5	1.5	360	94	100	4¾		74
	10	1952	505.10	504.5	0.16	1.8	2.1	360	97	100	4¾		
	15	1957	508.95	507.30	0.16	1.8	2.0	360	105	100			
	20	2002	512.74	512.43	0.18	1.8	2.5	360	110	100			
	25	2007	516.64	516.46	0.17	1.9	2.4	360	113	102			
	30	2012	520.54	520.50	0.17	1.9	2.3	355	118	104	5.7		
	35	2017	524.34	524.22	0.16	1.8	2.0	355	115	110	5.7		89
	40	2022	528.37	28.57	0.18	2.1	2.5	355	118	112	5.7		80
	45	2027	531.92	531.70	0.14	1.6	1.2	350	118	112	5.0		
	50	2022	534.92	535.1	0.1	1.2	1.4	350	118	112	5.0		
	55	2029	538.09	538.00	0.11	1.3	1.3	355	118	112			
	60	2032	541.53	541.600	0.13	1.7	1.8	355	118	112	"		
				Vm = 43.708	ΔPs = 0.1475	1.7	ΔH = 1.917	Ts = 356.25		Tm = 109.1			

COMMENTS:

EPA (Dur) 235

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP Outlet
Test Number ESP- 0-1-1 (B)

Date 4-30-81
Initial CW

Isokinetic equation:

$$\% I = \frac{1,039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	356	
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ 43,708 = Vm; Pb ~~29.27~~ 28.74; ΔH = 1.917; Tm = 109.1	Vm_{std}	~~38.49~~	39.13
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 27.2 %	Mf	~~.82~~	.728
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	30.72	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~28.43~~	27.26
Static pressure in stack, absolute, in. Hg −6.4" H_2O (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	~~27.796~~	28.27
Stack velocity, fpm ΔPs = 0.1475 $5,128.8\ (Cp)\left(\sqrt{\Delta Ps}_{avg}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	~~1681~~	1,703
Total sample time, minutes	θ	60	
Nozzle diameter, inches	Dn	0.377	
$\frac{1,039\ (356 + 460)(\cancel{38.49}\ 39.13)}{(\cancel{1681})(60)(\cancel{27.80})(\cancel{.82})(.377^2)}$ 1,703 (28.27) (.728)	% I	~~99.86~~	111.00

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ideal　　　　Run No. ESP-0-1-1 (B)
Sample Location ESP Outlet　　　　Sample Date 4-30-81
Sample Box No. —　　　　Recovery Date
Sample Type Particulate　　　　Cleanup Person

Filter No. 2
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

	1	2	3	4	5
Impinger Sequence	1	2	3	4	5
Impinger Type[a]					
Impinger Solution					
Final Volume (wt)[b]	285				
Initial Volume (wt)[b]	0				
Net Volume (wt)[b]					
Sample No.(s)					

Combined impinger contents, Sample No.
Liquid Level Marked　　　　Container(s) Sealed
Description of Impinger Solution
Total Moisture, gm ~~278.285~~ 308.7

SILICA GEL

505.5
481.8, 2 Times Used
= 23.7　　0-1-1　0-1-1B
Silica Gel
Color

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed
Impinger Rinse: Sample No.
Liquid Level Marked
Sealed
Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed
Acetone Blank: Sample No.
Liquid Level Marked
Sealed
Filter Blank: Sample No.
Sealed

Sample Disposition
Carrier　　　　Date Shipped:
Remarks:

Date of laboratory custody　　　　Seal(s) broken by
Personnel accepting custody　　　　Date broken
Remarks:

ESP-0-1-1 (B)

MIDWEST RESEARCH INSTITUTE

Run No. ______

PARTICULATE CLEAN-UP AND ANALYSIS

Date 4-30-81

FIELD ANALYSIS

Performed by ______

Impinger Sequence	1	2	3	4	5	6
Impinger Type*						
Final Volume**						
Initial Volume**						
Difference						

* S = Greenburg-Smith standard, M = modified, O = Other ______

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
		4					
		5					
		6					
		6					
		6					
		7					
		8					
		9					
		10					

Comments:

Codes:
1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 4892-L-03
Source Identification ESP Outlet
Test Run Number ESP-0-1-1 (B)
Pollutant(s) in Sample Particulate

Task	Date	Time	Personnel	Remarks
Sampling	4-30-81	1947 to 2030	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site	4-30-81	2040	Hoffmister	
Train Disassembly				
Train Cleanout				
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

RUN ESP-0-2-2 (A)

MRI Project Number 4892-L-03
Field Dates
Plant Idoal
Sampling Location ESP Outlet
Sampling Date 5-7-81

FIELD CREW

Crew Chief Hansen

Testing Engineer
1 Whited
2
3

Engr. Technician
1
2
3

Lab Technician
1
2
3

Process Engineer
1
2

Other
1
2

NOMOGRAPH DATA

PLANT Ideal

DATE 5-4-82

SAMPLING LOCATION ESP OUTLET

First half ESP-O-Z-2(A) 50 min.

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\,avg.}$	100
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	23.35
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.72
STATIC PRESSURE IN STACK, in. Hg (P_m ± 0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.25
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.98
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	340
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.1
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR	0.75	
CALCULATED NOZZLE DIAMETER, in.	.435	
ACTUAL NOZZLE DIAMETER, in.	.440	
REFERENCE Δp, in. H_2O	.95	

EPA (Dur) 234
4 72

NOMOGRAPH DATA

PLANT Ideal

DATE 5-4-81

SAMPLING LOCATION ESP Outlet

130 min. ESP-O-2-2-(A)

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.84
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	110
PERCENT MOISTURE IN GAS STREAM BY VOLUME	% H_2O	23.3
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	28.72
STATIC PRESSURE IN STACK, in. Hg (P_m ± 0.074 STACK GAUGE PRESSURE in in. H_2O)	P_s	28.25
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	.98
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	300
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.48
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	
C FACTOR		.75
CALCULATED NOZZLE DIAMETER, in.		0.290
ACTUAL NOZZLE DIAMETER, in.		.297
REFERENCE Δp, in. H_2O		0.42

EPA (Dur) 234
4 72

ISOKINETIC SAMPLING WORKSHEET

Plant *Ideal* | Date *5-6-81*
Sampling Location *ESP Outlet* | Initial *CC*
Test Number *ESP-O-2-2 (A)*

Isokinetic sampling equation:

$$Vm_i = K \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Where: $$K = \frac{5.168\ (Tm_{avg} + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}}$$

Vm_i = Volume of the meter per sampling interval, ft^3

K = Constant of fixed and assumed parameters, dimensionless

ΔPs = Velocity head of S pitot, inches H_2O

Ts = Stack temperature, °F

Assumed average meter temperature, °F	Tm_{avg}	110
Pitot coefficient	Cp	.84
Sampling time interval, minutes	θi	10
Mole fraction dry gas	Mf	.77
Nozzle diameter, inches	Dn	.297
Barometric pressure, inches Hg	Pb	28.72
$\frac{5.168\ (110 + 460)\ (.84)\ (10)\ (.77)\ (.297^2)}{\sqrt{28.72}}$	K	313.61 317.23

Mo (

Molec (Md

Static (Pb)

Stack vel

5,128.8

tal sampl

zzle diamet

39 (321.

