Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section Number: 9.9.1

Reference Number: 37

Title: Total Particulate Emissions Stack Testing Of the Kiln 6 Operations At Busch Agricultural Resources, Inc.

Environmental Technology And Engineering Corp.

May 1996

→ Andy Seeler AM/ ...

→ Paul Yeun

CORRESPONDENCE MEMORANDUM

AP-42 Section	9.9.1
Reference	37
Report Sect.	
Reference	

DATE: 6-11-96

File Code: 4530

PRELIMINARY* STACK TEST REVIEW

By: Matt Hostak Test Date: 5-8-96

Name of Source: Busch Agric. Resources Inc FID #: 436034720

Address: 605 Washington St. Stack #: S 02

City: Manitowoc Process #: P02 (Kiln #6)

Permit #: MIN-10-SJK-82-36-129A Date Issued:

Description of Source Tested: Kiln #6 is a double-deck drying facility using gas-fired burners to dry wet malt in 3 stages over a 24-hr period.

Description of Control Equipment: None

Test Firm: ET&E
Crew Chief & Phone#: Mike Hueniuk (414) 784-2434

Pollutant Tested: Total Particulates Test Method: EPA Method 5
Pollutant Tested: Particle Size Distrib'n Test Method: EPA Method 201A
Pollutant Tested: Test Method:

Test Production Level: 9300 bu/bed - for each of two beds
Rated Production Level: Same

Discussion of Results:

Poll. Test Ave. - (TOTAL PART.) 2.09 lb/hr Limit - 0.25 lb/hr
In Compliance? Y (N)

Poll. Test Ave. - (PM_{10}) 1.96 lb/hr Limit - NA
In Compliance? Y N

Poll. Test Ave. - ($PM_{2.5}$) 0.90 lb/hr Limit - NA
In Compliance? Y N

Poll. Test Ave. - Limit -
In Compliance? Y N

Is This a Valid Test? (Y) N If answer is no, please indicate the reason.

* Test may be reviewed in depth later, if necessary.

CC Joe Perez - AM/7
US EPA Region V

PARTICULATE CHECKLIST

Name of Source: Busch Agric. Resources Test Date: 5-8-96

1. Are the isokinetics per run between 90 and 110%? YES ✓ NO__
   If the %I for a run is outside the range, void the run. See 5.

2. Is the sample volume per run ≥ 30 DSCF? YES ✓ NO__
   If the sample volume for a run is < 30 DSCF, void the run. See 5.

3. Is the sample time per run ≥ 60 min.? YES ✓ NO__
   If the sample time for a run is < 60 min., void the run. See 5.

4. Is the sample time per sample point ≥ two min.? YES ✓ NO__
   If the sample time per point for a run is < two min., void the run. See 5.

5. A stack test shall consist of three valid runs or, at a minimum, two valid runs if one run is voided. Is this a valid test? YES ✓ NO__
   If no, inform the District or the source that the test is unacceptable and should be redone. Your review is over.

6. Is the total particulate per run added correctly? YES ✓ NO__
   If an incorrect total is found, correct the total and the results or call the consultant and ask for a correction.

7. Was the backhalf included in the total particulate? YES ✓ NO__
   NSPS sources are exempt from including the backhalf. All other sources must include the backhalf. If they don't, the test is invalid. See 5.

Eq. 1 Gr/DSCF = 15.43* g of part./sample volume of run in DSCF

Eq. 2 Gr/DSCF @ 12% CO_2 = (Gr/DSCF)*12/Stack CO_2

Eq. 3 Gr/DSCF @ 7% O_2 = (Gr/DSCF)*(20.9-7)/(20.9-Stack O_2)

Eq. 4 Lb/DSCF = (Gr/DSCF)/7000 Eq. 5 $Lb/MLb_{DRY} = 385.6*10^3*(Lb/DSCF)/MW_{DRY}$

Eq. 6 $Lb/MLb_{WET} = 385.6*10^3*(Lb/DSCF)*(1-(\%\ Moisture/100))/MW_{WET}$

Eq. 7 Lb/Hr = 60*DSCFM*(Lb/DSCF) Eq. 8 $Lb/10^6$ BTU = (Lb/Hr)/(10^6 BTU/Hr)

Eq. 9 $Lb/10^6$ BTU = (Lb/DSCF)*F Factor*20.9/(20.9-Stack O_2)

---

8. If the emission limit is in Gr/DSCF, Lb/DSCF, Lb/MLb, Lb/Hr or $Lb/10^6$ BTU, solve the needed Eq. Do your results match the consultant's? YES ✓ NO__
   If no, fix the problem or call the consultant for a correction.

9. Is the three run(or two run) average correct? YES ✓ NO__
   If no, write in the correct average.

10. Is the average result in compliance? YES__ NO ✓
    If no, the District should issue an NOV.

11. Was the source operating at a level representative of full capacity? YES ✓ NO__
    If no, the permit release may need to provide conditions to cap the source at the test level until a stack test at a higher production level(showing compliance) is performed. If the test was not for permit release, other actions may be warranted.

- MH 6-11-96

SUMMARY

On May 8, 1996, Environmental Technology & Engineering Corp personnel performed stack emissions testing on the Kiln 6 exhaust stacks at the Busch Agricultural Resources (BARI) facility located in Manitowoc, Wisconsin. The purpose of the testing was to determine the total particulate air emissions from the kiln at various steps of the kiln cycle. As requested by the Wisconsin DNR, the stack had been tested previously (November and December, 1995) and the emissions were determined to be higher than the existing permit limitation. Since that time, several process and ventilation modifications were made to reduce the particulate emissions, particularly during the dumping step of the cycle. Additionally, the existing permit limitation is currently under consideration for modification. In light of those factors, BARI and DNR personnel agreed to "re-test" the Kiln 6 emissions.

The Kiln 6 operations were tested during three separate hours of production - low temperature drying, medium and high temperature drying, and cooling and dumping. The emissions were previously limited to 0.25 pounds per hour under WDNR Air Pollution Permit No. MIN-10-SJK-82-36-129A. The results were as follows:

Test	Production Step	Particulate Emissions Concentration	Particulate Emissions Rates
1	Low temp drying	0.0009 #/1000# gas	2.34 #/hr
2	Med & Hi temp dry	0.0008	1.89
3	Cool & dumping	0.0008	2.05
		AVG -	2.09 #/hr ok

It should be noted that the emission levels reported are very close to, if not at, the practical limits of detection for EPA Method 5 testing. There was no real difference in emissions from test to test.

In addition to the total particulate testing, sampling was performed to assess the particle size characteristics of the emissions. Of particular interest was the fraction of emissions below and above 10 and 2.5 microns in size ("PM 10" and "PM2.5"). The results were as follows:

Test	Percent of Particulate Emissions Below: 10 Microns (TOTAL PART.) ok	2.5 Microns ok
1	99+ %	~ 40 %
2	95	48
3	87	42
AVG	93.7 %	43.3 %

CALCULATED BY M. HOSTAR

Again, the practical limits of detection were approached during the particle sizing efforts.

AVG. EM. RATES FOR PM_{10} & $PM_{2.5}$: 1.96 lb/hr PM_{10}; 0.90 lb/hr $PM_{2.5}$

Report to

BUSCH AGRICULTURAL RESOURCES, INC.
St. Louis, Missouri

for

TOTAL PARTICULATE EMISSIONS STACK TESTING

of the

KILN 6 OPERATIONS
at
BUSCH AGRICULTURAL RESOURCES, INC. - Manitowoc, Wisconsin

May 8, 1996

Michael J. Huenink
Industrial Hygienist
May 30, 1996

by

ENVIRONMENTAL TECHNOLOGY & ENGINEERING CORP
13000 W. Bluemound Rd Elm Grove, Wisconsin 53122
(414) 784-2434

TEST REPORT REVIEW SUMMARY

tegory:

TRBARI#6

1-Jul-97

ian L. Watson

Facility: Busch Agricultural Resources, Inc.
Location: Manitowoc, Wisconsin
Source: Malt Kiln #6
Test date: 08-May-96

