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.

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AP-42 Section 12.2
Reference
Report Sect. 4
Reference 190

PARTICULATE EMISSION EVALUATION FOR KEYSTONE COKE COMPANY OF CONSHOHOCKEN, PENNSYLVANIA

JULY 5-6, 1978

B•C•M PROJECT NO. 00-4989-03

Submitted by: Mark D. Mueller
Mark D. Mueller
Scientist

Approved by: Peter R. Charrington
Peter R. Charrington, P.E.
Section Manager,
Air Quality

COMMONWEALTH OF PENNSYLVANIA
REGISTERED PROFESSIONAL
PETER R. CHARRINGTON
ENGINEER
No. 20745-E

William P. May, Jr., P.E.
Assistant Vice President
Concept Design and Operations
Department

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C. LABORATORY ANALYSES AND DATA REDUCTION

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ABSTRACT

Particulate testing conducted at the KEYSTONE COKE COMPANY on their No. 3 and No. 4 coke oven battery exhaust stacks indicates compliance with current PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES regulations during the period tested.

The No. 3 battery stack had an emission concentration of .0206 grains/SCFD or 52% of the allowable emission concentration of .04 grains/SCFD. The No. 4 battery stack had an emission concentration of .0362 grains/SCFD or 91% of the allowable emission concentration.

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1.0 INTRODUCTION

The KEYSTONE COKE COMPANY retained BETZ•CONVERSE•MURDOCH, INC. (BCM) to conduct an outlet particulate emission evaluation of their No. 3 and No. 4 coke oven batteries located at their facility in Conshohocken, Pennsylvania. The outlet values obtained are herein compared to the appropriate allowable emission limits established by the PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES.

2.0 SCOPE AND OBJECTIVES

The scope of this project is defined in B•C•M Proposal No. 211-78-11, a copy of which appears in Appendix A of this report. In summary, sampling was conducted to determine the following parameters:

1. Gas Flow - ACFM & SCFM
2. Moisture - % by volume
3. Particulate concentration - G/DSCF & LBS/HR.
4. Gas Temperature - ^{o}F
5. Combustion Gas Analysis - % by volume of O_2, CO_2, CO and N_2.

3.0 PROCEDURES

3.1 Field Work

The field testing was conducted on July 5 and 6, 1978 on Battery stacks No. 3 and 4 respectively. Both stacks were of the natural draft design.

The BCM sampling team consisted of the following personnel:

Mark D. Mueller - Scientist
Patrick J. Ford - Scientist
Geoffrey A. Rogalsky - Technician

Mr. Earl Hall of KEYSTONE COKE COMPANY was present to observe testing procedures and inform the test team of process conditions.

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The following methods of field sampling were employed in the test program:

1. Gas flow, gas temperature and static pressure measurements were made as per Method Two of the Federal Register, Volume 42, No. 160, August 18, 1977 and are outlined in Appendix B, page B1.

2. Particulate sampling was conducted as per Method Five of the Federal Register, Volume 42, No. 160, August 18, 1977 and is outlined in Appendix B, pages B1 through B3.

3. A Fischer - type B No. 10-605 Orsat gas analyzer was used to determine the molecular weight of the flue gas. The following parameters were measured in order to calculate molecular weight of the dry flue gas: volume % carbon dioxide, oxygen and carbon monoxide. The volume % nitrogen was determined by difference. The specific procedure is outlined in Appendix B, pages B3 to B4.

3.2 Equipment Calibration

In accordance with accepted procedures established by the UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (E.P.A.), all gas velocity measuring equipment, volume metering equipment, temperature measuring equipment, and flow rate metering equipment had been calibrated within 60 days of the actual test date. Calibration data is listed in Appendix D.

3.3 Analytical Methods

All samples generated during the sampling program were returned to B•C•M LABORATORIES, Plymouth Meeting, Pennsylvania for analysis. Refer to Appendix C, for a detailed description of the methodology utilized in the analyses of the samples.

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3.4 Calculations

All calculations were performed primarily through the use of a computer. Raw data from the sampling program was developed through the use of the equations presented in the Federal Register, Volume 42, No. 160, August 18, 1977. The reduced data appears on the computer input sheet which is presented on page C4 of Appendix C. Pages C5 through C8 of the same Appendix contain a list of the equations employed in the determination of the test results.

4.0 SUMMARY OF RESULTS

A summary of pertinent test results and allowable emissions for each test is presented in Table I as follows:

TABLE I

PARTICULATE EMISSION RESULTS

Location	Emission Rate* Grains/DSCF	Emission Rate* LB/HR	Maximum Allowable Emission** Grains/DSCF
Battery No. 3	.0206	3.94	.04
Battery No. 4	.0362	7.10	.04

* Based on total particulate catch

** Based on Pennsylvania DER Regulation 123.13 C

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5.0 DISCUSSION OF RESULTS

During the period tested, both the No. 3 and the No. 4 coke oven battery stacks were within compliance with current applicable PENNSYLVANIA DER air pollution regulations.

Emissions from the No. 3 battery were .0206 grains/SCFD or 3.94 lb/hr while the emissions from the No. 4 battery were .0362 grains/SCFD or 7.10 lb/hr. In a comparison with the .04 grains/SCFD allowed by PADER regulations, the No. 3 and No. 4 batteries were 52% and 91% of the allowable limit, respectively.

Isokinetic testing conditions were maintained within the prescribed 100 ± 10% for both tests.

Betz•Converse•Murdoch•Inc.

B•C•M PROPOSAL

APPENDIX A

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Betz · Converse · Murdoch · Inc.

PROPOSAL

TO

KEYSTONE COKE COMPANY
RIVER ROAD
CONSHOHOCKEN, PA 19428

FOR

SOURCE SAMPLING EVALUATION
FOR THE
NO. 3 and NO. 4 COKE OVEN BATTERY STACKS

BCM PROPOSAL NO. 211-78-11

MAY 23, 1978

PREPARED BY:

MARK D. MUELLER
SCIENTIST, AIR QUALITY SECTION

WILLIAM P. MAY, P.E.
ASSISTANT VICE PRESIDENT
CONCEPT DESIGN AND OPERATIONS DEPARTMENT

BETZ·CONVERSE·MURDOCH·INC.
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING, PENNSYLVANIA 19462

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I. PROJECT SCOPE

II. PROJECT MANAGEMENT

III. CLIENT RESPONSIBILITY

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I. PROJECT SCOPE

PROJECT SCOPE

GENERAL

The Keystone Coke Co. located in Conshohocken, PA is currently under a compliance schedule from the Pennsylvania Department of Environmental Resources. Coke oven battery stacks No. 3 and No. 4 must be tested pursuant to the requirements of Chapter 139 of the Pennsylvania DER Rules and Regulations to determine compliance with Sections 123.13(c) and 123.41. Results must be submitted to the State on each battery stack by July 9, 1978.