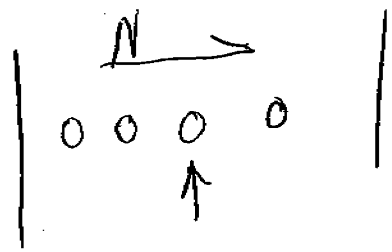
)(130)(28

Lost. 130

WATERPROOF PAPER

FIELD DATA

PLANT Ideal
DATE 5-4-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE
RUN NUMBER ESP-O-2-2(A)
OPERATOR White
AMBIENT TEMPERATURE 80
BAROMETRIC PRESSURE 28.72
STATIC PRESSURE (P_s) -6.4" H_2O
FILTER NUMBER(s) 7



PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. 44 / .297
ASSUMED MOISTURE, % 23.3
SAMPLE BOX NUMBER -
METER BOX NUMBER 5
TEMPERATURE METER NO. 5
METER ΔH@ 1.84
METER CORRECTION
C FACTOR .75
REFERENCE Δp ~~2.95~~ .42

$$VM = \cancel{66.45} \; 313.61 \; 317.73 \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

Schematic of Traverse Point Layout
Read and Record All Data
Every 10 Minutes

LEAK CK: Initial at 15" Hg, CFM 0.00
Final at 5 Hg, CFM 0.000

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
			419.210	~~357.845~~		~~2.35~~	~~2.3~~	~~300~~	~~100~~	~~100~~			100
	0	~~1810~~	~~427.60~~	~~427.22~~	.12				100	100			—
	10	~~1000~~			~~.11~~	2.35	2.3	300	100	102	7		
			427.60	427.22	.12	2.90	2.9	320	110	102	8		
off	10	1620	436.80	436.33	.15	~~2.9~~	~~3.1~~	~~320~~	~~115~~	102	~~8~~		
1820	20	1656	~~445.99~~		~~.15~~								
		~~1706~~											
on		1708	off						11.	102	8		
		1710	on			2.9	3.1	320	130	115	10		
			445.99	445.84	.15	4.0	4.1	320	130	120	15		
	70	1720	456.87	456.56	.21	4.5	4.5	320			10.	.297" ID	
	40	1730	468.50	467.78	.24			changed Nozzle			8.3		
50	off	1737			~~.08~~				115	110			
	on	1741				.33	.38	315	120	105	3	400ml/H_2O drained	
	60	1742	476.65	472.90	.08	.34	.33	315	120	105	2		
	70	1752	474.80	475.22	.08	.44	.40	320	120	105	3		
off 1802	80	1802	478.33	478.74	.10	.44	.38	330	120	105	3		
1816	90	1826	481.86	482.40	.10	.39	.33	315	118	107	3		
on	100	1836	485.24	485.18	.09	.43	.37	315	118	105	3		
	120	1846	488.80	489.30	.10	.34	.27	315	118	105	3		
	130	1856	492.40	492.50	.08	.34	.25	325	124	105	3		
	140	1906	495.61	495.58	.08	.37	.38	325	124	109	3		
	140	1906		499.23	.09			330	124	112	3	400ml/H_2O Drained	
	150	1916	499.01	502.5	.08	.34	.30	325	123	114	3		
	160	1926	502.21	505.67	.09	.39	.35	325	123	114	5		
	170	1936	505.61	509.28	.09	.39	.36	325	123	114	5	152 ml/H_2O	
0937			509.01			.34	.28	325					

$$\frac{(50\,min \times \ldots \times 120.6\%)}{180\,min.} = 118.1\%$$

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location 5-4-81
Test Number ESP-

Isokine...

M

Sta
(.

Stack

5,12

Total sa

Nozzle di

1,039 (

(1847)(50

Fi

(50mm

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Run No. ESP-0-2-2(A)
Sample Date 5-4-81
Recovery Date
Cleanup Person

Plant Ideal
Sample Location ESP Outlet
Sample Box No.
Sample Type

Filter No. 2
Sample No.
Sample Material Description

MOISTURE AND/OR SAMPLE

	1	2	3	4	5
Impinger Sequence					
Impinger Type[a]					
Impinger Solution	~~100~~ H_2O				
Final Volume (wt)[b]	400				
Initial Volume (wt)[b]	100	400	152		
Net Volume (wt)[b]	300				
Sample No.(s)					

SILICA GEL

560.7	581.2	446.3
454.5	461.2g	443.9
106.2	120.0	2.4

Silica Gel
Color

Combined impinger contents, Sample No. Container(s) Sealed
Liquid Level Marked
Description of Impinger Solution
Total Moisture, gm 1080.6

a/ S = Greenburg-Smith standard, M = Modified, O = Other
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No.
Liquid Level Marked
Sealed

Impinger Rinse: Sample No.
Liquid Level Marked
Sealed

Water Blank: Sample No.
Liquid Level Marked

Dry Catch: Sample No.
Description
Sealed

Acetone Blank: Sample No.
Liquid Level Marked
Sealed

Filter Blank: Sample No.
Sealed

Sample Disposition
Date Shipped:
Carrier
Seal(s) broken by
Remarks:
Date broken

Date of laboratory custody
Personnel accepting custody
Remarks:

ESP-0-2-2 (A)

Run No. ______

MIDWEST RESEARCH INSTITUTE

PARTICULATE CLEAN-UP AND ANALYSIS

Date 5/4/81

FIELD ANALYSIS

Performed by ______

Impinger Sequence	1	2	3	4	5	6
Impinger Type*						
Final Volume**						
Initial Volume**						
Difference						

* S = Greenburg-Smith standard, M = modified, O = Other ______

** Indicate value and units (ml or gm)

MRI LAB ANALYSIS

Sample No.	Filter No.	Code	Final Weight (gm)	Tare Weight (gm)	Sample Volume (ml)	Performed By	Date
		1					
		2					
		3					
		4					
		5					
		6					
		6					
		6					
		7					
		8					
		9					
		10					

Comments:

Codes:

1. Ether-chloroform extraction of impinger water
2. Impinger water residue
3. Impingers and back half of filter, acetone wash
4. Dry probe and cyclone catch (generally no data)
5. Probe, cyclone, flask and front half of filter, acetone wash
6. Filter
7. Ether blank
8. Chloroform blank
9. Water blank
10. Acetone blank

MRI-Form P10 (10/72)

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP Outlet

Test Run Number ESP-0-2-2(A)

Pollutant(s) in Sample ______

Task	Date	Time	Personnel	Remarks
Sampling	5-4-81	1610 TO 2012	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other		2030	Fritz	
Transport of Train to Cleanup Site				
Train Disassembly	5-4-81		Joel Pavlowis	
Train Cleanout	5-4-81		Joel Pavlowis	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN ESP-O-2-2(A)

MRI Project Number 4892-L-03
Field Dates
Plant Ideal
Sampling Location ESP Outlet
Sampling Date 5-5-81

FIELD CREW

Crew Chief Hansen

Testing Engineer 1 Whited
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

MRI - Form PO (10/72)

ANDERSEN SAMPLING CALCULATIONS

Plant *Ideal* Date *5-5-81*
Sampling Location *ESP-Outlet* Initial *CU*
Test No. *ESP-O-2-2 (A)*