ass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	AVERAGE
	Stack temperature	Deg F	70	72	80	74.0
	Pressure	in. Hg	29.3	29.3	29.3	29.3
	Moisture	%	1.3	1.8	1.4	1.5
	Oxygen	%	20.7	20.7	20.9	20.8
	Gas volume sampled	dscf	51.62	49.39	48.89	49.97
	Vol. flow, actual	acfm	596,832	569,885	574,988	580,568
	Vol. flow, standard*	dscfm	575,251	544,355	542,989	554,198
	Isokinetic variation	%	98.9	100.0	99.2	
	Process rate (bu/hr)	bu/hr	387.5	387.5	387.5	387.5
Indicate basis for process rate (production):						
	Pollutant mass:					
	Filterable PM	grams	0.0013	0.0004	0.0012	9.67E-04
	Condensable inorg. PM	grams		0.0007		2.00E-04
	Condensable org. PM	grams	0 0.0003	0.0002	0.0002	4.00E-04
	Total condensable PM	grams	0.0003	0.0009	0.0002	0.00046667
	Pollutant concentrations:					AVERAGE
	Filterable PM	gr/dscf	0.00038859	0.000124965	0.00037873	2.97E-04
	Condensable inorg. PM	gr/dscf	0	6.24823E-05	0	2.08E-05
	Condensable org. PM	gr/dscf	8.96745E-05	0.000218688	6.3121E-05	1.24E-04
	Total condensable PM	gr/dscf	8.96745E-05	0.00020117	6.3121E-05	1.45E-04
	~~TOC as propane~~ PM-10 (filt.)	~~ppmdv~~ % of PM	99	95	87	#DIV/0!
	~~SO2~~ PM-2.5 (filt.)	~~ppmdv~~ % PM	40	48	42	#DIV/0!
	CO2	% vol.	0.10	0.10	0	#DIV/0!
	NOx	ppmdv				#DIV/0!
	CO	ppmdv				#DIV/0!
	Formaldehyde	ppmdv				#DIV/0!
	MDI	ppmdv				#DIV/0!
	Phenol	ppmdv				#DIV/0!
						#DIV/0!
						#DIV/0!
	Pollutant mass flux rates:					AVERAGE
	Filterable PM	lb/hr	1.92E+00	5.83E-01	1.76E+00	1.42E+00
	Condensable inorg. PM	lb/hr	0.00E+00	2.92E-01	0.00E+00	9.72E-02
	Condensable org. PM	lb/hr	4.42E-01	1.02E+00	2.94E-01	5.85E-01
	Total condensable PM	lb/hr	4.42E-01	1.31E+00	2.94E-01	6.83E-01
	~~TOC as propane~~ PM-10 (filt.)	lb/hr	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	~~SO2~~ PM-2.5 (filt.)	lb/hr	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	CO2	lb/hr	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NOx	lb/hr	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	CO	lb/hr	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Formaldehyde	lb/hr	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	MDI	lb/hr	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Phenol	lb/hr	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		lb/hr				#DIV/0!
		lb/hr				#DIV/0!
	Emission factors (lb/1000 bu):					AVERAGE
	Filterable PM	lb/1000 bu	4.94E+00	1.50E+00	4.55E+00	3.67E+00
	Condensable inorg. PM	lb/1000 bu	0.00E+00	7.52E-01	0.00E+00	2.51E-01
	Condensable org. PM	lb/1000 bu	1.14E+00	2.63E+00	7.58E-01	1.51E+00
	Total condensable PM	lb/1000 bu	1.14E+00	3.39E+00	7.58E-01	1.76E+00
	~~TOC as propane~~ PM-10 (filt.)	lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	~~SO2~~ PM-2.5 (filt.)	lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	CO2	lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	NOx	lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	CO	lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Formaldehyde	lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	MDI	lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	Phenol	lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00
		lb/1000 bu	0.00E+00	0.00E+00	0.00E+00	0.00E+00

*DSCFM BASED ON A STANDARD TEMPERATURE OF 68 DEGREES FAHRENHEIT

inorg. and org. reversed!

Insert rows for PM-10 and PM-2.5

Delete rows

Delete rows

Delete Rows

Multiply filt. PM emission rates by % to determine PM-10 and 2.5 rates.

SUMMARY

On May 8, 1996, Environmental Technology & Engineering Corp personnel performed stack emissions testing on the Kiln 6 exhaust stacks at the Busch Agricultural Resources (BARI) facility located in Manitowoc, Wisconsin. The purpose of the testing was to determine the total particulate air emissions from the kiln at various steps of the kiln cycle. As requested by the Wisconsin DNR, the stack had been tested previously (November and December, 1995) and the emissions were determined to be higher than the existing permit limitation. Since that time, several process and ventilation modifications were made to reduce the particulate emissions, particularly during the dumping step of the cycle. Additionally, the existing permit limitation is currently under consideration for modification. In light of those factors, BARI and DNR personnel agreed to "re-test" the Kiln 6 emissions.

The Kiln 6 operations were tested during three separate hours of production - low temperature drying, medium and high temperature drying, and cooling and dumping. The emissions were previously limited to 0.25 pounds per hour under WDNR Air Pollution Permit No. MIN-10-SJK-82-36-129A. The results were as follows:

Test	Production Step	Particulate Emissions Concentration	Particulate Emissions Rates
1	Low temp drying	0.0009 #/1000# gas	2.34 #/hr
2	Med & Hi temp dry	0.0008	1.89
3	Cool & dumping	0.0008	2.05
		AVG -	2.09 #/hr

It should be noted that the emission levels reported are very close to, if not at, the practical limits of detection for EPA Method 5 testing. There was no real difference in emissions from test to test.

In addition to the total particulate testing, sampling was performed to assess the particle size characteristics of the emissions. Of particular interest was the fraction of emissions below and above 10 and 2.5 microns in size ("PM 10" and "PM2.5"). The results were as follows:

Test	Percent of Particulate Emissions Below: 10 Microns	2.5 Microns
1	99+ %	~ 40 %
2	95	48
3	87	42

Again, the practical limits of detection were approached during the particle sizing efforts.

1.0 TEST PURPOSE AND EMISSION LIMITATIONS

On May 8, 1996, Environmental Technology & Engineering Corp (ETE) personnel performed stack emissions testing on the Kiln 6 Operations exhaust stack at the Busch Agricultural Resources, Inc. (BARI) facility located in Manitowoc, Wisconsin. The purpose of the testing was to determine the total particulate air emissions from the kiln at various steps of the kiln cycles.

The Kiln 6 Operation was previously tested on November 17 and December 14, 1995 in response to a letter of inquiry from Mr. Jim Crawford of the Wisconsin Department of Natural Resources (WDNR)-Lake Michigan District Office. As noted in the letter, Kiln 6 was limited to 0.25 pounds per hour (#/hr) of total particulate emissions in WDNR Air Pollution Control Permit No. MIN-10-SJK-82-36-129A. The emissions were found to be in excess of that limit.

Since that time, there has been discussion between BARI and WDNR personnel regarding the process and appropriate particulate emission limitations. Several ventilation changes were made during the cooling and malt bed dumping activities (see Section 2.0). Additionally, the existing permit limitation is currently under consideration for modification. It was agreed that the process should be "re-tested" following the ventilation changes. It was also decided to evaluate the emissions in terms of "PM 10" concerns.

Mr. Kirby Kraft of BARI - St. Louis and Mr. Darryl Broadaway of BARI - Manitowoc facilitated in the coordination of the production activities and test efforts. Mr. Matt Hostak of the WDNR - Lake Michigan District Office witnessed the testing and operating conditions. The test efforts and sample analysis were performed by ETE personnel; Mr. Michael Huenink was the project leader.

2.0 PROCESS DESCRIPTIONS AND TEST TIMES

The facility was involved in the production of malt for the brewing industry. As a final step of that process, the malt was dried to pre-determined moisture content levels in large drying kilns. Kiln 6 was a "double-deck" drying kiln equipped with a lower and upper drying deck. "Wet" malt was loaded into the upper deck for partial drying during one cycle. At the conclusion of the cycle, it was dumped to the lower bed for final drying during the next cycle. This allowed for final product to be dumped from the kilning operation during each cycle. A kiln cycle was started every 24 hours and typically involved the following steps:

1) Loading and leveling of malt on a large bed (through which heated air could be blown during the drying steps);
2) Low temperature drying;
3) Medium temperature drying;
4) High temperature drying;
5) Cooling;
6) Product dumping.

Prior to being exhausted to atmosphere, the kiln exhaust gases passed through heat exchangers which served to heat the air blown through the malt beds. For the Kiln 6 operations, the final exhaust rate through the heat exchanger remained relatively constant during the test efforts.

Testing was performed during kilning steps similar to the previous test efforts. The testing was performed during the following times:

Test	Test_Period	Kiln Cycle Activities During Test
1	16:55-18:13	Latter part of low temp drying
2	19:15-20:29	Medium temp drying and start of high temp drying
3	22:15-23:34	Latter part of high temp drying, cooling, lower malt bed dumping, and post-dumping ventilation

All tests were performed for a total of 60 "test" minutes. Because of the large number of sampling ports (12 for each test) and the need to move the equipment from port to port, each test typically occurred over a 75 minute period.

The test period for the final test was timed to conclude when the ventilation system and dampers were shut down and fully closed (no emission potential). Approximately midway through the test, the ventilation scheme also changed as shown below:

2.0 (continued)