For ease of discussion and mutual understanding of the BCM services to be provided, the suggested scope is subdivided into the steps as noted below. It is proposed that BCM provide the following services.

A. Project Planning

To accomplish the following, the BCM Manager of the Air Quality Section will contact and discuss the project with Keystone personnel prior to sampling:

I. Establish lines of communications

2. Discuss the project scope and objectives to assure Keystone and BCM are in agreement

3. To insure the sampling requirements have or will be completed by the scheduled testing date (Refer to Section on Client Responsibility)

B. Field Testing Program

BCM intends to provide two men for two days to perform the sampling with the necessary equipment.

1. Efficiency Testing - Three, 2-hour particulate runs will be performed in accordance with current Pennsylvania DER and EPA testing requirements on each of two coke oven battery stacks. Each test will result in the following minimum data:

a. Gas Flow - ACFM & SCFM
b. Moisture - % by volume
c. Particulate concentration - G/SCF & Lbs/Hr.
d. Gas Temperature - °F
e. Combustion Gas Analysis - % by volume of O_2, CO_2, CO and N_2

C. Data Reduction and Report Preparation

BCM personnel will review and evaluate all testing data, and incorporate all pertinent operating data as supplied by the Keystone Coke. Five copies of the report will include, but not be limited to, the following data:

1. A description of the work undertaken
2. A discussion of the sampling and analytical techniques employed
3. A tabulation of all field and laboratory data
4. All calibration sheets for each item utilized in the program
5. All operational data for each system.
6. A comparison to pertinent Pennsylvania DER regulations

D. COMPENSATION

It is proposed that the above outlined services be performed on the basis of Betz•Converse•Murdoch's schedule of charges plus direct expenses for personnel. Only those costs incurred will be charged, and they will not exceed the Estimated Probable Cost without Keystone Coke's approval. We expect the Estimated Probable Cost will fully cover the services herein described.

ESTIMATED PROBABLE COST . . .

E. INVOICES

Invoices will be submitted for work completed on a monthly basis, with terms net thirty (30) days with past-due balances subject to interest at the rate of one (1%) percent per month, effective forty-five (45) days after date of invoice. This represents an annual interest charge of twelve (12%) percent.

F. WORK SCHEDULE

Work on this project can be started within 14 calendar days of your authorization to proceed and can be completed within 30 calendar days after the completion of the field work.

G. DELAYS

Delays caused by unforeseen occurrences such as unfavorable weather conditions, partial or complete plant shutdowns, strikes, floods or fires which extend the effort required will constitute a Change-of-Scope. Upon notification to you, additional effort resulting from such delays will be billed on the basis of our current schedule of charges plus direct expenses.

H. VALIDITY

It is understood that this proposal is valid for 60 days. Subsequent to that date, BCM reserves the right to review the basis of payment to allow for changing costs and adjust starting and completing dates to conform to workload, if need be.

I. INSURANCE

BCM will maintain insurance coverage in the following amounts and upon request of the client, will provide a Certificate of Insurance so indicating:

Type of Policy	Limits of Liability
(a) Standard Workmen's Compensation & Employer's Liability	Statutory
(b) General Liability	
Bodily Injury	$500,000 Each Occurrence $500,000 Aggregate
Property Damage	$500,000 Each Occurrence $500,000 Aggregate
(c) Automobile Liability	
Combined Single Limit (Bodily Injury & Property Damage)	$500,000 Each Occurrence

J. SAFETY

BCM personnel always endeavor to conduct field activities in such a manner as to protect themselves and others from accidents and injury. When special safety equipment is required, the client should so specify. Normally, BCM personnel will use their own safety equipment (hard hats, goggles) unless instructed to do otherwise.

II. PROJECT MANAGEMENT

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PROJECT MANAGEMENT

BCM will assign key personnel who are fully qualified and experienced with similar studies. Biographical information is enclosed for each, and the following briefly describes their duties relative to this study.

Project Manager

Mr. Peter R. Charrington, P.E., Section Manager, Air Quality, will be responsible for all activities relating to field testing in the Air Quality Section. Mr. Charrington has had extensive experience in field testing and will be primary plant contact.

Field Project Engineer

Mr. Doug Mueller has broad experience in industrial plant surveys from both a source and ambient viewpoint. Mr. Mueller will be in charge of the survey team and coordinate all field activities.

An assistant project engineer and technician will be assigned as needed in the survey.

III. CLIENT RESPONSIBILITY

CLIENT RESPONSIBILITY

In order to insure that the proposed project is completed successfully, it shall be the responsibility of Keystone to provide the following:

1. A plant liaison for the BCM field team for the duration of the program.

2. Provide safe access to all sampling locations and electric power (110 V, 20 amp service) to within 50' of each sampling location.

3. Provide operating data for all sources tested.

Betz•Converse•Murdoch•Inc.

FIELD SAMPLING PROGRAM

APPENDIX B

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1.0 TEST SITE LOCATION

Four (4) sampling ports spaced ninety degrees apart were located at approximately the 100 foot level of each stack. A sampling pattern of three (3) points per test port was utilized in each case for a total of twelve (12) sampling points. A three hour test run at 12 points per run (15 minutes per point) was conducted at each of the testing locations. The length of sampling time was due to the fact that Pennsylvania DER requires 50 DSCF of sampled gas for a valid test. This requirement was met in each case.

2.0 SAMPLING PROCEDURES

2.1 Gas Flow and Gas Temperature Measurements

The gas flow rate and the gas temperature profile were measured by conducting a simultaneous velocity and temperature traverse. Gas velocity heads and static pressure were measured with a calibrated "S" type Pitot tube which was connected to an inclined manometer. A Chromel-Alumel thermocouple attached to a THERMO-ELECTRIC CORPORATION potentiometer was used to measure the gas temperature at each of the traverse points. The gas flow and gas temperature measurements followed Method Two of the Federal register, Volume 42, Number 160, August 18, 1977.