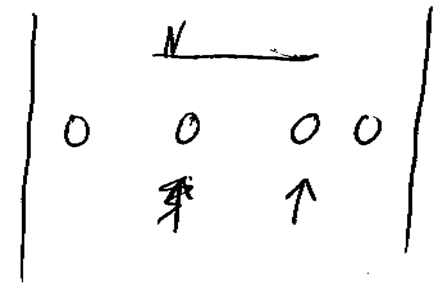
Velocity head at sampling location, in. H_2O	ΔPs	.08
Stack temperature at sample point, °F	Ts	340
Barometric pressure, in. Hg	Pb	28.82
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O)	Ps	28.35
Percent moisture in gas stream by volume	% H_2O	
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.77
Molecular wt. dry stack gas, lb/lb-mole *assumed from ESP-O-2-2 method 11* (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	30.90
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	27.93
Stack velocity, fpm $5{,}128.8\ (Cp) \left(\sqrt{\Delta Ps}\right) \sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	1225
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min *Fs: ~~0.6~~ 0.538*	D_{n_c}	.284
Actual nozzle diameter, in. *6 - 7.0*	D_{n_a}	.273
Assumed meter temperature, °F	Tm	~~100~~ 110
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	
Calculated meter flow rate, ft^3/min $Fs \left(\frac{Tm+460}{Ts+460}\right) \left(\frac{Ps}{Pb}\right) (Mf)$	Fm	~~.292~~ .277

WATERPROOF PAPER

FIELD DATA

Anderson Mark III

PLANT Ideal
DATE 5-5-81
SAMPLING LOCATION ESP Outlet
SAMPLE TYPE
RUN NUMBER ESP-O-2-2(A)
OPERATOR Whited
AMBIENT TEMPERATURE 60
BAROMETRIC PRESSURE 28.82
STATIC PRESSURE (P_s) -6.4" H2O
FILTER NUMBER(s) 8



Schematic of Traverse Point Layout

$Fm = \cancel{.292}$ .297

PROBE LENGTH AND TYPE 4'6"
NOZZLE I.D. .
ASSUMED MOISTURE, % 23
SAMPLE BOX NUMBER
METER BOX NUMBER 9
TEMPERATURE METER NO.
METER ΔH@ 1.84
METER CORRECTION
C FACTOR —
REFERENCE Δp —

LEAK CK: Initial at 15" Hg, CFM 0.00
Final at ___ Hg, CFM ___

Read and Record All Data Every 10 Minutes

$VM = \_\_\_ \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³ Desired	GAS METER READING (V_m), ft³ Actual	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	0942		413.100									
	10	0952	416.07	416.20	.10	.25	.24	330	70	70	4		60
	20	1002	419.04	418.98	.11		.24	320	70	70	4		
	30	1012	422.01	419.89	.12		.26	320	75	70	4		
	40	1022	424.98	424.41	.11		.27	320	75	75	4		60
	50	1032	427.95	427.31	.10		.29	320	79	75	4		60
	60	1042	430.92	430.48	.11		.29	320	79	75	4		60
	70	1052	433.89	433.62	.11		.31	320	79	75	4		60
	80	1102	436.86	436.82	.11		.31	320	79	76	4		60
	90	1112	439.83	439.74	.10		.26	320	79	79	4		60
	100	1122	442.80	442.75	.10		.27	320	78	78	4		60
	110	1132	445.77	445.63	.10		.28	320	79	79	4½		60
	120	1142	448.74	448.68	.11		.28	320	79	79	4½		56
	130	1152	451.71	451.70	.11		.28	315	79	79	4½		56
	140	1202	454.68	454.58	.11		.27	310	79	79	4½		56
	150	1212	457.65	457.69	.10		.28	305	81	79	4½		55
	160	1222	460.62	460.68	.11		.28	305	82	78	4½		55
	170	1232	463.59	463.53	.10		.26	305	82	80	4½		55
	180	1242	466.56	466.555	.10		.26	305	82	80	4½		55
				53.455	.106		.273	316.39		77.33			

COMMENTS:

ISOKINETIC PERFORMANCE WORKSHEET

Plant Ideal
Sampling Location ESP Outlet
Test Number ESP-O-2-2 (A)

Date 5-5-8
Initial CO

Isokinetic equation:

$$\% I = \frac{1{,}039(Ts_{avg}+460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$

Average stack temperature, °F	Ts_{avg}	340 (316)	
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ ΔH = .273 Pb = 28.82 Tm = 77.33 Vm = 53.455	Vm_{std}	50.61	
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$ 29.00%	Mf	.71	
Molecular wt. dry stack gas, lb/lb-mole ($\%CO_2 \times 0.44$) + ($\%O_2 \times 0.32$) + ($\%N_2 + \%CO \times 0.28$)	Md	30.90	
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	~~27.03~~	27.16
Static pressure in stack, absolute, in. Hg −6.4" H₂O (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	28.35	
Stack velocity, fpm 5,128.8 (Cp)$\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$ ΔP = (.106) ΔP = .08 Ts = 340 Ts (316)	Vs	~~1411.5~~ 1,242 (1,409)	
Total sample time, minutes	θ	180	
Nozzle diameter, inches	Dn	.273	
$\frac{1{,}039\ ((316)\ 340 + 460)(50.61)}{(\cancel{1411}\text{)(180)(28.35)(}\cancel{.70}\text{)(.273}^2)}$	% I	~~108.6~~	(107.3) 125.4

1,242
(1,409)
.71

(   ) = actual

PARTICULATE SAMPLE RECOVERY AND INTEGRITY

Plant Ided   Run No. Anderson ESP-O-2-2 (A)

Sample Location ESP OutleT   Sample Date 5-5-81

Sample Box No. ______   Recovery Date ______

Sample Type ______   Cleanup Person ______

Filter No. 8 ______ ______

Sample No. ______ ______ ______

Sample Material Description ______

MOISTURE AND/OR SAMPLE

						SILICA GEL	
Impinger Sequence	1	2	3	4	5		
Impinger Type[a]							
Impinger Solution							
Final Volume (wt)[b]	~~7[illegible]~~ 2[illegible]	~~[illegible]~~	~~439~~			762.4	
Initial Volume (wt)[b]	200	~~[illegible]~~	~~[illegible]~~			751.2	
Net Volume (wt)[b]	~~[illegible]~~ 190	~~[illegible]~~	~~439~~			11.2	
Sample No.(s)				428		Silica Gel	

Combined impinger contents, Sample No. ______   Color ______

Liquid Level Marked ______   Container(s) Sealed ______

Description of Impinger Solution ______

Total Moisture, gm 439.2

a/ S = Greenburg-Smith standard, M = Modified, O = Other ______
b/ Indicate value in units, ml or gm

RECOVERED SAMPLE

Probe Rinse: Sample No. ______   Dry Catch: Sample No. ______
Liquid Level Marked ______   Description ______
Sealed ______   Sealed ______

Impinger Rinse: Sample No. ______   Acetone Blank: Sample No. ______
Liquid Level Marked ______   Liquid Level Marked ______
Sealed ______   Sealed ______

Water Blank: Sample No. ______   Filter Blank: Sample No. ______
Liquid Level Marked ______   Sealed ______

Sample Disposition ______

Carrier ______   Date Shipped: ______

Remarks: ______

Date of laboratory custody ______   Seal(s) broken by ______

Personnel accepting custody ______   Date broken ______

Remarks: ______

SAMPLE HANDLING LOG

Project Number 4892-L-03

Source Identification ESP OuTLeT

Test Run Number ESP-0-2-2(A)

Pollutant(s) in Sample ______

Task	Date	Time	Personnel	Remarks
Sampling	5-5-81	0942 To 1242	Whited	
Probe Technician			Whited	
Meter Technician			Whited	
Other				
Transport of Train to Cleanup Site		1245	Cobb	
~~Train~~ Disassembly	5-5-81		J. Purdom	
~~Train~~ Cleanout	5-5-81		J. Purdom	
Packing and Storage				
Shipment to Analysis Site				
Lab Analysis				
Write Up				