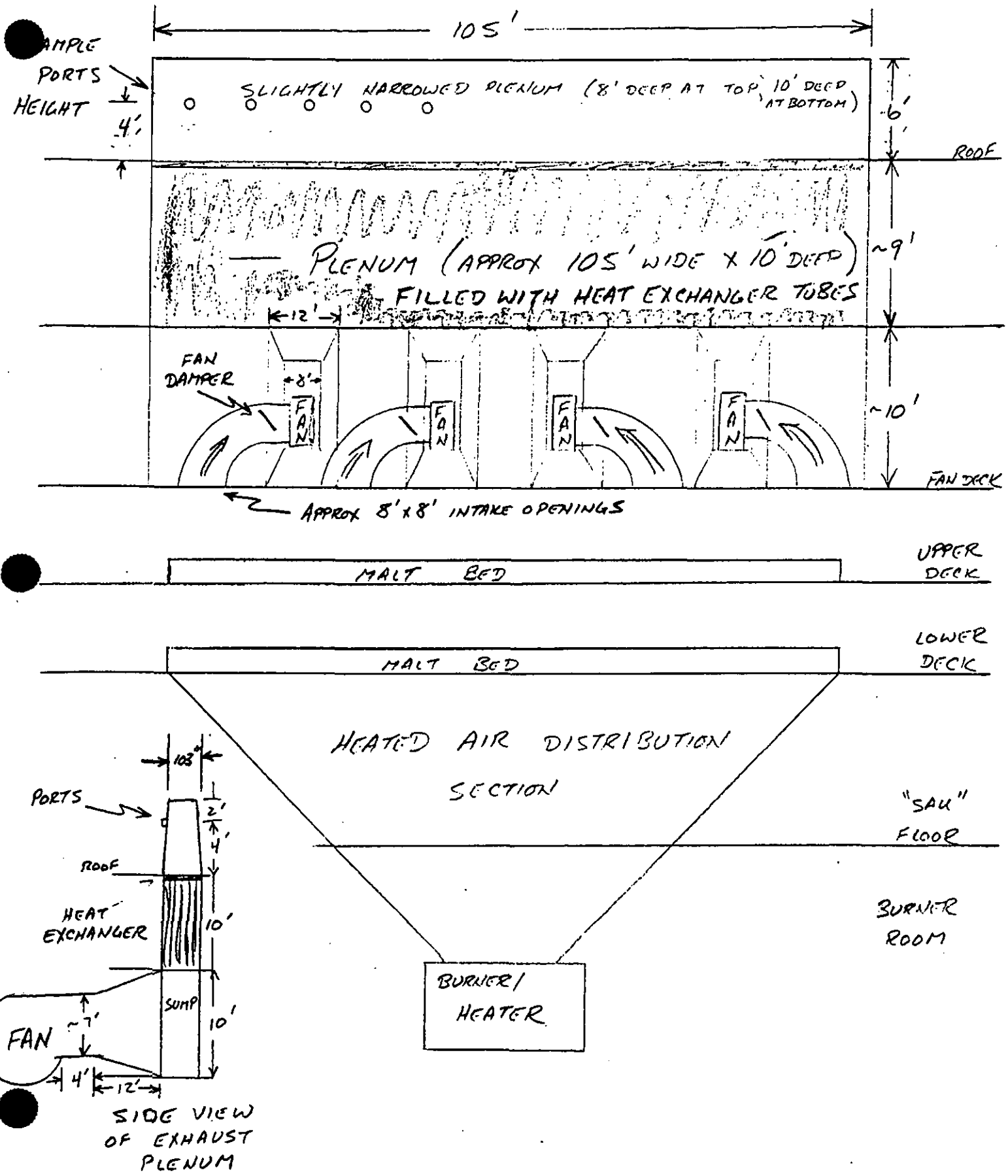
Approx. Time	Kilning Process Step	Vent. Condition
8-11PM	Drying at high temp.	4 fans on - dampers 100% open
11-11:30PM	a) Cooling - 20 minutes	4 fans on - dampers 100% open
	b) Dumping lower deck (upper deck full) - 5 minutes	2 center fans on - dampers 10% open
	c) Post-dumping - 10 minutes	2 center fans on - dampers 100% open
11:30PM	Dumping upper deck to lower deck - 5 to 10 minutes	All fans off - dampers 0% open
11:45PM-3:45AM	No kilning cycle activities	All fans off - dampers 0% open

As agreed upon before the test efforts, testing during the final test was performed in the six outside ports at the start of the test (all fans on) and was concluded in the center six ports of the plenum (two center fans on). This was considered a conservative approach which likely "over-measured" the exhaust gas flow rates during the test as well as the particulate emission rates.

The sampling locations are shown in Figure 1. Both the total particulate and particle size test efforts were performed concurrently during each of the three test periods.

KILN 6

FIGURE 1



SIDE VIEW OF EXHAUST PLENUM

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3.0 TEST RESULTS

Testing to determine total particulate emissions was performed using EPA Method 5 (40 CFR Part 60, Appendix A). In conjunction with the testing, exhaust gas flow rates were measured using EPA Methods 1 through 4. Those rates are included in the results tables. Testing to determine particle size distribution was performed using EPA Method 201A. A brief summary of the methods are included in Section 4.0 of this report.

3.1 Total Particulate Emissions

The results of the testing to determine particulate matter emissions from Kiln 6 are shown in Tables 2-1, 2-2, and 2-3. The test results indicated particulate emission levels in excess of the existing permit limitation as follows:

Test	Particulate Emissions Concentration	Particulate Emissions Rates
1	0.0009 #/1000# gas	2.34 #/hr
2	0.0008	1.89
3	0.0008	2.05
	AVG	2.09 #/hr
	WDNR Permit Limitation -	0.25 #/hr

3.2 Particle Size Distribution

Particle size sampling was performed on the exhaust concurrent with the total particulate sampling. Exhaust gas from the operation was drawn through the "sizer" at a constant rate. That rate was selected as the average sampling velocity based upon a preliminary pitot traverse of the entire exhaust plenum. The sizer was placed at each of the 24 sampling points during each hour-long test. This traverse approximated an isokinetic sample.

An Anderson Mark III cascade impactor (the "sizer") was equipped with a series of seven filters; each filter represented a different particle "cut" size. From the weight collected on each filter, a curve could be drawn showing the distribution of particle emissions according to size (see Figure 3-1). From the curve, the percentage of particles above and below any given size (e.g., 10 or 2.5 microns) could be interpolated. The results could be summarized as follows:

3.2 (continued)

Test	Percent of Particulate Emissions Below: 10 Microns	2.5 Microns
1	99+ %	~ 40 %
2	95	48
3	87	42

Applying the percentages to the total particulate results, nearly all of the trace total particulate emissions would be considered "PM 10." Approximately half of the trace emissions would be considered "PM 2.5."

The data presented is based on spherical particles of density equal to 1.0. Generally, there is no need to correct the data for the actual particle shape and density since these spherical unit density particles are used as reference calibration particles. Results are then presented in terms of equivalents of these reference particles. If, however, it is desired to correct the curve, the actual diameter would be the measured diameter divided by one over the square root of the actual particle density. For example, given a particle density of 4.0, the actual diameters would be one half the reported diameters.

BUSCH - MANITOWOC KILN 6 TEST 1 5-8-96 TABLE 2-1

BAROMETRIC PRESSURE, in Hg = 29.300
TIP DIAMETER, in = .5000
STACK AREA, sq ft = 901.300
SAMPLING TIME PER POINT, min = 2.50
NUMBER OF POINTS = 24
GAS METER VOLUME, acf = 52.45
WATER COLLECTED, ml = 14
PARTICULATE COLLECTED, grams = 0.0016
ORSAT RESULTS
CO2 = 0.10 O2 = 20.70 CO = 0.00 N2 = 79.20

SAMPLING POINT	STACK TEMP deg F	PITOT DEL P inches	ORIFICE METER inches	GAS METER OUTLET T deg F	GAS VELOCITY fps
1	71	0.050	3.33	51	12.72
2	71	0.035	2.27	51	10.65
3	70	0.025	1.62	52	8.99
4	70	0.030	1.93	52	9.85
5	69	0.030	1.93	52	9.84
6	68	0.035	2.27	52	10.62
7	68	0.020	1.30	54	8.02
8	69	0.020	1.30	55	8.03
9	69	0.025	1.62	57	8.98
10	69	0.020	1.30	58	8.03
11	69	0.030	1.93	59	9.84
12	70	0.035	2.27	60	10.64
13	70	0.040	2.60	61	11.37
14	70	0.050	3.33	61	12.71
15	70	0.050	3.33	61	12.71
16	70	0.040	2.60	61	11.37
17	70	0.055	3.60	62	13.33
18	70	0.055	3.60	62	13.33
19	70	0.045	2.90	63	12.06
20	70	0.035	2.27	65	10.64
21	70	0.060	3.90	67	13.92
22	70	0.040	2.60	68	11.37
23	70	0.065	4.58	69	14.49
24	70	0.040	2.60	69	11.37
AVG VALUES	70		2.541	59	11.04

TOTAL GAS WITHDRAWN, scf = 52.28
DRY GAS WITHDRAWN, scf = 51.62
WATER VAPOR WITHDRAWN, scf = 0.66
PERCENT WATER VAPOR = 1.26
ACTUAL WET FLOW RATE, acfm = 596,832
STANDARD DRY FLOW RATE, scfm = 575,251
, m3/hr = 977,467
PARTICULATE CONCENTRATION, grains/dscf = 0.0005
PARTICULATE EMISSION RATE, lb/hr = 2.34
LB PARTICULATE PER 1000 LB GAS = 0.0009
PERCENT OF ISOKINETIC SAMPLING = 98.9

BUSCH - MANITOWOC KILN 6 TEST 2 5-8-96 TABLE 2-2

BAROMETRIC PRESSURE, in Hg = 29.300
TIP DIAMETER, in = .5000
STACK AREA, sq ft = 901.300
SAMPLING TIME PER POINT, min = 2.50
NUMBER OF POINTS = 24
GAS METER VOLUME, acf = 50.16
WATER COLLECTED, ml = 19
PARTICULATE COLLECTED, grams = 0.0013
ORSAT RESULTS
CO2 = 0.10 O2 = 20.70 CO = 0.00 N2 = 79.20

SAMPLING POINT	STACK TEMP deg F	PITOT DEL P inches	ORIFICE METER inches	GAS METER OUTLET T deg F	GAS VELOCITY fps
1	69	0.050	3.23	58	12.71
2	69	0.040	2.60	58	11.37
3	68	0.080	5.20	58	16.07
4	68	0.025	1.62	59	8.98
5	68	0.070	4.55	60	15.03
6	69	0.010	0.66	60	5.69
7	70	0.035	2.27	61	10.65
8	70	0.030	1.92	62	9.86
9	69	0.010	0.66	62	5.69
10	71	0.025	1.62	64	9.01
11	71	0.020	1.30	65	8.06
12	71	0.020	1.30	67	8.06
13	71	0.020	1.30	69	8.06
14	71	0.020	1.30	69	8.06
15	71	0.035	2.27	69	10.66
16	72	0.055	3.60	69	13.37
17	72	0.025	1.62	70	9.01
18	74	0.030	1.92	70	9.89
19	75	0.040	2.62	72	11.43
20	76	0.050	3.23	71	12.80
21	76	0.050	3.23	71	12.80
22	76	0.040	2.62	72	11.45
23	77	0.040	2.62	72	11.46
24	76	0.050	3.23	73	12.80
AVG VALUES	72		2.354	66	10.54