2.2 Particulate Sampling

All sampling procedures and sample equipment in the test program were those outlined in Method Five of the Federal Register, Volume 42, Number 160, August 18, 1977.

510896

The size of the nozzle required to maintain isokinetic sampling was calculated from the results of the initial velocity and temperature traverse. The sampling train utilized a glass-lined stainless steel (316) probe which was maintained above 250°F by an internal heating element. A nozzle of the calculated size was attached at the end of the probe which was inserted into the stack. A calibrated "S" type Pitot tube and a Chromel-Alumel thermocouple were clamped to the probe and were used to monitor the velocity head and the temperature at the traverse points during the sampling period. Sampled gas at the outlet passed through the nozzle and the probe and then through a glass fiber filter for the removal of the suspended particulates. The Method 5 filter was housed in a heated chamber whose temperature was maintained above 250°F. From the filter the gas passed to the impinger train. The first two impingers each contained 150 ml of deionized water. The third impinger contained no reagents and was the knockout impinger. The fourth impinger contained approximately 200 grams of coarse silica gel which collected any moisture and/or vapors which had not been captured in the preceeding impingers.

The second impinger was a 50 ml Greenburg-Smith impinger, while the first, third and fourth impingers were 500 ml impingers of the Greenburg-Smith design, modified by replacing the tip with a 1/2" ID glass tube.

From the impinger train the gas passed through an umbilical cord to the control console, a Model 2343 RAC Stak Samplr which contained the following pieces of equipment (listed in the order in which sampled gas passed through them): a main valve, a by-pass valve for flow adjustment, an air-tight vacuum pump, and a calibrated orifice. The orifice was equipped with pressure taps which were connected across an inclined manometer used to insure that isokinetic conditions were maintained during the test. A schematic diagram is depicted on page B11 of this Appendix.

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The entire sampling train was subjected to a leak check prior to and after each sample run. Prior to the run, the nozzle was plugged and the pump vacuum was held at 15 in. Hg for one minute. After the run was completed, the train was again leak checked at a vacuum greater than the highest vacuum recorded during the sample run. In all cases the leakage rate was minimal.

Upon the completion of a test, the soiled glass fiber filter was removed from its holder and placed in a Petri dish which was subsequently sealed. The probe and the nozzle were washed internally with acetone; the particulate matter remaining in the probe was removed with a nylon brush attached to a polyethylene line. The brush was rinsed, and the washings were added to the nozzle and probe washings. The front half of the glass filter holder was also rinsed with acetone, and the washings obtained were added to those collected from the nozzle and the probe. All washings were stored in sealed sample bottles. The contents of the first, second, and third impingers were measured volumetrically and then stored in a sealed sample bottle. The impinger glassware was rinsed with deioniozed water and these washings were added to the impinger samples. The silica gel used in the fourth impinger was removed and placed in a sealed polyethylene sample bottle. Samples of the deionized water and acetone reagents used in the test program were stored in separate sample bottles to be analyzed as blanks.

2.3 Molecular Weight Determinations

A Fischer-type (b) No. 10-605 Orsat gas analyzer was used to determine the molecular weight of the flue gas. The following parameters were measured in order to calculate molecular weight: volume percent carbon dioxide (CO_2), volume percent oxygen (O_2), and volume percent carbon monoxide (CO); the

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volume percentage of nitrogen (N_2) was determined by difference. These parameters were measured using the principle of gas absorption in specific absorbing solutions. A 100 ml flue gas sample was drawn from the stack through the glass manifold by the use of the leveling bottle following aspiration of the sample lines. The system was then closed by adjusting the stopcock at the inlet of the manifold. The sample was bubbled through three (3) absorbing solutions which selectively collected different gaseous components of the flue gas in the following manner: carbon dioxide was collected by a potassium hydroxide solution in the first absorber, oxygen was collected by a potassium pyrogallate solution in the second absorber and carbon monoxide was collected by a cupric chloride solution in the third absorber.

3.0 FIELD DATA

The gas velocity head, gas temperature, inlet and outlet dry gas meter temperatures, elapsed time, orifice pressure, and the sample gas volume were recorded during the testing program. The field data sheets for the sample runs follow:

BETZ ENVIRONMENTAL ENGINEERS, Inc.

VELOCITY DETERMINATIONS

Client: KEYSTONE COKE - BATTERY #3

Location: CONSHOHOCKEN

Date: 7/5/78

Stack Pressure: -.53" H2O

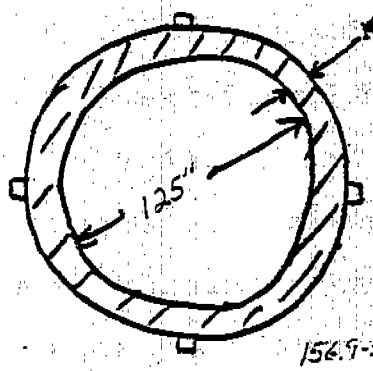
Barometric Pressure:

Pitot Factor: #6-1 .829

Engineer: DM

Sample Port Location:

Circ. = 41'1" = 493"



$d = \frac{C}{\pi}$

$d = \frac{493}{\pi} =$

156.9

156.9-32 = 124.9

(125")

Pitot/Temperature Readings

Point No.	Distance (Inches)	Port A		Port B		Port C		Port D		Port	
		ΔP	T	ΔP	T	ΔP	T	ΔP	T	ΔP	T
1	5.5	.005		.005		.006		.006			
2	18.3	.013	342	.005	322	.008	353	.006	345		
3	37.0	.015		.013		.010		.009			
TOTAL		341									
AVG.		.008									

510900

PLANT: KEYSTONE COKE
DATE: 7/5/78
SAMPLING LOCATION: BATTERY #1
SAMPLE TYPE: PART
RUN NUMBER: 1
OPERATOR: DM
AMBIENT TEMPERATURE: 80
BAROMETRIC PRESSURE:
STATIC PRESSURE (P_s): -.53" H_2O
FILTER NUMBER(S):
GEL NUMBER(S):
THIMBLE NUMBER(S): —