APPENDIX L

SAMPLE CALCULATIONS AND NOMENCLATURE

NOMENCLATURE

Equation No.	Symbol	Description	Units
1	Vi	Initial meter reading	dcf
	Vf	Final meter reading	dcf
	Vm	Volume meter, actual	dcf
2	Pb	Barometric pressure	in. Hg
	ΔH_{avg}	Average orifice pressure drop	in. H_2O
	Tm_{avg}	Average meter temperature	°F
	Vm_{std}	Volume meter, standard conditions	dscf
3	Vlc	Total moisture collected	grams
	Wwc_{std}	Volume of water vapor collected, standard conditions	ft^3
	% H_2O	Percent moisture by volume	-
4	Mf	Mole fraction of dry gas	-
5	% CO_2	Percent carbon dioxide by volume, dry	-
	% O_2	Percent oxygen by volume, dry	-
	% CO	Percent carbon monoxide by volume, dry	-
	% N_2	Percent nitrogen by volume, dry	-
6	Md	Molecular weight, dry stack gas	lb/lb-mole
7	Ms	Molecular weight, stack gas	lb/lb-mole
8	θi	Sampling time interval	minutes
	Dn	Diameter of nozzle	inches
	ΔPs	Velocity head of S pitot	in. H_2O
	Ts	Temperature of stack gas	°F
	Vm_i	Volume of meter per sampling interval	ft^3
9	ΔPs_{avg}	Average velocity head of S pitot	in. H_2O
	Ts_{avg}	Average temperature of stack gss	°F
	Ps	Stack pressure, absolute	in. Hg
	Vs	Average stack gas velocity	fpm
10	θ	Total time of test	minutes
	% I	Percent isokinetic	-
11	ID	Inside diameter of stack	inches
	As	Area of stack	in^2
12	Qs	Stack flowrate, dry standard conditions	dscfm
13	m_n	Total particulate matter collected	mg
	Cs_{std}	Concentration of particulate collected, dry basis, standard conditions	gr/dscf
14	Cs_{act}	Concentration of particulate collected, actual conditions	gr/acf
15	Ep	Particulate emission rate	lb/hr

PARTICULATE CALCULATION EQUATIONS

1. $Vm = Vf - Vi$

2. $$Vm_{std} = \frac{17.64\ (Vm)\left(Pb + \frac{\Delta H_{avg}}{13.6}\right)}{Tm_{avg} + 460}$$

3. $Vwc_{std} = 0.0471\ (Vlc)$

$$\%\ H_2O = \frac{100\ (Vwc_{std})}{Vm_{std} + Vwc_{std}}$$

4. $$Mf = \frac{100 - \%\ H_2O}{100}$$

5. $\%\ N_2 = 100 - (\%\ CO_2 + \%\ O_2 + \%\ CO)$

6. $Md = (\%\ CO_2 \times 0.44) + (\%\ O_2 \times 0.32) + (\%\ N_2 + \%\ CO \times 0.28)$

7. $Ms = (Md \times Mf) + 18(1 - Mf)$

8. $$Vm_i = \frac{5.168\ (Tm + 460)\ (Cp)\ (\theta i)\ (Mf)\ (Dn^2)}{\sqrt{Pb}} \times \sqrt{\frac{\Delta Ps}{Ts + 460}}$$

9. $$Vs = 5{,}128.8\ (\sqrt{\Delta Ps}_{avg})\sqrt{\frac{Ts_{avg} + 460}{Ps \times Ms}} \times C_p$$

10. $$\%\ I = \frac{1{,}039\ (Ts_{avg} + 460)\ (Vm_{std})}{Vs\ (\theta)\ (Ps)\ (Mf)\ (Dn^2)}$$

11. $$As = \pi\left(\frac{ID}{2}\right)^2$$

12. $$Qs = \frac{0.122\ (Vs)\ (As)\ (Mf)\ (Ps)}{Ts_{avg} + 460}$$

13. $$Cs_{std} = 0.0154\left(\frac{m_n}{Vm_{std}}\right)$$

14. $$Cs_{act} = \frac{17.64\ (Cs_{std})\ (Ps)\ (Mf)}{Ts_{avg} + 460}$$

15. $Ep = 0.00857\ (Cs_{std})\ (Qs)$

ANDERSEN SAMPLING CALCULATION WITH PRESEPARATOR

1. Static pressure in stack

   $P_s = Pb \pm (0.074 \times \text{gauge pressure, in } H_2O)$

2. Mole fraction, dry gas

   $$mf = \frac{100 - \%\ H_2O}{100}$$

3. Molecular weight, dry stack gas, lb/lb-mole

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

4. Molecular weight, stack gas, lb/lb-mole

   $Ms = (Md)(Mf) + 18(1 - Mf)$

5. Stack velocity, fpm

   $$Vs = 5{,}128.8\ (Cp)\ \left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$$

6. Sample rate for 15 µ cutoff

   Viscosity = 63 + 0.4T(°K),
   then see graph for flow rate (F_s)