TOTAL GAS WITHDRAWN, scf = 50.28
DRY GAS WITHDRAWN, scf = 49.39
WATER VAPOR WITHDRAWN, scf = 0.89
PERCENT WATER VAPOR = 1.78
ACTUAL WET FLOW RATE, acfm = 569,885
STANDARD DRY FLOW RATE, scfm = 544,355
, m3/hr = 924,968
PARTICULATE CONCENTRATION, grains/dscf = 0.0004
PARTICULATE EMISSION RATE, lb/hr = 1.89
LB PARTICULATE PER 1000 LB GAS = 0.0008
PERCENT OF ISOKINETIC SAMPLING = 100.0

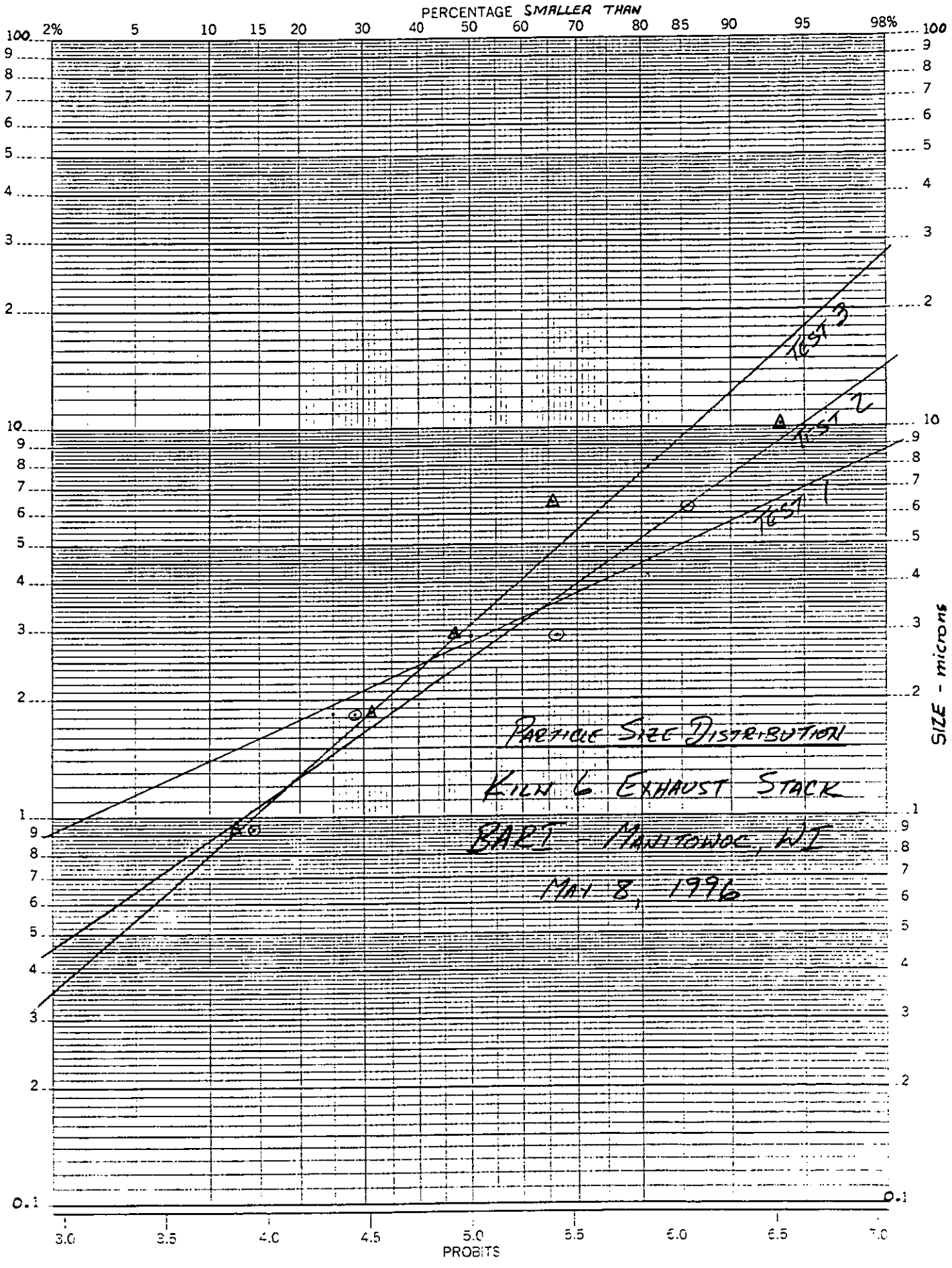
BUSCH - MANITOWOC KILN 6 TEST 3 5-8-96 TABLE 2-3

BAROMETRIC PRESSURE, in Hg = 29.300
TIP DIAMETER, in = .5000
STACK AREA, sq ft = 901.300
SAMPLING TIME PER POINT, min = 2.50
NUMBER OF POINTS = 24
GAS METER VOLUME, acf = 49.66
WATER COLLECTED, ml = 15
PARTICULATE COLLECTED, grams = 0.0014
ORSAT RESULTS
CO2 = 0.00 O2 = 20.90 CO = 0.00 N2 = 79.10

SAMPLING POINT	STACK TEMP deg F	PITOT DEL P inches	ORIFICE METER inches	GAS METER OUTLET T deg F	GAS VELOCITY fps
1	76	0.040	2.62	59	11.44
2	76	0.040	2.62	59	11.44
3	77	0.055	3.60	60	13.43
4	77	0.040	2.62	60	11.45
5	77	0.025	1.62	61	9.05
6	77	0.020	1.30	61	8.10
7	77	0.045	2.90	62	12.14
8	77	0.045	2.90	62	12.14
9	77	0.025	1.62	63	9.05
10	76	0.030	1.92	63	9.91
11	75	0.025	1.62	65	9.04
12	75	0.025	1.62	66	9.04
13	75	0.055	3.60	68	13.40
14	74	0.050	3.22	69	12.77
15	78	0.070	4.58	70	15.16
16	86	0.025	1.62	70	9.13
17	87	0.040	2.62	71	11.56
18	88	0.040	2.62	72	11.57
19	84	0.025	1.62	73	9.11
20	84	0.030	1.92	73	9.98
21	86	0.020	1.30	72	8.16
22	86	0.020	1.30	73	8.16
23	84	0.030	1.92	72	9.98
24	84	0.030	1.92	73	9.98
AVG VALUES	80		2.300	67	10.63

TOTAL GAS WITHDRAWN, scf = 49.60
DRY GAS WITHDRAWN, scf = 48.89
WATER VAPOR WITHDRAWN, scf = 0.71
PERCENT WATER VAPOR = 1.42
ACTUAL WET FLOW RATE, acfm = 574,988
STANDARD DRY FLOW RATE, scfm = 542,989
, m3/hr = 922,647
PARTICULATE CONCENTRATION, grains/dscf = 0.0004
PARTICULATE EMISSION RATE, lb/hr = 2.05
LB PARTICULATE PER 1000 LB GAS = 0.0008
PERCENT OF ISOKINETIC SAMPLING = 99.2

FIGURE 3-1



46 8080

K&E PROBABILITY X 3 LOG CYCLES
KEUFFEL & ESSER CO. MADE IN U.S.A.

4.0 METHODS OF TESTING

The equipment used to sample was the Western Precipitation Division of the Joy Manufacturing Company Emission Parameter Analyzer. Samples were collected and analyzed in accordance with procedures outlined in EPA Method 5 - "Determination of Particulate Emissions from Stationary Sources" as found in 40 CFR Part 60, Appendix A. EPA Methods 1 through 4 were performed in conjunction with the testing as noted in Method 5.

The sampling train consisted of a stainless steel probe tip, a heated stainless steel lined probe, and heated glass cyclone, flask, and fiberglass filter. A series of four impingers followed in an ice bath. The first was a modified Greenburg-Smith impinger with 100 ml of distilled water; the second was a Greenburg-Smith impinger with 100 ml of distilled water; the third was a modified Greenburg-Smith impinger dry; the fourth was also a modified Greenburg-Smith impinger containing a tared quantity of Silica Gel. The gas then passed through a vacuum pump, calibrated dry gas meter, and a calibrated orifice. A schematic drawing of the sampling train is included.

The temperatures of the stack gas stream, as well as strategic locations within the sampling devices, were monitored by RTDs and read directly from a gauge on the control unit.

The initial gas stream velocity was obtained from a preliminary traverse using an "S" type pitot tube. The initial moisture was estimated from previous tests of similar processes. This data, along with the stack temperature, was used to set a nomograph so that rapid calculations of isokinetic sampling conditions could be made.

The principle of the method was to collect the sample representative of the exhaust by adjusting the sample collection velocity to match the exhaust gas stream velocity at the point of collection. The velocity at the point of collection was measured with an "S" type pitot tube attached to the probe and the collection velocity was matched to the stack gas velocity by adjusting the flow as indicated by the calibrated orifice.