BCM

FIELD DATA SHEET

ORSAT:
CO_2 2.0% / 3.4%
O_2 18 22.8 32 32.5
CO
N_2

PYROMETER NUMBER: 1
THERMOCOUPLE NUMBER:
PROBE NUMBER AND TYPE: GLASS-LINED #7-
NOZZLE I.D. AND NO.: 1/2" #1
ASSUMED MOISTURE (%): 10
SAMPLE BOX NUMBER:
METER BOX NUMBER: 2
METER $H_@$: 1.98
C FACTOR: .99
REFERENCE ΔH: .043
PITOT C_p AND NO.: # 6-1 .829
H_2O PICKUP (ml):

T_m = 85

READ AND RECORD ALL DATA EVERY 5 MINUTES

+12 ml

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 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
			Ø									
A1	00	1314	999.197	.006	.27	.27	322	76	75	1	290	56
1	05	1319	100 1.00	.006	.27	.27	328	79	77	1	290	56
2	10	1324	1002.75	.010	.43	.43	330	83	78	2	255	55
2	15	1329	1004.90	.010	.43	.43	340	84	79	2	275	57
3	20	1334	1005.90	.013	.57	.57	350	86	80	3	270	55
3	25	1339	1007.85	.016	.65	.65	350	89	81	3	260	56
OFF	30	1344	1009.698	CHANGE TEST PORTS								
B1	30	1348	1009.698	.007	.20	.20	290	82	82	1	260	56
1	35	1353	1011.000	.008	.34	.34	307	90	83	2	260	62
2	40	1358	1012.75	~~.007~~ .010	.43	.43	305	93	85	3	255	61
2	45	1403	1014.40	.010	.43	.43	305	94	86	5	255	61
3	50	1408	1016.20	.008	.34	.34	365	98	89	5	260	60
3	55	1413	1017.80	.008	.34	.34	368	98	89	X.5	255	60
OFF	60	1418	1019.507	CHANGE TEST PORTS								
C1	60	1434	1019.507	.005	.21	.21	293	92	89	1	255	61
1	65	1439	1021.10	.005	.21	.21	320	94	90	1	255	62
2	70	1444	1022.20	.005	.21	.21	326	96	91	1	255	65
2	75	1449	1023.90	.005	.21	.21	356	98	92	1	255	65 ICE DOWN
3	80	1454	1024.90	.020	.88	.88	325	98	92	4	255	63
3	85	1459	1027.10	.022	.95	.95	300	103	94	4	255	62
OFF	90	1504	1030.238	CHANGE TEST PORTS								

510901

CO_2 3.0%
O_2 31.6, 36, 37.4

(1.8)
14.4, 17.6, 18.2 (18.2)
CO = .03
29.97 = N/2

PLANT Keystone Core DATE 7/5/78 RUN NUMBER 1

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 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
D1	90	1510	1030.238	.015	.65	.65	275	101	94	3	270	64
1	95	1515	1032.55	.014	.62	.62	320	102	95	3	260	65
2	100	1520	1034.60	.016	.69	.69	326	102	95	4	260	67
2	105	1525	1036.90	.016	.69	.69	370	105	96	4	265	68
3	110	1530	1038.70	.018	.78	.78	373	106	97	4	265	68
3	115	1535	1041.10	.018	.78	.78	370	107	98	4	260	69 ICE DOWN
~~OFF~~	~~120~~	~~1540~~		~~CHANGE TEST PORTS~~ (EXTEND TEST 15 MIN/PORT TO INC CU FT)								
D2 3	120	1540	1044.00	.018	.78	.78	380	107	98	4	255	64
2 2	125	1545	1046.10	.014	.62	.62	385	107	98	4	255	64
2 1	130	1550	1048.20	.008	.34	.34	345	106	98	2	255	66
OFF	135	1555	1050.100	CHANGE TEST PORTS								
C1	135	1600	1050.300	.008	.34	.34	337	102	92	2	255	67
2	140	1605	1051.95	.006	.26	.26	330	106	99	2	255	67
3	145	1610	1053.20	.005	.21	.21	324	106	99	2	260	68
OFF	150	1615	1054.881	CHANGE TEST PORTS								
B1	150	1620	1054.881	.005	.21	.21	335	101	96	2	260	68
B2	155	1625	1056.20	.008	.34	.34	358	101	98	3	255	66 ICE DOWN
B3	160	1630	1057.40	.010	.43	.43	361	101	97	3	250	62
OFF	165	1635	1059.253	~~.010~~	~~.43~~	~~.43~~	~~356~~	~~102~~	~~97~~	~~3~~	~~255~~	~~63~~
A1	165	1640	1059.253	CHANGE TEST PORTS								
A2	170	1645	1061.00	.010	.43	.43	356	102	97	3	255	63
A3	175	1650	1062.80	.009	.39	.39	360	103	97	2	265	62
OFF	180	1655	1064.530	.010	.43	.43	369	104	97	3	260	63
				END RUN								
	180		65.333	.100	.457		339	94.2				

510902

BETZ ENVIRONMENTAL ENGINEERS, Inc.

VELOCITY DETERMINATIONS

Client: Keystone Coke

Location: #4 Battery

Date: 7/8/78

Stack Pressure: -.01" H2O

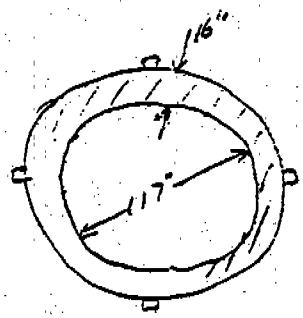
Barometric Pressure:

Pitot Factor: .829 #6-1

Engineer: DM

Sample Port Location:

$C_{oo} = 39' = 468"$



$d = \frac{C}{\pi}$

$d = \frac{468}{\pi} = 149.0$

I.D. = 149 - 32 = 117"

117"

Pitot/Temperature Readings

Point No.	Distance (Inches)	Port A		Port B		Port C		Port D		Port	
		ΔP	T	ΔP	T	ΔP	T	ΔP	T	ΔP	T
1	5.1	.008		.010		.008		.015			
2	17.1	.015	375	.015	324	.015	357	.020	379		
3	34.6	.015		.018		.018		.025			
TOTAL											
AVG.		.015	359								