7. Calculated nozzle diameter, in.

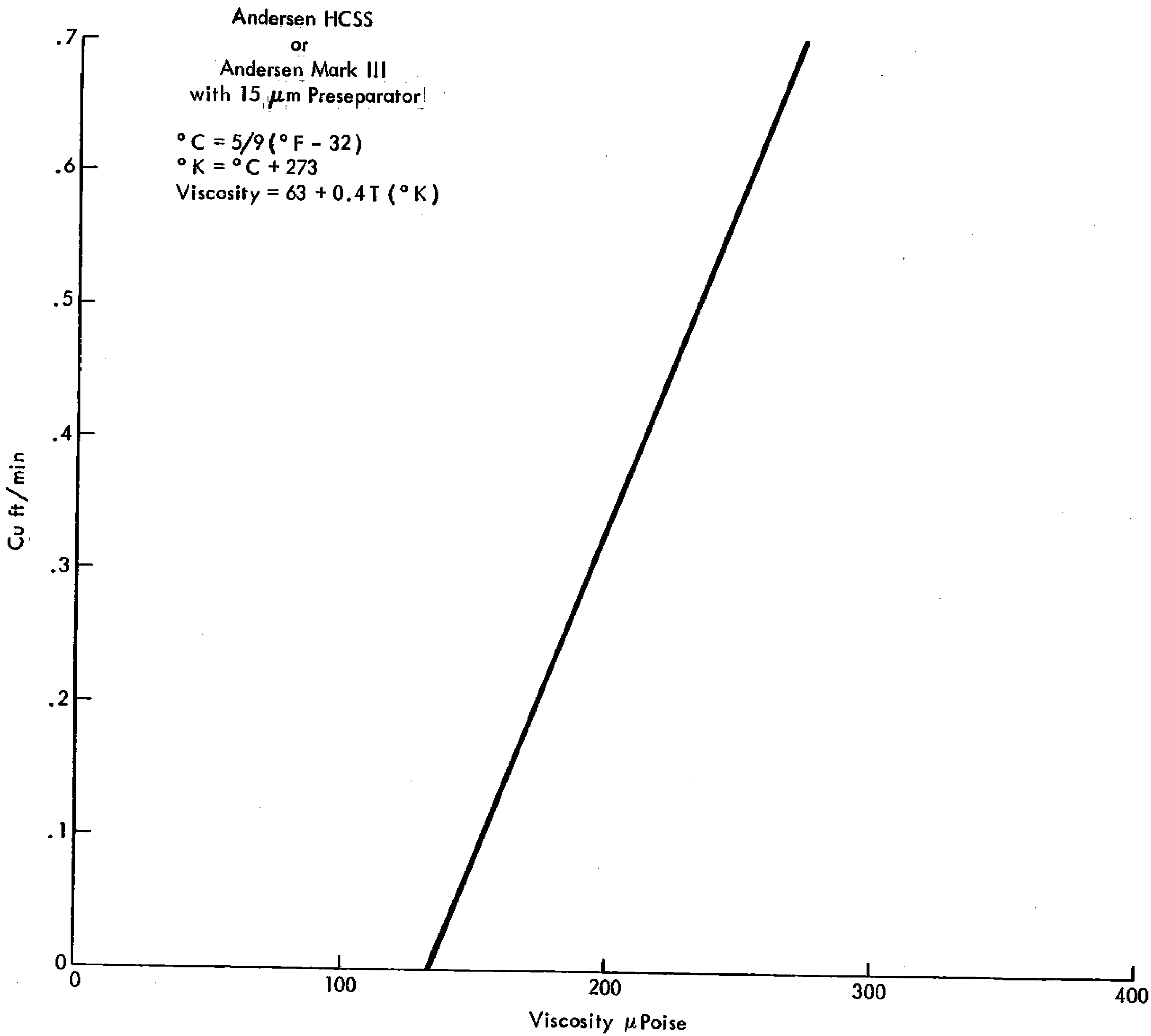
   $$24\sqrt{\frac{Fs/VS}{\pi}}$$

8. Calculated meter flow rate, ft^3/min (F_m)

   $$Fm = Fs\left(\frac{Tm + 460}{Ts + 460}\right)\left(\frac{Ps}{Pb}\right)\ (Mf)$$

9. Percent isokinetic

   $$\%\ I = \frac{1{,}039(Ts_{avg} + 460)(Vm_{std})}{Vs(\theta)(Ps)(Mf)(Dn^2)}$$


Andersen HCSS
or
Andersen Mark III
with 15 μm Preseparator
° C = 5/9 (° F - 32)
° K = ° C + 273
Viscosity = 63 + 0.4 T (° K)
Cu ft/min
.7
.6
.5
.4
.3
.2
.1
0
0
100
200
300
400
Viscosity μ Poise

Andersen D_{50} Calculations

Below is the formula for calculating the cutpoint on a Mark III sampler at various temperatures and pressures:

Plate No.	No. of Holes	Hole Diameter (cm)
0	264	0.1613
1	264	0.1181
2	264	0.0914
3	264	0.0711
4	264	0.0533
5	264	0.0343
6	264	0.0254
7	156	0.0254

$$D_{P50} = \sqrt{\frac{18\mu\ \Psi N \Pi\ D_c^{3}}{4\ C\ \rho\ Q}}$$

Where:

D_{P50} = 50% effective cutoff diameter of particle, cm

μ = gas viscosity, poise = 63 + 0.40 T (°K) 10^{-6}

Ψ = dimensionless inertial impaction parameter, 0.14

N = number of jets per plate

D_c = jet diameter, cm

C = Cunningham slip correction factor

$$= 1 + \left(\frac{2\lambda}{D_p}\right) \left[1.257 + 0.40e \left(-1.10 \frac{D_p}{\lambda}\right)\right] = \left(1 + \frac{2\lambda}{D_p} \quad (1.257)\right)$$

ρ = particle density, 1 gm/cm^3

Q = actual gas flow rate, cm^3/sec

λ = mean free path length for gas molecules

$$\lambda = \frac{\mu \ (82.057) \ T \ (^oK)}{0.499 \ P \ M \sqrt{\frac{8 \ R \ T \ (^oK)}{\pi \ M}}}$$

Where:

P = Pressure = 1 ATM

M = Molecular weight of gas = 28.9 for air

R = 8.31×10^7

μ = Gas viscosity = $63 + 0.40 \ T \ (^oK) \ 10^{-6}$

T = Temperature in ^oK

To solve the equation for D_{p50}, you must first compute μ, then substitute μ into the equation for λ, and then substitute λ into the equation for C. Since C is dependent upon D_{p50}, several iterations are normally required to solve for the proper C to use in the equation for D_{p50}.

A sample calculation of the cutpoint of stage 4 at 300°F and a flow rate of 0.6 CFM follows:

1. $\mu = (63 + 0.40 \ T) \times 10^{-6} = [63 + (0.4)(421)] \times 10^{-6}$

$= 2.31 \times 10^{-4}$ poise

2. $\lambda = \dfrac{\mu\ (82.057)\ T}{0.499\ PM\ \sqrt{\dfrac{8RT}{\pi\ M}}} = 996.29 \times 10^{-8}$

3. $C = 1 + \dfrac{2\lambda}{D_{p50}}\ (1.257) = 1 + \dfrac{.250 \times 10^{-4}}{D_{p50}}$

4. $D_{p50} = \sqrt{\dfrac{18\ \mu\ \Psi\ N\ \pi\ D_c{}^3}{4\ C\ \rho\ Q}}$

$$D_{p50} = \sqrt{\dfrac{(18)\ (2.31 \times 10^{-4})\ (0.14)\ (264)\ (3.14)\ (.0533)^3}{(4)\ \left(1 + \dfrac{.250 \times 10^{-4}}{D_{p50}}\right)\ (1)\ (283)}}$$

$$D_{p50} = \sqrt{\dfrac{6.454 \times 10^{-8}}{1 + \dfrac{.250 \times 10^{-4}}{D_{p50}}}}$$

Substituting D_{p50} = 2.5 micrometers into the right hand side of the equation, we get:

$$D_{p50} = \sqrt{5.867 \times 10^{-8}} = 2.43 \text{ micrometers}$$

APPENDIX M

LABORATORY AND ANALYTICAL DATA - MISCELLANEOUS

M-1 Paved Road Fugitive Emission Tests

M-2 Raw Product and Insufflation Dust Grab Samples

M-1 Paved Road Fugitive Emission Tests

MIDWEST RESEARCH INSTITUTE
Silt Analysis

Run No. ____
MRI Project No. 4892-L4

Date 6/19/81
Recorded By [illegible]

Sample No: Bag #296
Material: Road Dust

Split Sample Balance:
Make Ohaus
Capacity 2610 g
Smallest Division .1 g

Material Weight (after drying)
Pan + Material: ____
Pan: ____
Dry Sample: ____

Final Weight: 45.7

% Silt = $\frac{\text{Net Weight} < 200 \text{ Mesh}}{\text{Total Net Weight}} \times 100 =$ 28.4 %

SIEVING

Time: Start:	Weight (Pan Only)
Initial (Tare):	384.0 g
~~20~~ min: 5	396.2 g
~~20~~ min: 10	396.8 g
~~40~~ min: 15	397.0 g

SIZE DISTRIBUTION

Screen	Tare Weight (Screen)	Final Weight (Screen + Sample)	Net Weight (Sample)	%
3/8 in.				
4 mesh				
10 mesh				
20 mesh				
40 mesh	399.7 g	412.5 g	12.8 g	
100 mesh	341.6 g	350.8 g	9.2 g	
~~140 mesh~~				
200 mesh	356.5 g	367.0 g	10.5 g	
Pan	384.0 g	397.0 g	13.0 g	