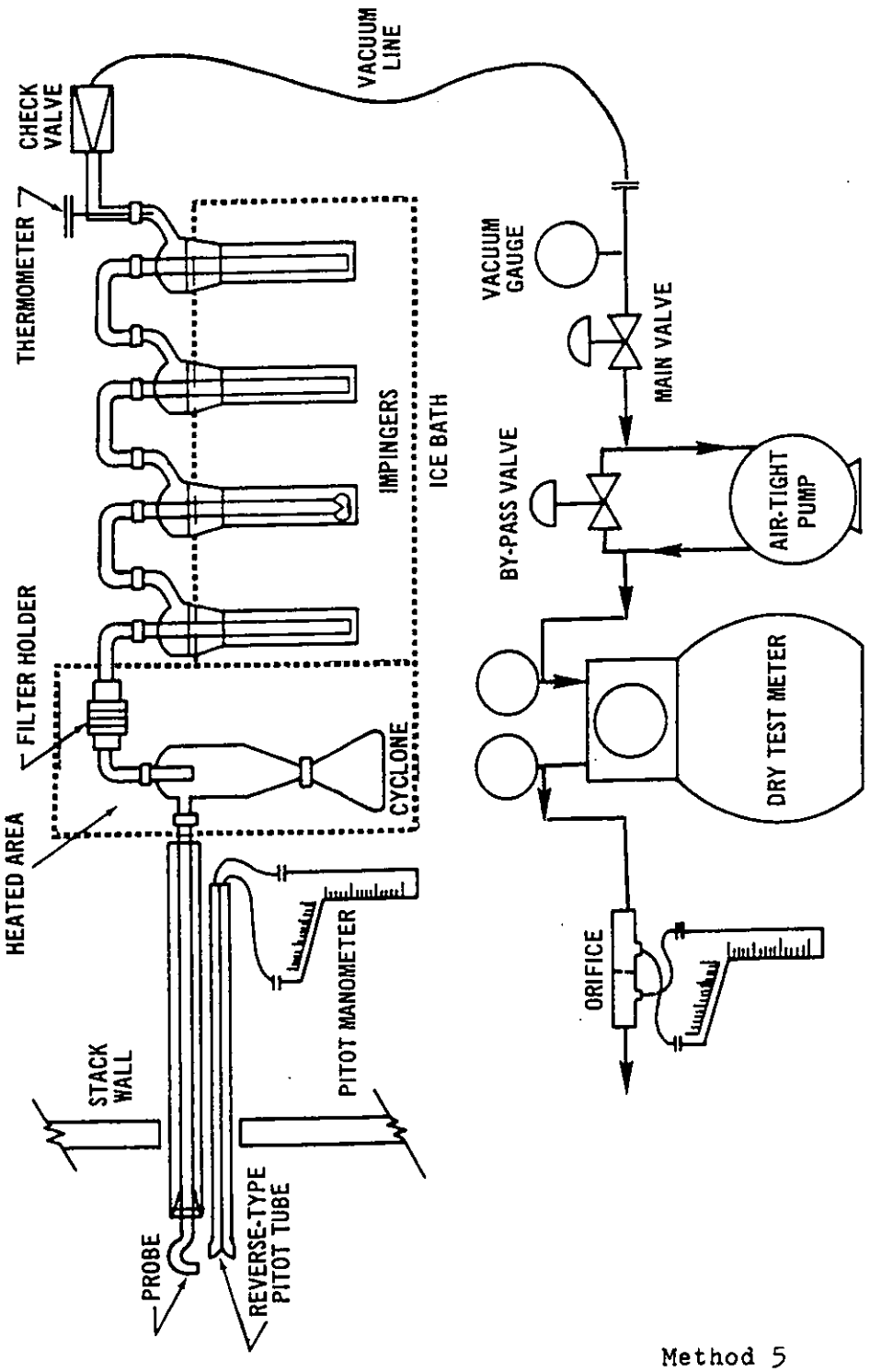
To determine the molecular weight of the stack gas, integrated bag samples were drawn into an Orsat analyzer and analyzed for percentage CO2, O2, CO, and N2.

At the completion of the test, the probe tip and probe were washed with acetone. In the lab, the cyclone and flask were also washed with acetone. The acetone washes were then combined, transferred to a tared beaker, and evaporated to dryness at room temperature. The filter and beaker were then desiccated to the tared humidity conditions and weighed. The sum of these two weights constituted the filterable particulate fraction (or "front-half" portion) of the catch.

4.0 (continued)

The impinger contents (water) were measured and weighed for determination of the actual moisture content of the exhaust gas stream. The impingers were then rinsed with acetone and the solution was evaporated, leaving any remaining oils or residue. Each of the three impinger contents were extracted using methylene chloride, similar to an oil/grease extraction of water. The extractions were then evaporated off, leaving any residual oil or grease. The remaining impinger contents were then boiled down, leaving any suspended solids. The sum of the impinger rinse residues, extraction residuals, and water boil-down residues constituted the condensible particulate fraction (or "back-half" portion) of the catch.

The combined front-half and back-half fractions were used to determine the total particulate emission rates. A computer was used to calculate the stack velocities, emission concentrations, emission rates and volumetric flow rates using the field and laboratory data.



Particulate sampling train.

5.0 CALIBRATION DATA

The probe tips, pitot tubes, dry gas meters, and control box orifices were calibrated prior to the particulate and particle sizing testing according to procedures outlined in the Maintenance, Calibration, and Operation of Isokinetic Source-Sampling Equipment as published by the EPA. The values obtained were:

Probe tip diams. d = 0.500 (all Kiln 6 tests)

Pitot tube coeffs. Cp = 0.84

Orifice coeffs. dH@ = 1.822 (Total Particulate) = 0.765 (Particle Sizing)

The dry gas meters presently installed in the control boxes are temperature compensating meters. The correction factors for the dry gas meters are best represented by the following equations:

Total Particulate - Gama = 1.000 + ((Td - 70) x .00012)
Particle Sizing - Gama = 1.002 + ((Td - 70) x .00012)

where: Td = Dry Gas Meter Temperature

The most recent calibrations were performed March 18 and April 5, 1996.

6.0 DISCUSSION

As seen in the previous test efforts, the results were at or near the limits of detection for the EPA Methods employed. The total catch for each total particulate test was less than 2 milligrams. The weight collected on each of the particle size filters was typically a few tenths of a milligram. The total particulate levels were so low that no real difference could be determined between the three tests.

Similarly, there was little catch on the particle size samples. However, given the relatively low particulate loading, the particle size distribution curves (Figure 3-1) were quite similar.

The final set of tests was taken over a period during which the ventilation conditions changed (see Section 2.0) half-way through the test. Since these changes were anticipated, the sampling strategy was designed to sample at the plenum locations where the active fans were in operation (the center of the plenum). Since other fans were off at the time, the actual flow rate during this last test was likely less than reported. The reported emission rates would also likely be less than those reported due to this decreased exhaust flow rate. Certainly, this approach would be considered conservative since it would yield the highest potential emission rates during the test.

APPENDIX A

SAMPLE CALCULATIONS

SAMPLE CALCULATION

BAROMETRIC PRESSURE, in Hg (Pb) = 29.200
STACK PRESSURE, in Hg (Pb + Pg/13.6) = 29.178
TIP DIAMETER, in (An = PI*D^2/576) = .2450
STACK AREA, sq ft (A) = 10.560
SAMPLING TIME PER POINT, min = 2.50
NUMBER OF POINTS = 24
GAS METER VOLUME, acf (Vm) = 66.06
WATER COLLECTED, ml (Vf - Vi) = 86.00
PARTICULATE COLLECTED, grams (Mn) = 0.0755
CO2 = 0.60 O2 = 21.00 CO = 0.00 N2 = 78.40
WET MOLECULAR WEIGHT, lb/mole (Ms) = 28.45

SAMPLING POINT	STACK TEMP deg F	PITOT DEL P inches	ORIFICE DEL H inches	GAS METER OUTLET T deg F	GAS VELOCITY fps
1	110	1.450	4.05	32	72.51
2	110	1.350	3.75	32	69.97
3	110	1.350	3.75	32	69.97
4	110	1.300	3.70	32	68.66
5	110	1.250	3.60	32	67.33
6	110	1.250	3.60	32	67.33
7	110	1.050	2.95	32	61.71
8	110	1.000	2.85	32	60.22
9	110	1.000	2.85	34	60.22
10	110	1.050	2.95	34	61.71
11	110	0.950	2.75	38	58.69
12	115	0.950	2.75	38	58.95
13	115	1.300	3.70	42	68.96
14	115	1.250	3.60	42	67.62
15	115	1.200	3.40	42	66.26
16	115	1.200	3.40	42	66.26
17	115	1.150	3.30	44	64.86
18	115	1.150	3.30	46	64.86
19	115	1.050	2.95	48	61.98
20	115	1.150	3.30	48	64.86
21	115	1.000	2.85	50	60.48
22	115	1.100	3.15	50	63.43
23	115	1.050	2.95	50	61.98
24	115	0.900	2.55	50	57.38
AVG VALUES	113		3.250	40	64.42

TOTAL GAS WITHDRAWN, scf = 69.39
DRY GAS WITHDRAWN, scf (Vmstd) = 65.35
WATER VAPOR WITHDRAWN, scf (Vwstd) = 4.05
PERCENT WATER VAPOR (%H2O) = 5.83
ACTUAL WET FLOW RATE, acfm = 40,819.39
STANDARD DRY FLOW RATE, scfm (Qs) = 34,558.69
PARTICULATE CONCENTRATION, grains/dscf (Cs) = 0.018
PARTICULATE EMISSION RATE, lb/hr (ER) = 5.325
PARTICULATE EMISSIONS, lb/1000 lb (EC) = 0.033
PERCENT OF ISOKINETIC SAMPLING (I) = 101.67

SAMPLE CALCULATIONS

1. **DRY MOLECULAR WEIGHT (Md)** lb/lb-mole

   Md = .44*% CO2 + .32*%O2 + .282*%N2 + .28*%CO

2. **WATER VAPOR PERCENT (%H2O)**

   Vw std = 0.04707*(Vf - Vi)

   where: Vw std = standard cubic feet of water vapor
   Vf = Final volume of impingers, ml
   Vi = Initial volume of impingers, ml

   %H2O = Vw std * 100/(Vm std + Vw std)

   where Vm std = standard cubic feet of gas sampled

3. **WET MOLECULAR WEIGHT (Ms)** lb/lb-mole

   Ms = Md*(1 - %H2O/100) + 18*%H2O/100

4. **STACK PRESSURE (Ps)** in. Hg

   Ps = Pb + Pg/13.6

   where: Pb = barometric pressure (uncorrected), in. Hg
   Pg = stack gauge pressure, in. H2O
   13.6 = specific gravity of mercury (Hg)