$T_m = 110$

510903

BCM

FIELD DATA SHEET

PLANT: Keystone Coke
DATE: 7/6/78
SAMPLING LOCATION: #4 Battery
SAMPLE TYPE: Part.
RUN NUMBER: 2
OPERATOR: DM
AMBIENT TEMPERATURE: 85
BAROMETRIC PRESSURE:
STATIC PRESSURE (P_s): -.02" H_2O
FILTER NUMBER(S):
GEL NUMBER(S):
THIMBLE NUMBER(S): –

ORSAT:
CO_2 3.2
O_2 14.2
CO 0.0

PYROMETER NUMBER:
THERMOCOUPLE NUMBER:
PROBE NUMBER AND TYPE:
NOZZLE I.D. AND NO.: 1/2" #1
ASSUMED MOISTURE (%): 5
SAMPLE BOX NUMBER:
METER BOX NUMBER: 2
METER $H_@$: 1.98
C FACTOR: 1.11
REFERENCE ΔP: .040
PITOT C_p AND NO.: .829 #6-1
H_2O PICKUP (ml): +95 ml

READ AND RECORD ALL DATA EVERY 5 MINUTES

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 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
A1	00	1459	100.433	.020	.92	.92	398	94	95	5	245	65
1	05	1504	103.99	.016	.74	.74	374	97	95	4	255	66
1	10	1509	105.40	.014	.64	.64	370	100	96	4	260	68
2	15	1514	107.80	.021	.95	.95	360	104	99	5	260	65
2	20	1519	110.05	.020	.92	.92	390	105	100	5	260	65
2	25	1524	112.65	.020	.92	.92	397	108	102	5	265	65
3	30	1529	115.10	.020	.92	.92	402	110	104	5	270	70 (ice down)
3	35	1534	117.75	.025	1.15	1.15	399	111	105	6	275	67
3	40	1539	120.50	.025	1.15	1.15	412	112	106	6	275	66
OFF	45	1544	122.845	CHANGE TEST PORTS								
B1	45	1548	122.845	.010	.46	.46	366	108	106	3	270	67 (ice down)
1	50	1553	124.80	.007	.32	.32	395	107	106	2	260	62
2	55	1558	126.40	.011	.51	.51	400	106	106	3	275	61
2	60	1601	127.60	.014	.64	.64	400	106	106	3	275	61
3	65	1608	130.05	.020	.92	.92	393	106	106	3	275	62
3	70	1613	132.90	.016	.74	.74	395	107	106	4	275	63
OFF	75	1618	135.186	CHANGE TEST PORTS								
1	75	1630	135.186	.005	.23	.23	380	105	105	2	260	65
1	80	1635	135.55	.005	.23	.23	373	105	105	2	250	65
2	85	1640	137.95	.016	.74	.74	377	106	106	4	285	63
2	90	1645	140.20	.016	.74	.74	397	108	106	4	280	63

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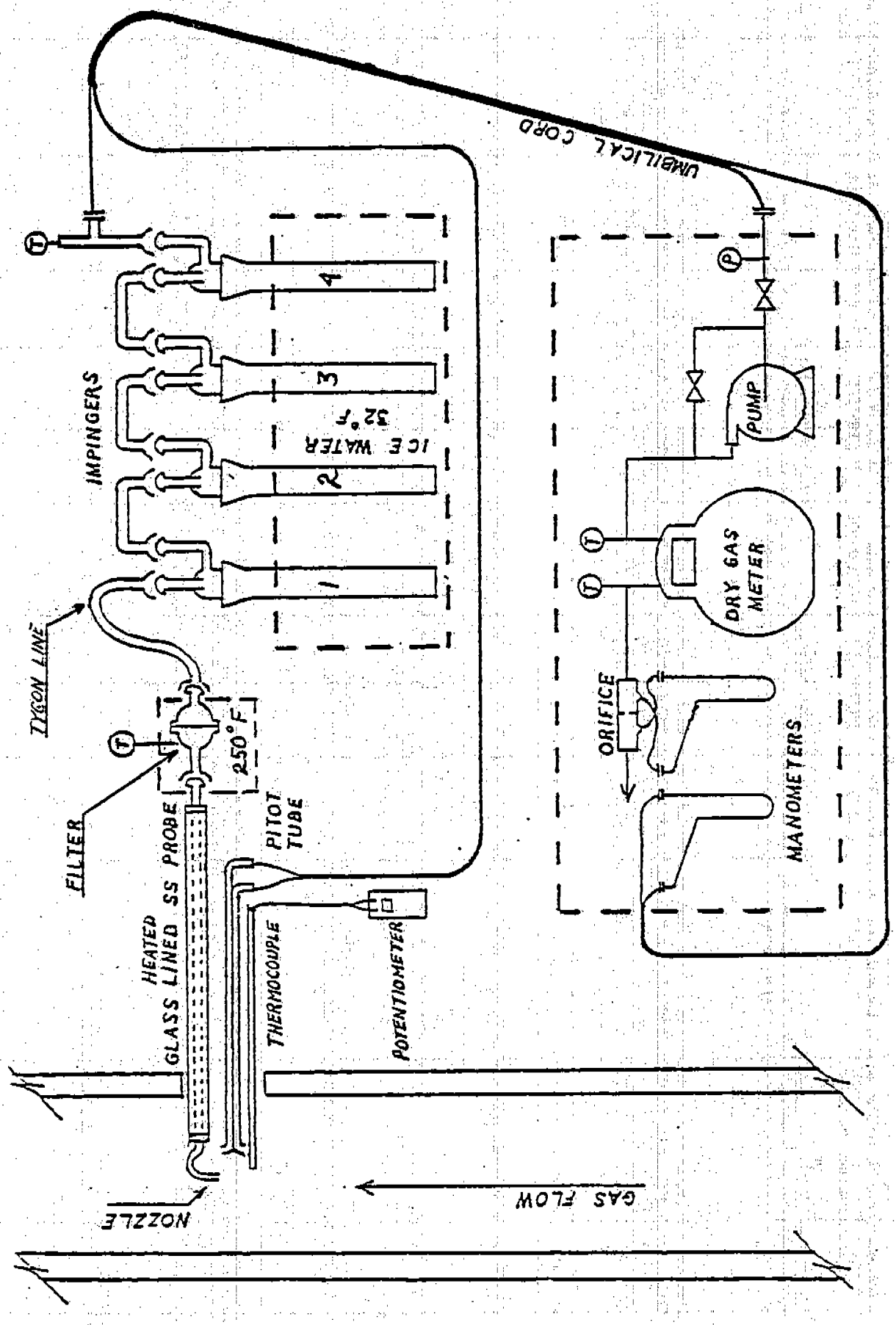
PLANT Keystone Coke DATE 7/6/78 RUN NUMBER 2 - Part.