45.5 g

Comments:

7/80

MIDWEST RESEARCH INSTITUTE
Silt Analysis

Run No. ______
MRI Project No. 4892-L4

Date 6/19/81
Recorded By 180

Sample No: Bag # 30 G
Material: Road Dust

Split Sample Balance:
Make Ohaus
Capacity 2610 g
Smallest Division .1g

Material Weight (after drying)
Pan + Material: ______
Pan: ______
Dry Sample: ______

Final Weight: 22.5

% Silt = $\frac{\text{Net Weight} < 200 \text{ Mesh}}{\text{Total Net Weight}}$ X 100 = 19.6 %

SIEVING

Time: Start:	Weight (Pan Only)
Initial (Tare):	385.0g
~~20~~ min: 5	388.9g
~~30~~ min: 10	389.0g
~~40~~ min: 15	—

SIZE DISTRIBUTION

Screen	Tare Weight (Screen)	Final Weight (Screen + Sample)	Net Weight (Sample)	%
3/8 in.				
4 mesh				
10 mesh				
20 mesh	436.3g	440.9	4.6g	
40 mesh	399.8g	402.8	3.0g	
100 mesh	342.9g	347.6g	4.7g	
140 mesh	—			
200 mesh	357.8g	363.1g	5.3g	
Pan	385.0g	389.4g	4.4g	
			22.0g	

Comments:

7/80

MIDWEST RESEARCH INSTITUTE

Silt Analysis

Run No. ______
MRI Project No. 4892-L4

Date 6/19/81
Recorded By [illegible]

Sample No: Bag #31-G
Material: Road Dust

Split Sample Balance:
Make Ohaus
Capacity 2610g
Smallest Division .1g

Material Weight (after drying)
Pan + Material: ______
Pan: ______
Dry Sample: ______

Final Weight: 20.1

% Silt = $\frac{\text{Net Weight} < 200 \text{ Mesh}}{\text{Total Net Weight}}$ X 100 = 10.0 %

SIEVING

Time: Start:	Weight (Pan Only)
Initial (Tare):	
~~20~~ min: 5	—
~~20~~ min: 15	362.6g
~~40~~ min: 20	362.6g

SIZE DISTRIBUTION

Screen	Tare Weight (Screen)	Final Weight (Screen + Sample)	Net Weight (Sample)	%
3/8 in.				
4 mesh				
10 mesh				
20 mesh	—			
40 mesh	398.9g	411.0g	12.1	
100 mesh	352.6g	356.3g	3.7	
140 mesh	—			
200 mesh	498.5g	500.7g	2.2	
Pan	360.6g	362.6g	2.0	
			20.0	

Comments:

7/80

MIDWEST RESEARCH INSTITUTE
Silt Analysis

Run No. ______
MRI Project No. 4892-L4

Date 6/19/81
Recorded By [illegible]

Sample No: Bag 32-G
Material: Road Dust

Split Sample Balance:
Make Ohaus
Capacity 2610g
Smallest Division .1g

Material Weight (after drying)
Pan + Material: ______
Pan: ______
Dry Sample: ______

Final Weight: 20.9

$$\% \text{ Silt} = \frac{\text{Net Weight} < 200 \text{ Mesh}}{\text{Total Net Weight}} \times 100 = 18.8\ \%$$

SIEVING

Time: Start:	Weight (Pan Only)
Initial (Tare):	384.2g
~~20~~ min: 5	388.0g
~~30~~ min: 10	388.0g
~~40~~ min: 15	—

SIZE DISTRIBUTION

Screen	Tare Weight (Screen)	Final Weight (Screen + Sample)	Net Weight (Sample)	%
3/8 in.				
4 mesh				
10 mesh				
20 mesh	436.9g	443.0g	6.1g	
40 mesh	399.9g	402.4g	2.5g	
100 mesh	341.5g	345.8g	4.3g	
140 mesh	—			
200 mesh	356.7g	359.9g	3.2g	
Pan	384.2g	388.0g	3.8g	
			19.9	

Comments:

7/80

MIDWEST RE RCH INSTITUTE

Road Surface Dust Collected: Raw Data

Project No. 4892-L4

O Sample Location	A Hand Sweepings (Bag + Sample)	B Bag Tare Weight	C (A - B)	D Vacuum Bag + Sample	E Tare Weight of Vacuum Bag	F (D - E) Sample	G Empty Vacuum Bag Weight	H (G - E) left in bag	I Seived I=(F-H) I = C + D - G	J total sample (F) J = C + F	Date	Initials
Bag #29 G				61.9g	15.0g	46.9g	16.2g	1.2g	45.7g	46.9g		
Bag #30 G				38.8g	15.0g	23.8g	16.3g	1.3g	22.5g	23.8g		
Bag #31-G				36.5g	15.3g	21.2g	16.4g	1.1g	20.1g	21.2g		
Bag #32-G				37.6g	15.3g	22.3g	16.7g	1.4g	20.9g	22.3g		

Comments:

M-2 Raw Product and Insufflation Dust Grab Samples

RAW PRODUCT SAMPLE ANALYSIS RESULTS[a]

	Composition, weight %				
	Type I product			Type II product	
Sample No.: Date collected: Plant shift: Shift hours:	555 5-1-81 First 0700-1500	666 5-2-81 First 0700-1500	777 5-4-81 Second 1500-2300	888 5-5-81 First 0700-1500	999 5-6-81 First 0700-1500
Na_2O	0.29	0.29	0.30	0.29	0.24
K_2O	0.90	0.90	1.00	0.80	0.40
Li_2O	0.12	0.12	0.10	0.14	0.12
LOI[b]	34.08	34.34	33.89	34.72	34.51
Total S as SO_3	0.42	0.33	0.31	0.40	0.36
Cl	0.03	0.01	0.01	0.03	0.02
CaO	41.96	42.05	41.94	41.53	40.22
SiO_2	13.40	13.44	13.92	13.91	15.56
MgO	2.06	1.84	1.98	1.56	1.62
Al_2O_3	4.19	4.50	4.37	4.21	4.46
Fe_2O_3	2.09	1.67	1.72	1.97	2.17
TiO_2	0.22	0.19	0.19	0.20	0.21

[a]Analytical results provided by Spectrochemical Laboratories, Inc., 8350 Frankstown Avenue, Pittsburgh, Pennsylvania 15221.

[b]LOI = Loss on ignition.

INSUFFLATION DUST SAMPLE ANALYSIS RESULTS[a]

	Composition, weight %				
	Type I product		Type II product		
Sample No.: Date collected:	111 5-1-81	222 5-4-81	333 5-5-81	444 5-6-81	10 10[b] 5-6-81
Na_2O	0.60	0.55	0.55	0.55	0.50
K_2O	3.10	3.01	2.60	2.22	2.00
Li_2O	0.01[c]	0.01[c]	0.08	0.06	0.10
LOI[d]	22.15	23.03	21.60	24.00	22.34
Total S as SO_3	2.97	3.11	2.47	3.88	3.67
Cl	0.34	0.36	0.43	0.25	0.24
CaO	46.37	46.92	47.30	45.70	45.54
SiO_2	15.79	14.56	15.32	14.86	15.08
MgO	1.50	1.34	2.18	2.01	2.14
Al_2O_3	4.61	4.73	4.64	3.25	5.36
Fe_2O_3	2.19	1.97	2.29	2.77	2.57
TiO_2	0.24	0.22	0.25	0.21	0.19

[a]Analytical results provided by Spectrochemical Laboratories, Inc., 8350 Frankstown Avenue, Pittsburgh, Pennsylvania 15221.