5. **AVERAGE STACK VELOCITY (Vs)** feet per second

   Vs = Kp*Cp* (DELP) Tsavg/(Ps*Ms)

   where: Kp = 85.49 unit conversion
   Cp = 0.85, pitot tube calibration factor
   DELP = square root of velocity head, in. H2O
   Tsavg = average stack temperature, deg R (460+F)
   Ps = stack pressure
   Ms = wet molecular weight

6. **STACK GAS FLOW RATE (Qs)** std cubic feet per minute

   Qs = 60*(1 - %H2O/100)*Vs*A*(528*Ps/Tsavg/29.92)

   where: A = stack area, ft2
   528 = std temperature, deg R
   29.92 = std pressure, in. Hg

7. **DRY GAS VOLUME** (Vm std) std cubic feet

Vm std = GAMA*(Vm-(AL-.02)t)*(Pb+DELH/13.6)/29.92

where: GAMA = dry gas meter calibration factor
Vm = volume of dry gas metered, cubic feet
AL = post test leak rate, cubic feet per minute
t = total time of test, minutes
DELH = average orifice pressure drop, in.H2O

8. **PARTICULATE CONCENTRATION** (Cs) grains/dry std cubic foot

Cs = Mn * 15.43/Vm std

where: Mn = particulate captured, grams
15.43 = grains per gram

9. **EMISSION RATE** (ER) pounds per hour

PMRA = Mn*A*60/(t*An*453.6) AREA METHOD lb/hr

PMRC = Cs*Qs*60/(15.43*453.6) CONC. METHOD lb/hr

ER = (PMRA + PMRC)/2

where: An = area of sampling nozzle, square feet

10. **EMISSION CONCENTRATION** (EC) lb/1000 lb exhaust gas

EC = ER * 386700 * (1-%H2O/100)/(Qs*60*Ms)

where: 386700 = cubic feet per lb mole * 1000

11. **ISOKINETIC SAMPLING PERCENTAGE** (I) %

I = PMRA/PMRC

BARI – Particle Size Calcs

Test 1

51.30 ft^3 (DRY) $\quad \bar{T}_m = 59\ F \quad \bar{T}_s = 70 \quad \%H_2O = 1.26$

$$ACFM\ Sampled = \frac{51.30\left[1.002 + ((59-70).0001\not{2})\right]\frac{530}{528}}{(1 - .0126)}$$

$$= 52.19\ \text{ACTUAL CUBIC FEET}$$

$$ACFM = \frac{52.19\ ft^3}{60\ min} = 0.870\ ACFM$$

STAGE	CUT SIZE	WT GAIN	CUMULATIVE PERCENT
0	10.1 μ	0	
1	6.3	.0002g	50% (GREATER THAN 6.3μ)
3	2.9	0	
4	1.85	.0001	75%
5	.93	.0001	100%
7	.38	0	
FINAL		0	
		.0004g.	

BARI - PARTICLE SIZE

TEST 2

51.42 ft³ $\bar{T}_M$ = 63F $\bar{T}_S$ = 72F $\%H_2O$ = 1.78

$$ACF\ SAMPLED = \frac{51.42\left[1.002 + ((63-70).00012)\right]\frac{530}{528}}{(1-.0178)}$$

$$= 52.81\ \text{ACTUAL CUBIC FEET}$$

$$ACFM = \frac{52.81\ ft^3}{60\ min} = 0.880\ ACFM$$

STAGE	CUT SIZE	WT. GAIN	CUMULATIVE PERCENT	
0	10.0	0		
1	6.25	.0001	14.3%	(GREATER THAN 6.25μ)
3	2.9	.0001	28.6	
4	1.83	.0003	71.4	
5	.93	.0001	85.7	
7	.38	.0001	100	
FINAL		0		
		.0007		

BART. - PARTICLE SIZE

TEST 3

53.65 ft³ $\bar{T}_M = 64$ $\bar{T}_S = 80$ $\%H_2O = 1.42$

$$ACF\ SAMPLED = \frac{53.65\left[\left(.002 + ((64-70).00012)\right]\frac{540}{528}\right.}{(1 - .0142)}$$

$$= 55.73 \text{ ACTUAL CUBIC FEET}$$

$$ACFM = \frac{55.73\ ft^3}{65\ min} = 0.86 \text{ ACFM}$$

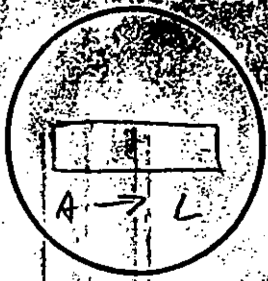
STAGE	COT SIZE	WT GAIN	CUMULATIVE PERCENT
0	10.3	.0002	6.3% (GREATER THAN 10.3μ)
1	6.4	.0009	34.4
3	2.95	.0006	53.1
4	1.87	.0005	68.8
5	.94	.0006	87.5
7	.39	.0004	100
FINAL		0	
		.0032	

APPENDIX B

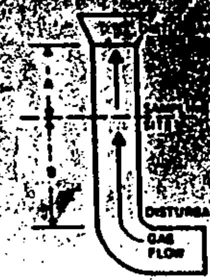
FIELD & LABORATORY DATA SHEETS

Environmental Technology & Engineering Corp.

PARTICULATE FIELD DATA



CROSS SECTION



PLANT Gibson [illegible]
DATE 5/8/[illegible]
LOCATION Manitowoc
OPERATOR MW/CSH
STACK NO. Kiln 6
RUN NO. 1
SAMPLE BOX NO. 1
METER BOX NO. 1

AMBIENT TEMPERATURE 45
BAROMETRIC PRESSURE [illegible]
ASSUMED MOISTURE, % 2%
PROBE LENGTH, in. 8'
NOZZLE DIAMETER, in. 1/2"
STACK DIAMETER, in. 105"X103"
PROBE HEATER SETTING 250
HEATER BOX SETTING 250

METER ΔH 1.000 / 1.822 4/5/96
C FACTOR
PROCESS WEIGHT RATE

ORSAT RESULTS
CO_2 0.1
O_2 20.7 MTG BAG
CO –
N_2 BAL

LEAK CHECKS
Pre .002@2[illegible]
Pitot OK@4"
Post .002@22
Pitot OK@4"

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s)	($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
A 1	16:55		71	.050		3.33		654.00		51			<2	
2	57½	+.01	71	.035		2.27		6.5		51				
B 1	1700/01		70	.025		1.62		8.7		52			<2	
2	3½		70	.030		1.93		60.5		52				
C 1	6/7		69	.030		1.93		2.4		52			<2	
2	9½	+.01	68	.035		2.27		4.4		52				
D 1	12/13		68	.020		1.30		6.5		54			<2	
2	15½		69	.020		1.30		8.2		55				
E 1	18/19		69	.025		1.62		9.8		57			<2	
2	21½	+.01	69	.020		1.30		71.7		58				
F 1	24/25		69	.030		1.93		3.3		59			<2	
2	27½		70	.035		2.27		5.3		60				
G 1	30/37		70	.040		2.60		7.4		61			<2	
2	39½	+.01	70	.050		3.33		9.7	52.15	61				
H 1	42/43		70	.050		3.33		82.2		61			<2	
2	45½		70	.040		2.60		4.7		61				
I 1	48/49		70	.055		3.60		6.9		62			<2	
2	51½	+.01	70	.055		3.60		9.5		62				
K 1	54/55		70	.045		2.90		92.2		63			<2	
2	57½		70	.035		2.27		4.3		65				
J 1	1800/01		70	.060		3.90		6.6		67			<2	
2	3½	+.01	70	.040		2.60		9.2		68				
L 1	6/8		70	.065		4.58		701.5		69			<2	
2	10½		70	.040		2.60		4.3		69				
	1912							6.45						

LABORATORY DATA SHEET
PARTICULATE & WATER COLLECTED

JOB NAME BARI - Manitowoc DATE OF TEST 5-8-96

JOB NO. _____ TEST ENGINEER MJH

RUN NO. 1 STACK Kiln #6

SAMPLE BOX 1 FILTER 2067 WASH BOTTLE —

BEAKERS: FH Ace 14 BH Trichl 9 BH Ace 15 BH H_2O F

WATER COLLECTED

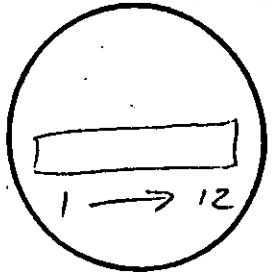
Impinger No.	Final Wt. - g	Initial Wt. - g	Collected - g
1	101	100	1
2	103	100	3
3	4	0	4
SIL GEL	693	687	6
		WATER TOTAL	14

PARTICULATE COLLECTED

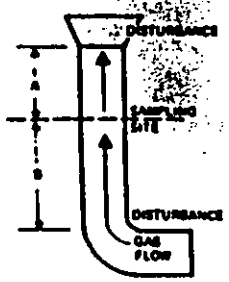
	Blank	Final Wt.	Tare Wt.	Collected - g
Filter		0.7875	0.7874	0.0001
FH Wash	0.0003	103.2229	103.2214	0.0012
			FILTERABLE TOTAL	0.0013
Extract	0.0004	90.9740	90.9736	0.0000
Acetone	0.0006	95.5261	95.5255	0.0000
Water	0.0002	115.2860	115.2855	0.0003
			CONDENSIBLE TOTAL	0.0003
			PARTICULATE TOTAL	0.0016

Environmental Technology & Engineering Corp.