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 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
C3	95	1650	142.60	.020	.92	.92	402	110	106	5	285	64
3	100	1655	145.15	.022	1.00	1.00	418	111	107	5	285	63
OFF	105	1700	147.848	CHANGE TEST PORTS								
D1	105	1707	147.848	.010	.46	.46	355	107	106	3	295	70 (ice/dam)
1	110	1712	149.85	.010	.46	.46	362	106	106	3	290	63
2	115	1717	151.70	.015	.70	.70	363	106	106	3	290	65
2	120	1722	153.90	.017	.79	.79	395	107	106	4	285	63
3	125	1727	156.30	.022	1.00	1.00	390	108	106	5	283	63
3	130	1732	158.90	.023	1.05	1.05	406	110	106	5	285	63
OFF	135	1737	161.566	END RUN								
	135		61.133	.125	.749		387.7	105.2				

510905


UMBILICAL CORD
IMPINGERS
ICE WATER
32°F
1
2
3
4
TYGON LINE
FILTER
250°F
HEATED
GLASS LINED SS PROBE
PITOT
TUBE
THERMOCOUPLE
POTENTIOMETER
NOZZLE
GAS FLOW
ORIFICE
DRY GAS
METER
PUMP
MANOMETERS

510906

LABORATORY ANALYSIS AND DATA REDUCTION

APPENDIX C

1.0 ANALYTICAL METHODS

All particulate samples generated in the sampling program were returned to BCM LABORATORIES, INC. of Plymouth Meeting, Pennsylvania for analysis. The following discussion describes the analytical methods employed.

1.1 Particulate Samples

All glass fiber filters used in the particulate sampling program had been tare-weighed following a twenty-four hour drying period at 105°C and desiccation prior to their use in the field. Upon their return to the laboratory, they were dried for twenty-four (24) hours, desiccated and reweighed. The weight difference was the amount of sample collected on the filter.

Nozzle, probe and filter holder acetone washings were evaporated to dryness in a tared beaker. The amount of residue remaining was then multiplied by the blank factor to attain the net particulate matter collected at these locations in the sampling train.

Aliquots of the impinger solutions were evaporated to dryness at 105°C in tared beakers. The residue which remained was the impinger catch and it was multiplied by the aliquot factor to determine the total particulate catch.

A blank distilled water solution was evaporated to dryness at 105°C in a tared beaker. An acetone blank was evaporated to dryness in a tared beaker. Any residue which remained in either case was a contaminant in the reagents and was considered as a blank weight in subsequent calculations. Laboratory results of the particulate sampling program are listed in Table C1 on page C2.

TABLE C-1

LABORATORY RESULTS

Run No.	Location	Particulate Catch (mg)				Total Moisture Gain (ml)
		Filter	P+C	Impinger	Total	
1	# 3 Battery	31.5	13.3	39.3	84.1	55.8
1	# 4 Battery	52.9	17.2	65.5	135.6	107.2

2.0 COMPUTER INPUT DATA SHEET

The reduced data calculated from the particulate sampling data sheets and analytical laboratory results were combined on the following computer input sheet. This sheet is instrumental in utilizing the computer for the calculation and presentation for the relevent sampling program parameters.

510910

10	Number of Tests	2														
20	Test Identification	3B	4B													
30	Stack Area, IN^2	12,272	10,751													
40	Stack Temperature, °F	339.0	387.7													
50	Sample Volume, Dry, CF	65.333	61.133													
60	Avg. Meter Temperature, °F	94.2	105.2													
70	Avg. Orifice (Δ H) IN H_2O	.457	.749													
80	Nozzle, Dia. IN	.505	.505													
90	Duration of Test, Min.	180	135													
100	CO_2	3.0	3.2													
110	CO	0.0	0.0													
120	O_2	13.6	14.2													
130	N_2	83.4	82.6													
140	Stack Pressure, IN Hg	30.10	30.18													
150	Barometric Pressure, IN Hg	30.14	30.18													
160	Pitot Correction Factor	.829	.829													
170	Pitot Traverse (Avg.$\sqrt{\Delta P}$) IN H_2O	.100	.125													
180	Volume, H_2O Collected, ml	55.8	107.2													
190	Ml, SO_3	0	0													
200	Ml, SO_2	0	0													
210	Total Collected Weight, mg	84.1	135.6													
220	Normality of SO_3	0	0													
230	Normality of SO_2	0	0													
240	Meter Calibration Factor	1.00	1.00													

CLIENT: Keystone Coke
LOCATION: Connellsville Pa
JOB NO.: 00-4989-03

NAME OF FILE: Keycoke, 1

AIRPOL 1 INPUT DATA SHEET

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3.0 EQUATIONS FOR THE CALCULATIONS OF TEST RESULTS

The following series of equations was programmed into the computer to facilitate the calculations leading to the results of the test program. The equations were prescribed in Methods 2, 3 and 5 of the Federal Register, Volume 46, Number 160, August 18, 1977, appropriately amended, and were used to calculate the results of particulate testing and the flow, temperature, and static pressure testing.