[b]Sample No. 10 10 is a duplicate of Sample No. 444.

[c]Not detected. The number indicates the minimum limit of detection.

[d]LOI = Loss on ignition.

APPENDIX N

UNDUCTED SOURCE RAW FIELD DATA - PAVED ROAD FUGITIVE EMISSION TESTS

MIDWEST RESEARCH INSTITUTE
Paved Road Loading

Run No. 1
MRI Project No. 4892-L(03)

Date 4/30/81
Recorded By [illegible]

Type of Material Sampled:
Site of Sampling: ENTRANCE ROAD
No. of Traffic Lanes 2
Type of Pavement: Asphalt/Concrete
Surface Condition SMOOTH - LIGHTLY LOADED
Closed Trucks

SAMPLING METHOD

1. Sampling device: Portable vacuum cleaner (broom sweep first if loading is heavy)
2. Sampling depth: Loose surface material
3. Sample container: Metal or plastic bucket with sealed poly liner
4. Gross sample specifications:
   (a) 1 sample within 100 m of the air sampling site
   (b) composite of up to 3 increments: lateral strips of 1 m minimum width extending from curb to curb
   (c) total sample weight of at least 4.5 Kg

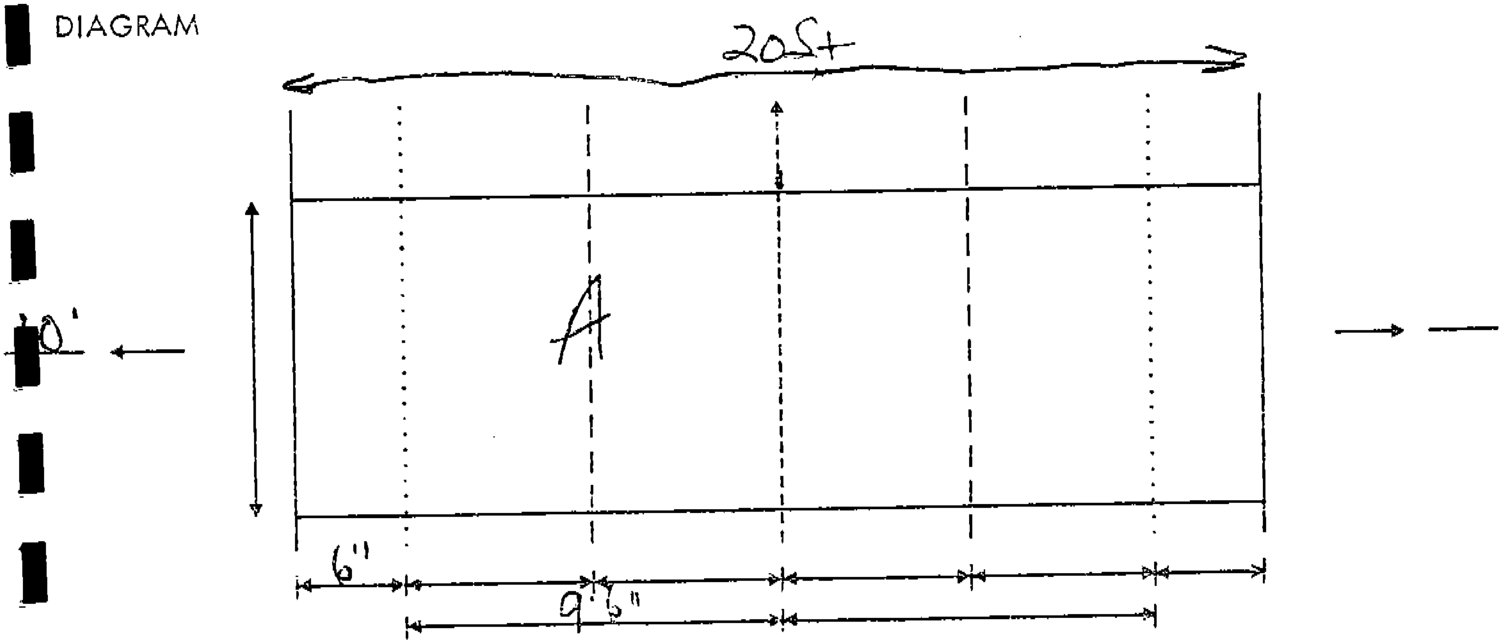
Indicate deviations from above method:

SAMPLING DATA

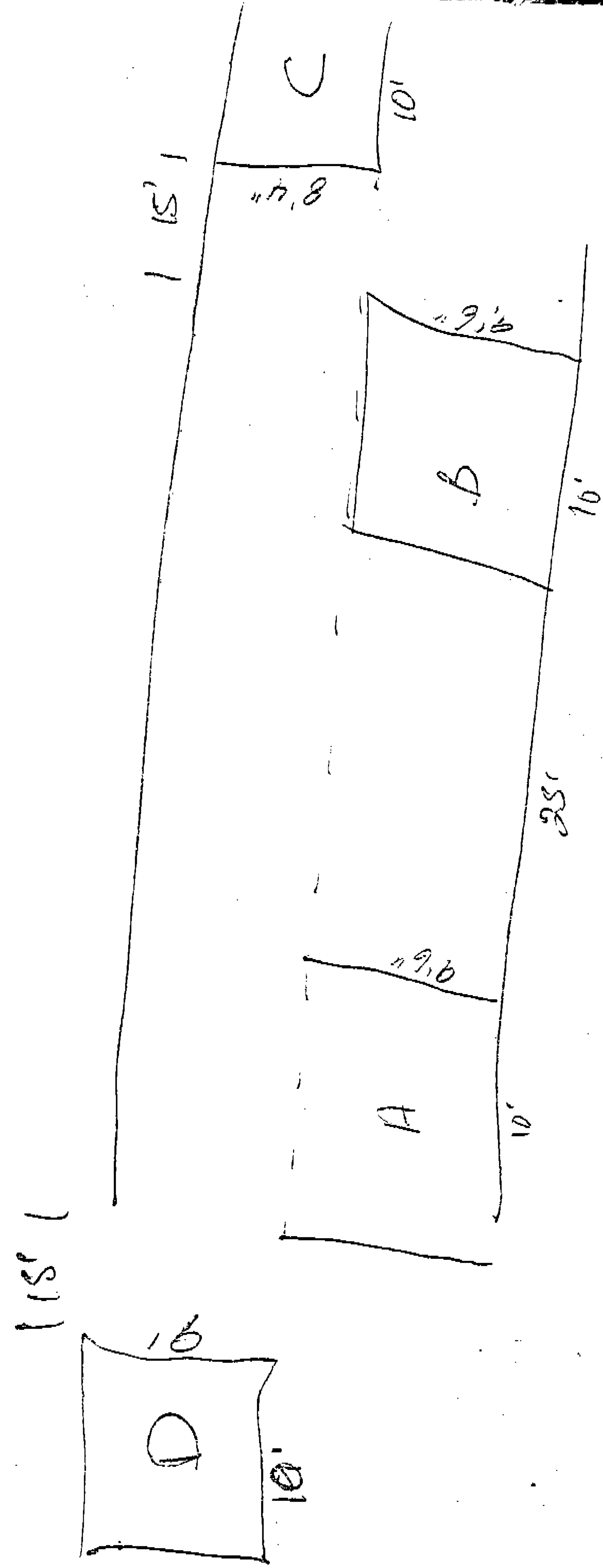
Sample No.	Vac Bag	Time	Surface Area	Quantity of Sample
1-A	326	0930		
1-B	316	0935		
1-C	306	0945		
1-D	296	0955		