PARTICULATE FIELD DATA



CROSS SECTION



PLANT BUSCH AGRIC
DATE 5/8/96
LOCATION MANITOWOC
OPERATOR MTH/CSH
STACK NO. KILN 6
RUN NO. 2
SAMPLE BOX NO. 4
METER BOX NO. 1

AMBIENT TEMPERATURE 50
BAROMETRIC PRESSURE
ASSUMED MOISTURE, % 20%
PROBE LENGTH, in. 8'
NOZZLE DIAMETER, in. 1/2"
STACK DIAMETER, in. 105" x 103"
PROBE HEATER SETTING 250
HEATER BOX SETTING 250

METER ΔH, 1.822
C FACTOR
PROCESS WEIGHT RATE

ORSAT RESULTS
CO2 0.1
O2 20.7 INTG
CO —
N2 BAL BAG

LEAK CHECKS
Pre <.02@22
Pitot ok@4"
Post <.020 22
Pitot ok@4"

2½ min/PT

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD ($\sqrt{P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), F	SAMPLE BOX TEMPERATURE F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
12-1	19:15:00		69	.050	3.23		708.00		58			4	
-2	17½	-.02	69	.040	2.60		10.6		58				
10-1	20/21		68	.080	5.20		13.0		58			6	
-2	23½		68	.025	1.62		16.1		59				
11-1	26/27		68	.070	4.55		17.9		60			4½	
-2	29½		69	.010	0.66		20.8		60				
8-1	32/33	-.03	70	.035	2.27		21.9		61			3½	
-2	35½		70	.030	1.92		24.0		62				
9-1	38/39		69	.010	0.66		25.9		62			2	
-2	41½		71	.025	1.62		27.1		64				
6-1	44/45		71	.020	1.30		28.9		65			3	
-2	47½		71	.020	1.30		30.6		67				
7-1	50/51	+.01	71	.020	1.30		32.3		69			3	
-2	53½		71	.020	1.30		33.9		69				
4-1	56/57		71	.035	2.27		35.6	50.16	69			4	
4-2	59½		72	.055	3.60		37.7		69				
5-1	20:02/3		72	.025	1.62		40.2		70			3½	
-2	5½		74	.030	1.92		42.0		70				
3-1	8/12	-.01	75	.040	2.62		43.9		72			4½	
-2	14½		76	.050	3.23		46.2		71				
1-1	17/18		76	.050	3.23		48.7		71			5	
-2	20½		76	.040	2.62		51.1		72				
2-1	23/24		77	.040	2.62		53.3		72			4½	
-2	26½		76	.050	3.23		55.6		73				
	79						58.16						

LABORATORY DATA SHEET
PARTICULATE & WATER COLLECTED

JOB NAME BARI - Manitowoc DATE OF TEST 5-8-96

JOB NO. _____ TEST ENGINEER MJH

RUN NO. 2 STACK Kiln #6

SAMPLE BOX 4 FILTER 2069 WASH BOTTLE —

BEAKERS: FH Ace 16 BH Trichl 10 BH Ace 17 BH H_2O 6

WATER COLLECTED

Impinger No.	Final Wt. - g	Initial Wt. - g	Collected - g
1	104	100	4
2	107	100	7
3	3	0	3
SIL GEL	628	623	5
		WATER TOTAL	19

PARTICULATE COLLECTED

	Blank	Final Wt.	Tare Wt.	Collected - g
Filter		0.7789	0.7788	0.0001
FH Wash	0.0003	96.3277	96.3271	0.0003
		FILTERABLE TOTAL		0.0004
Extract	0.0004	88.4079	88.4073	0.0002
Acetone	0.0006	112.0865	112.0857	0.0007
Water	0.0002	111.6439	111.6432	0.0005
		CONDENSIBLE TOTAL		0.0009
		PARTICULATE TOTAL		0.0013

SILEX

667 652 15
100 132 32
47

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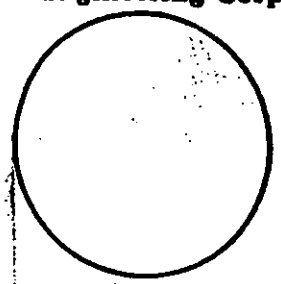
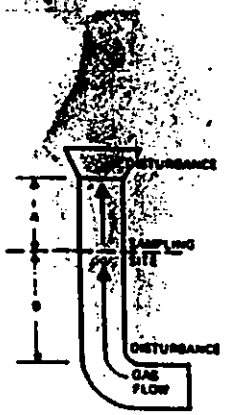


CROSS SECTION



PARTICULATE FIELD DATA

PLANT BUSCH AGRIC
DATE 5/8/96
LOCATION MANITOWOC
OPERATOR MTW
STACK NO. KILN 6
RUN NO. 3
SAMPLE BOX NO. 5
METER BOX NO. 1

AMBIENT TEMPERATURE 45
BAROMETRIC PRESSURE
ASSUMED MOISTURE, % 2%
PROBE LENGTH, in. 8'
NOZZLE DIAMETER, in. 1/2"
STACK DIAMETER, in. 105" x 103"
PROBE HEATER SETTING 250
HEATER BOX SETTING 250

METER ΔH 1.822
C FACTOR
PROCESS WEIGHT RATE

ORSAT RESULTS
CO2 0
O2 20.9
CO —
N2 BAL

LEAK CHECKS
Pre 4@22
Pitot OK @ 4"
Post 4@22"
Pitot OK @ 4

2½ MIN/PT

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD ($\sqrt{P_s}$) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
2-1	1015:00		76	.040	2.62		759.00		59			4	
-2	17½		76	.040	2.62		61.3		59				
1-1	20/21	-.03	77	.055	3.60		63.5		60			4	
-2	23½		77	.040	2.62		66.4		60				
4-1	26/27		77	.025	1.62		68.6		61			3½	
-2	29½		77	.020	1.30		70.4		61				
3-1	32/33		77	.045	2.90		72.1		62			4	
2	35½	-.02	77	.045	2.90		74.5		62				
6-1	38/40		77	.025	1.62		76.8		63			3	
-2	42½		76	.030	1.92		78.6		63				
5-1	45/46		75	.025	1.62		80.5		65			3	
-2	48½		75	.025	1.62		82.3		66				
12-1	51/55		75	.055	3.60		84.1	49.6	68			5	
2	57½		74	.050	3.22		86.6	49.6	69				
10-1	11:00/2	-.03	78	.070	4.58		89.1		70			6	
-2	1½		86	.025	1.62		92.0		70				
11-1	7/9		84	.040	2.62		93.7		71			4	
-2	11½		88	.040	2.62		95.9		72				
8-1	14/15		84	.025	1.62		98.1		73			3	
-2	19½		84	.030	1.92		800.1		73				
9-1	22/23		86	.020	1.30		1.9		72			2½	
-2	25½	.01	86	.020	1.30		3.0		73				
7-1	28/29		84	.030	1.92		5.1		72			3	
-2	31½		84	.030	1.92		6.8		73				
	34						808.66						

LABORATORY DATA SHEET
PARTICULATE & WATER COLLECTED

JOB NAME BARI - Manitowoc DATE OF TEST 5-8-96

JOB NO. _____ TEST ENGINEER MJH

RUN NO. 3 STACK Kiln #6

SAMPLE BOX 5 FILTER 2070 WASH BOTTLE —

BEAKERS: FH Ace 18 BH Trichl 11 BH Ace 19 BH H_2O H

WATER COLLECTED

Impinger No.	Final Wt. - g	Initial Wt. - g	Collected - g
1	100	100	0
2	106	100	6
3	1	0	1
SIL GEL	686	674	8
		WATER TOTAL	15

PARTICULATE COLLECTED

	Blank	Final Wt.	Tare Wt.	Collected - g
Filter		0.7742	0.7740	0.0002
FH Wash	0.0003	114.4186	114.4173	0.0010
			FILTERABLE TOTAL	0.0012
Extract	0.0004	88.9534	88.9530	0.0000
Acetone	0.0006	110.0778	110.0772	0.0000
Water	0.0007	109.7678	109.7674	0.0002
			CONDENSIBLE TOTAL	0.0002
			PARTICULATE TOTAL	0.0014

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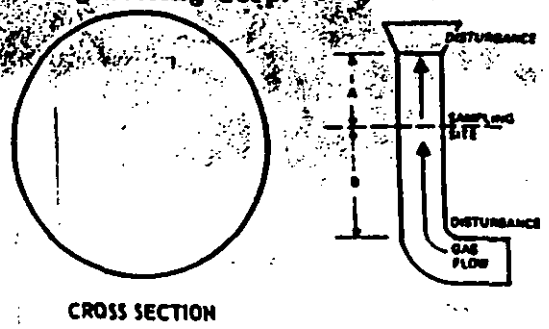
PARTICULATE FIELD DATA SET "W"



CROSS SECTION

PLANT BART
DATE 5-8-96
LOCATION MANITOWOC
OPERATOR WJD
STACK NO. K1W6
RUN NO. 1
SAMPLE BOX NO. 3
METER BOX NO. 2

AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
ASSUMED MOISTURE, %
PROBE LENGTH, in.
NOZZLE DIAMETER, in. 1/2
STACK DIAMETER, in.
PROBE HEATER SETTING
HEATER BOX SETTING

METER ΔH,
C FACTOR
PROCESS WEIGHT RATE

ORSAT RESULTS
CO2
O2
CO
N2

LEAK CHECK:
Pre ✓
Pitot
Post ✓
Pitot

PARTICLE SIZE

Port / TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
1	1655			.04	1.50		758.310		52			5	
							65.1		52				
5	1701			.04	1.50		67.6		52				
							69.7		52				
6	09			.04	1.50		72.0		53				
							7		53				
1	13			.04	1.50		76.3		54				
							78.6		55				
2	19			.04	1.50		81.2		55				
							83.3		56				
3	25			.04	1.50		85.5		58				
							87.7		60				
12	36			.04	1.50		90.9		62				
							92.4		62				
11	43			.04	1.50				62				
							91.8		62				
10	49			.04	1.50		92.0		62				
							99.1		62				
7	55			.04	1.00		01.4		63				
							03.5		63				
8	01			.04	1.00		05.6		64				
							07.8		64				
9	08			.04	1.00		10.0	(51.30)	65				
							12.1						
							7614.30						