EQUATIONS FOR PARTICULATE, MOISTURE, AND FLOW CALCULATIONS

(BASED ON STANDARD CONDITIONS OF 68°F AND 29.92"Hg)

1. $V_{w(std)} = 0.0471\ V_{wc}$

2. $V_{m(std)} = 17.64\ V_m \dfrac{P_{bar} + .07355\ \Delta H}{T_m + 460}\gamma$

3. $B_{wo} = \dfrac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$

4. $M_d = 0.44(\%CO_2) + 0.28(\%CO) + 0.32(\%O_2) + 0.28(\%N_2)$

5. $M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$

6. $EA = \dfrac{(\%O_2) - 0.5(\%CO)}{0.264(\%N_2) - (\%O_2) + 0.5(\%CO)}\ 100$

7. $V_s = (85.49)(60)(C_p)\sqrt{\Delta P}\sqrt{\dfrac{T_s + 460}{(P_s)(M_s)}}$

8. $Q_s = \dfrac{(V_s)(A_s)}{144}$

9. $Q_{s(std)} = Q_s(1 - B_{wo})\ 17.64\ \dfrac{P_s}{T_s + 460}$

10. $C'_s = 0.0154\ \dfrac{W_t}{V_{m(std)}}$

11. $C'_w = 0.0154\ \dfrac{W_t}{V_{m(std)} + V_{w(std)}}$

12. $C'_c = \dfrac{12\ C'_s}{\%CO_2}$

13. $C'_a = W_w\ \dfrac{(T_s + 460)(29.92)}{(528)(P_s)}$

14. $E = 0.00857\ Q_{s(std)}\ C'_s$

15. $A_n = \dfrac{(\pi)(D_n)^2}{(144)(4)}$

16. $I = \dfrac{(60)(1.667)(T_s + 460)(0.00267\ V_{wc} + V_{m(std)}/17.64)}{(\theta)(V_s)(P_s)(A_n)}$

510913

LEGEND

A_n	=	Area of nozzle, ft^2
A_s	=	Area of stack, in^2
B_{wo}	=	Moisture content of gas stream, dimensionless
C_p	=	Pitot correction factor, dimensionless
C'_a	=	Particulate concentration (stack conditions), gr/ft^3
C'_c	=	Particulate concentration at 12% CO_2 (dry), gr/dscf
C'_s	=	Particulate concentration (dry), gr/dscf
C'_w	=	Particulate concentration (wet), gr/scf
D_n	=	Diameter of nozzle, in.
E	=	Particulate emission rate, lb/hr
EA	=	Excess air, percent
ΔH	=	Orifice pressure drop, in. H_2O
I	=	Isokinetic ratio, percent
M_d	=	Dry molecular weight of stack gas, lb/lb-mole
M_s	=	Molecular weight of stack gas, lb/lb-mole
P_{bar}	=	Barometric pressure, in. Hg
P_s	=	Stack pressure (absolute), in. Hg
$\sqrt{\Delta P}$	=	Average of square roots of pitot pressure differential, in. H_2O
Q_s	=	Stack gas flow, acfm
$Q_{s(std)}$	=	Stack gas flow, scfm
T_m	=	Average dry gas meter temperarure, ^oF
T_s	=	Average stack temperature, ^oF
V_m	=	Dry sample volume (meter conditions), ft^3
$V_{m(std)}$	=	Dry sample volume (standard conditions), ft^3

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V_s = Stack velocity, ft/min

V_{wc} = Volume of liquid collected in impingers and silica gel, ml

$V_{w(std)}$ = Volume of liquid collected, ft^3

W_t = Total weight of particulates collected, mg

θ = Duration of test, min.

4.0 TEST RESULTS

The complete results of the computer analysis and data reduction of the input data generated from the sampling program is presented on page C-10.

510916

PARAMETERS		3B	4B
AREA OF BREECHING	(SQ IN)	12272.00	10751.00
SAMPLE VOLUME(DRY)	(STD CU FT)	52.75	57.59
MOISTURE	(%)	4.0202	8.0481
MOLECULAR WEIGHT	STACK GASES	28.38	28.19
GAS TEMPERATURE	(F)	339	388
GAS VELOCITY	(FPM)	410	531
GAS VOLUME	(SCFM)(DRY)	22234	22885
GAS VOLUME	(ACFM)	34924	39614
PARTICULATE CONC :			
GRAINS/STD CU.	FOOT (DRY BASIS)	.0266	.0362
GRAINS/STD CU.	FOOT (WET BASIS)	.0198	.0333
GRAINS/STD CU.	FOOT 12% CO2	.0826	.1357
GRAINS/CU.	FOOT (STK COND)	.0132	.0209
POUNDS/HOUR		3.9419	7.0996
ORSAT ANALYSIS :			
CARBON DIOXIDE	(VOL %)	3.00	3.20
CARBON MONOXIDE	(VOL %)	.00	.00
OXYGEN	(VOL %)	13.60	14.20
NITROGEN	(VOL %)	83.40	82.60
EXCESS AIR	(%)	161.57	186.68
ISOKINETIC	(%)	95.96	100.28

510917

CALIBRATION DATA

APPENDIX D

1.0 PITOT CALIBRATION

The pitot tubes were calibrated by measuring the velocity head in a duct with both an "S" type pitot and a standard pitot with a known coefficient. This was done at several different velocities. The pitot tube coefficient can be calculated as follows:

$$C_{p(test)} = C_{p(std)} \sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Where:

$C_{p(test)}$ = Pitot tube coefficient of "S" type pitot

$C_{p(std)}$ = Pitot tube coefficient of standard pitot

ΔP_{test} = Velocity head measured by "S" type pitot

ΔP_{std} = Velocity head measured by standard pitot

Coefficients were determined for each leg of the "S" type pitot. No C_p may deviate more than ± 0.01 from the average C_p, and the difference between the average C_p for each leg must be ≤ 0.01.

2.0 DRY GAS METER AND ORIFICE METER

The dry gas meter and orific were calibrated using a wet test meter. Gases were moved through the dry gas meter at orifice pressure differentials (ΔH's) of 0.5, 1.0, and 2.0 inches of water. With the information obtained, γ, the ratio of accuracy of wet test meter to dry test meter; and $\Delta H_@$, the orifice pressure

510919

differential that gives 0.75 cfm of air at 68°F and 29.92 inches of mercury, were calculated. The γ has a tolerance of 1.00 ±0.01 and the $\Delta H_@$ has a tolerance of 1.84 +0.26 -0.24. The γ and $\Delta H_@$ are determined as follows:

$$\gamma = \frac{V_w P_b \ (t_d + 460)}{V_d [P_b + .07353 (\Delta H)] (t_w + 460)}$$

$$\Delta H_@ = \frac{0.0317 \ (\Delta H)}{P_b \ (t_d + 460)} \left(\frac{(T_w + 460) \ \theta}{V_w} \right)^2$$

Where:

ΔH = Orifice pressure differential, in H_2O

P_b = Barometric pressure, in Hg

t_d = Average temperature of dry gas meter, °F

t_w = Average temperature of wet test meter, °F

θ = Duration of test, min.