Sample No.	Vac Bag	Time	Surface Area	Quantity of Sample

DIAGRAM



7/80


A
B
C
D
10'
15'
25'
9'6"
8'4"
16

APPENDIX O

UNDUCTED SOURCE COMPUTER PRINTOUTS - PAVED ROAD FUGITIVE EMISSION TESTS

OPEN DUST EMISSION FACTORS

SAMPLE #: BAG 29
SAMPLE DESCRIPTION: 4892-L4

PAVED ROAD FORMULA

Given:

s = Silt content of road surface material (%) = 28.40
W = Average vehicle weight (tons) = 12.07
L = Surface dust loading on traveled portion of road (lb/mile) = 109.20
N = Number of active travel lanes = 2
I = Industrial road augmentation factor (a) = 1

$$\text{EMISSION FACTOR} = 0.09 * I\ (4/N) * (s/10) * (L/1{,}000) * (W/3)^{0.7}$$

$$= 0.09 * 1 * (4/\ 2) * (28.40/10) * (109.20/1{,}000) * (12.07/3)^{0.7}$$

$$= 0.147911\text{bs./ VEHICLES-MILE TRAVELED}$$

(a) - Equals 7.0 for trucks coming from unpaved roads and releasing dust from vehicle under-bodies;
Equals 3.5 when 20% of the vehicles are forced to travel temporarily with one set of wheels on an unpaved road berm while passing on narrow roads;
Equals 1.0 for traffic entirely on paved surfaces.

OPEN DUST EMISSION FACTORS

SAMPLE #: BAG 30
SAMPLE DESCRIPTION: 4892-L4

PAVED ROAD FORMULA

Given:

s = Silt content of road surface material (%) = 19.60
W = Average vehicle weight (tons) = 12.07
L = Surface dust loading on traveled portion of road (lb/mile) = 55.40
N = Number of active travel lanes = 2
I = Industrial road augmentation factor (a) = 1

$$\text{EMISSION FACTOR} = 0.09 * I\ (4/N) * (s/10) * (L/1{,}000) * (W/3)^{0.7}$$

$$= 0.09 * 1 * (4/2) * (19.60/10) * (55.40/1{,}000) * (12.07/3)^{0.7}$$

= 0.051790lbs./ VEHICLES-MILE TRAVELED

(a) - Equals 7.0 for trucks coming from unpaved roads and releasing dust from vehicle underbodies;
Equals 3.5 when 20% of the vehicles are forced to travel temporarily with one set of wheels on an unpaved road berm while passing on narrow roads;
Equals 1.0 for traffic entirely on paved surfaces.

OPEN DUST EMISSION FACTORS

SAMPLE #: BAG 31
SAMPLE DESCRIPTION: 4892-L4

PAVED ROAD FORMULA

Given:

s = Silt content of road surface material (%) = 10.00
W = Average vehicle weisht (tons) = 12.07
L = Surface dust loadins on traveled rortion of road (lb/mile) = 49.40
N = Number of active travel lanes = 2
I = Industrial road ausmentation factor (a) = 1

$$\text{EMISSION FACTOR} = 0.09 * I\ (4/N) * (s/10) * (L/1{,}000) * (W/3)^{0.7}$$

$$= 0.09 * 1 * (4/\ 2) * (10.00/10) * (\ 49.40/1{,}000) * (\ 12.07/3)^{0.7}$$

= 0.0235611bs./ VEHICLES-MILE TRAVELED

(a) - Equals 7.0 for trucks comins from unraved roads and releasins dust from vehicle under-bodies;
Equals 3.5 when 20% of the vehicles are forced to travel temrorarily with one set of wheels on an unraved road berm while rassins on narrow roads;
Equals 1.0 for traffic entirely on raved surfaces.

OPEN DUST EMISSION FACTORS

SAMPLE #: BAG 32
SAMPLE DESCRIPTION: 4892-L4

PAVED ROAD FORMULA

Given:

s = Silt content of road surface material (%) = 18.80
W = Average vehicle weight (tons) = 12.07
L = Surface dust loading on traveled portion of road (lb/mile) = 52.00
N = Number of active travel lanes = 2
I = Industrial road augmentation factor (a) = 1

$$\text{EMISSION FACTOR} = 0.09 * I\ (4/N) * (s/10) * (L/1{,}000) * (W/3)^{0.7}$$

$$= 0.09 * 1 * (4/\ 2) * (18.80/10) * (52.00/1{,}000) * (12.07/3)^{0.7}$$

$$= 0.046627 \text{lbs./ VEHICLES-MILE TRAVELED}$$

(a) - Equals 7.0 for trucks coming from unpaved roads and releasing dust from vehicle under-bodies;
Equals 3.5 when 20% of the vehicles are forced to travel temporarily with one set of wheels on an unpaved road berm while passing on narrow roads;
Equals 1.0 for traffic entirely on paved surfaces.

OPEN DUST EMISSION FACTORS

SAMPLE #: COMPOSITE
SAMPLE DESCRIPTION: 4892-L4

PAVED ROAD FORMULA

Given:

s = Silt content of road surface material (%) = 19.20
W = Average vehicle weight (tons) = 12.07
L = Surface dust loading on traveled portion of road (lb/mile) = 66.50
N = Number of active travel lanes = 2
I = Industrial road augmentation factor (a) = 1

$$\text{EMISSION FACTOR} = 0.09 * I\ (4/N) * (s/10) * (L/1{,}000) * (W/3)^{0.7}$$

$$= 0.09 * 1 * (4/2) * (19.20/10) * (66.50/1{,}000) * (12.07/3)^{0.7}$$

$$= 0.060898 \text{ lbs./ VEHICLES-MILE TRAVELED}$$

(a) - Equals 7.0 for trucks coming from unpaved roads and releasing dust from vehicle under-bodies;
Equals 3.5 when 20% of the vehicles are forced to travel temporarily with one set of wheels on an unpaved road berm while passing on narrow roads;
Equals 1.0 for traffic entirely on paved surfaces.

APPENDIX P

PROJECT PARTICIPANTS

PROJECT PARTICIPANTS

Midwest Research Institute

Dr. H. K. Wilcox, Head, Field Programs Section
Fred Bergman, Principal Chemist, Project Leader
Dr. George Scheil, Senior Chemist
Mark D. Hansen, Associate Environmental Scientist, Crew Chief
George R. Cobb, Associate Chemist, Team Member
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Fritz Hoffmeister, Staff Industrial Hygienist, Team Member
Barbara Dent, Staff Industrial Hygienist
Dan Olson, Assistant Chemist
John Kinsey, Associate Environmental Scientist
Frank Pendleton, Junior Environmental Scientist
Marilyn Gabriel, Junior Environmental Chemist
Kim Cowherd, Technician
Clifford Stodden, Technician

PEDCo Environmental, Inc.

Steven P. Schliesser
Ronald Hawks

Ideal Basic Industries, Inc., Ada, Oklahoma, Cement Plant

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Bob Reese, Project Engineer
Tom Quaid, Technical Supervisor

U.S. EPA Industrial Environmental Research Laboratory

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