SEE PARTICULATE TEST

PARTICULATE FIELD DATA

SET 'X'

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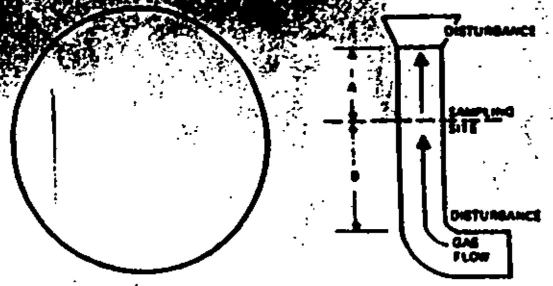

CROSS SECTION

PLANT BART
DATE 5-8-96
LOCATION MANITOWOC
OPERATOR WJD
STACK NO. KILN 6
RUN NO. 2
SAMPLE BOX NO. 3B
METER BOX NO. 2

AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
ASSUMED MOISTURE, %
PROBE LENGTH, in.
NOZZLE DIAMETER, in. 1/2
STACK DIAMETER, in.
PROBE HEATER SETTING
HEATER BOX SETTING

METER ΔH@
C FACTOR
PROCESS WEIGHT RATE

ORSAT RESULTS
CO_2
O_2
CO
N_2

LEAK CHECKS
Pre ✓
Pitot
Post ✓
Pitot

PARTICLE SIZE

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (V_m), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER °F	PUMP VACUUM in. Hg gauge	VELOCITY fps
9	1915			.04	1.00		7615.00		60			5	
							17.2						
8	21			.04	1.00		19.4		60				
							21.6						
7	27			.04	1.00		23.8		60				
							26.0						
12	33			.04	1.00		28.1		60				
							30.3						
11	39			.04	1.00		32.3		61				
							34.4						
10	45			.04	1.00		36.6		62				
							38.7						
3	53			.04	1.00		40.8		64				
							43.0						
2	59			.04	1.00		45.1		64				
							47.2						
1	05			.04	1.00		49.3		65				
							51.4						
6	11			.04	1.00		53.5		66				
							55.6						
5	17			.04	1.00		57.7		68				
							59.9						
4	23			.04	1.00		62.1	51.42	70				
							64.3						
	2128						[illegible]						

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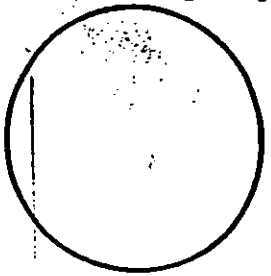
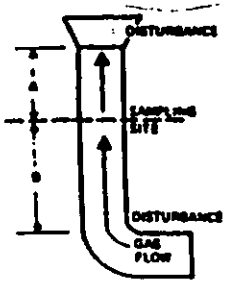
PARTICULATE FIELD DATA

EXTRA SAMPLE TIME 1129 - 1134



CROSS SECTION



PLANT BARE
DATE 5-8-96
LOCATION MANITOWOC
OPERATOR WJD
STACK NO. KILN 6
RUN NO. 3
SAMPLE BOX NO. 3C
METER BOX NO. 2

AMBIENT TEMPERATURE
BAROMETRIC PRESSURE
ASSUMED MOISTURE, %
PROBE LENGTH, in.
NOZZLE DIAMETER, in. 1/2
STACK DIAMETER, in.
PROBE HEATER SETTING
HEATER BOX SETTING

METER ΔH,
C FACTOR
PROCESS WEIGHT RATE

ORSAT RESULTS
CO2
O2
CO
N2

LEAK CHECKS
Pre ✓
Pitot
Post ✓
Pitot

PARTICLE SIZE

TRAVERSE POINT NUMBER	SAMPLING TIME (θ), min.	STATIC PRESSURE (in. H_2O)	STACK TEMPERATURE (T_s), °F	VELOCITY HEAD (ΔP_s) ($\sqrt{\Delta P_s}$)	PRESSURE DIFFERENTIAL ACROSS ORIFICE METER (ΔH) in. H_2O ACTUAL	DESIRED	GAS SAMPLE VOLUME (Vm), ft³	GAS SAMPLE TEMPERATURE AT DRY GAS METER INLET ($T_{m_{IN}}$), °F	OUTLET ($T_{m_{OUT}}$), °F	SAMPLE BOX TEMPERATURE °F	TEMPERATURE OF GAS LEAVING CONDENSER OR LAST IMPINGER F	PUMP VACUUM in. Hg gauge	VELOCITY fps
2	1015			.04	1.00		766.10		58			5	
							69.2						
3	21			.04	1.00		71.5		58				
							73.6						
4	27			.04	1.00		75.8		59				
							78.0						
1	33			.04	1.00		80.1		59				
							82.2						
12	41			.04	1.00		84.5		60				
							86.5						
11	47			.04	1.00		88.6		60				
							90.8						
10	53			.04	1.00		93.0		64				
							95.1						
9	54			.04	1.00		97.2		65				
							98.6						
8	05			.04			99.4		66				
							02.4						
7	13			.04			04.8		70				
							06.5						
5	19			.04	1.00		08.6	82.5	72				
							10.7						
6	25			.04	1.00		12.8	84.5	73				
							15.0						
							17.3						

EMISSION TEST REPORT REVIEW SUMMARY

Source Category:

Filename: TRBARI#6
Ref. No.:
Date: 01-Jul-97
Reviewer: Brian L. Watson

Facility: Busch Agricultural Resources, Inc.
Location: Manitowoc, Wisconsin
Source: Malt Kiln #6
Test date: 08-May-96

Emission Data/Mass Flux Rates/Emission Factors

Test ID	Parameter	Units	Values reported			
			Run 1	Run 2	Run 3	AVERAGE
	Stack temperature	Deg F	70	72	80	74.0
	Pressure	in. Hg	29.3	29.3	29.3	29.3
	Moisture	%	1.3	1.8	1.4	1.5
	Oxygen	%	20.7	20.7	20.9	20.8
	Gas volume sampled	dscf	51.62	49.39	48.89	49.97
	Vol. flow, actual	acfm	596,832	569,885	574,988	580,568
	Vol. flow, standard*	dscfm	575,251	544,355	542,989	554,198
	Isokinetic variation	%	98.9	100.0	99.2	
	Process rate (bu/hr)	bu/hr	387.5	387.5	387.5	387.5
Indicate basis for process rate (production):						
	Pollutant mass:					
	Filterable PM	grams	0.0013	0.0004	0.0012	9.67E-04
	Condensable inorg. PM	grams	0.0003	0.0007	0.0002	4.00E-04
	Condensable org. PM	grams	0	0.0002	0	6.67E-05
	Total condensable PM	grams	0.0003	0.0009	0.0002	0.00046667
	Pollutant concentrations:					AVERAGE
	Filterable PM	gr/dscf	3.89E-04	1.25E-04	3.79E-04	2.97E-04
	Condensable inorg. PM	gr/dscf	8.97E-05	2.19E-04	6.31E-05	1.24E-04
	Condensable org. PM	gr/dscf	0.00E+00	6.25E-05	0.00E+00	2.08E-05
	Total condensable PM	gr/dscf	8.97E-05	2.81E-04	6.31E-05	1.45E-04
	PM-10 (filterable)	% of PM	99.0%	95.0%	87.0%	9.37E-01
	PM-2.5 (filterable)	% of PM	40.0%	48.0%	42.0%	4.33E-01
	CO2	% vol.	0.1	0.1	0.0	6.67E-02
	Pollutant mass flux rates:					AVERAGE
	Filterable PM	lb/hr	1.92E+00	5.83E-01	1.76E+00	1.42E+00
	Condensable inorg. PM	lb/hr	4.42E-01	1.02E+00	2.94E-01	5.85E-01
	Condensable org. PM	lb/hr	0.00E+00	2.92E-01	0.00E+00	9.72E-02
	Total condensable PM	lb/hr	4.42E-01	1.31E+00	2.94E-01	6.83E-01
	PM-10 (filterable)	lb/hr	1.90E+00	5.54E-01	1.53E+00	1.33E+00
	PM-2.5 (filterable)	lb/hr	7.66E-01	2.80E-01	7.40E-01	5.96E-01
	CO2	lb/hr	3.94E+03	3.73E+03	0.00E+00	2.56E+03
	Emission factors (lb/1000 bu):					AVERAGE
	Filterable PM	lb/1000 bu	4.94E+00	1.50E+00	4.55E+00	3.67E+00
	Condensable inorg. PM	lb/1000 bu	1.14E+00	2.63E+00	7.58E-01	1.51E+00
	Condensable org. PM	lb/1000 bu	0.00E+00	7.52E-01	0.00E+00	2.51E-01
	Total condensable PM	lb/1000 bu	1.14E+00	3.39E+00	7.58E-01	1.76E+00
	PM-10 (filterable)	lb/1000 bu	4.90E+00	1.43E+00	3.96E+00	3.43E+00
	PM-2.5 (filterable)	lb/1000 bu	1.98E+00	7.22E-01	1.91E+00	1.54E+00
	CO2	lb/1000 bu	1.02E+04	9.63E+03	0.00E+00	6.60E+03

*DSCFM BASED ON A STANDARD TEMPERATURE OF 68 DEGREES FAHRENHEIT