V_d = Dry gas meter volume, ft^3

V_w = Wet test meter volume, ft^3

3.0 POTENTIOMETER CALIBRATION

The Thermo - Electron potentiometers were calibrated by using a known voltage source as an input to the potentiometer.

4.0 PROBE CALIBRATION

The probes were calibrated by measuring the outlet temperatures at various variable transformer settings while passing air through at approximately 0.75 cubic feet per minute.

STAKSAMPLR CALIBRATION SHEET

Man Orifice	CF w	CF d	T W	IT d	OT d	Td Avg.	Time
0.5	5.00	5.072	64	81.0	76.7	78.9	13:30
1.0	5.502	5.517	64	82.5	74	78.2	10:36
2.0	10.00	9.923	64	78.2	70.8	74.5	13:46
4.0	10						
6.0	10						
8.0	10						

Date 4/3/78 Box No. 2 Inspector PRC

Pump ✓ Oil ✓ Wick ✓ Pump Serial No. 72-325

Manometers ✓ Knobs ✓ Oil ✓ Tubing ✓ LK

Quick Connects ✓ Vacuum Gage ✓ Valves ✓

Dry Gas Meter ✓ Volume 279.47 ft³ Serial No JA59130

Thermometers ✓ In 70 °F Out 70 °F Ambient 70 °F

Amphenol ✓ Lights Switches ✓ Variac ✓

Leak Check - Max. Vacuum 23 in. Hg Leak Rate 0.00 CFM

Remarks Pump Light flickers and probe Light out

Pb 30.53

Tolerances:

Y = 0.99 - 1.00 - 1.0

ΔH = 1.6 - 1.84 - 2.1

$\frac{0.0317 \text{ (Man. orifice)}}{P_b\ (OT_d + 460)} \left(\frac{(T_w + 460)^t}{CF_w}\right)$	Man.	$\Delta H_@$	$\frac{CF_w P_b\ (T_d \text{ avg.} + 460)}{CF_d\ (P_b + 13.6\ (T_w + 460)}$ (Man. orifice)	Man.	Y
$\frac{0.01585}{30.53\ (76.7 + 460)} \left(\frac{(64 + 460)\ 13.5^2}{5.00}\right)$	.5	1.94	$\frac{5.00 \times 30.53 (78.9 + 460)}{5.072\ (30.53 + 0.0368)\ (64 + 460)}$	.5	1.01
$\frac{0.0317}{30.53\ (74 + 460)} \left(\frac{(64 + 460)\ 10.6^2}{5.502}\right)$	1.0	1.98	$\frac{5.502 \times 30.53\ (78.2 + 460)}{5.517\ (30.53 + 0.0737)\ (64 + 460)}$	1.0	1.02
$\frac{0.0634}{30.53\ (70.8 + 460)} \left(\frac{(64 + 460)\ 13.76^2}{10.00}\right)$	2.0	2.04	$\frac{10.00 \times 30.53 (74.5 + 460)}{9.923\ (30.53 + 0.147)\ (64 + 460)}$	2.0	1.02

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PITOT CALIBRATION

Pitot No. 61 Date 4-7-78 Engineer RJF

Range	Run No.	ΔP_{std}	A SIDE ΔP	A SIDE C_p	A SIDE DEV.	B SIDE ΔP	B SIDE C_p	B SIDE DEV.	DIF.
1	1	.018	.025	.840	.011	.025	.840	.006	
	2	.02	.026	.868	.039	.026	.868	.034	
	3	.018	.029	.780	-.049	.028	.794	-.04	
	AVG.			.829			.834		-.005
2	1	.20	.28	.837	.01	.28	.837	.000	
	2	.20	.29	.822	-.005	.28	.837	.000	
	3	.20	.29	.822	-.005	.28	.837	.000	
	AVG.			.827			.837		-.01
3	1	.44	.64	.821	-.002	.625	.831	.007	
	2	.425	.635	.810	-.009	.63	.813	-.01	
	3	.44	.63	.827	.008	.63	.827	.003	
	AVG.			.819			.824		-.005
4	1	.59	.86	.820	.004	.855	.822	.002	
	2	.585	.86	.817	.001	.85	.821	.001	
	3	.58	.865	.811	-.005	.85	.818	-.002	
	AVG.			.816			.820		-.004
5	1	.785	1.15	.818	.008	1.15	.818	.008	
	2	.77	1.15	.810	.000	1.15	.810	.000	
	3	.755	1.15	.802	-.008	1.15	.802	-.008	
	AVG.			.810			.810		.000
6	1	1.05	1.55	.815	-.004	1.5	.828	.000	
	2	1.05	1.5	.828	.009	1.45	.842	.014	
	3	1.05	1.55	.815	-.004	1.55	.815	-.013	
	AVG.			.819			.828		-.009
7	1	1.1	1.65	.808	-.009	1.6	.821	-.004	
	2	1.1	1.6	.821	.004	1.55	.834	.009	
	3	1.1	1.6	.821	.004	1.6	.821	-.004	
	AVG.			.817			.825		-.008

$$C_p = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{"S"}}}$$

DEV. $= C_p - \overline{C_p}$

DEV. ≤ 0.01

DIF. $= \overline{C_{p(A)}} - \overline{C_{p(B)}}$

DIF. ≤ 0.01

510922

PYROMETER CALIBRATION SHEET

Pyrometer 1 Date 3/31/78 Inspector DM

Indicated Temperature (From pyrometer)	Actual Temperature (From standard)	Difference
100	108	+8
200	207	+7
300	304	+4
400	403	+3
500	503	+3
600	602	+2
700	702	+2
800	804	+4
900	904	+4
1000	1003	+3
1100	1102	+2
1200	1202	+2
1300	1301	+1
1400	1404	+4
1500	1505	+5
1600	1606	+6
1700	1705	+5
1800	1804	+4
1900	1903	+3
2000	2005	+5
Avg.		+3.9

510923

NOZZLE DIAMETER CALIBRATION SHEET

Set No. 1 Date 3/31/78 Inspector DM

Nominal Size	Micrometer Readings				Comments
	1	2	3	Ave.	
0.125	.122	.121	.120	.121	
0.1875	.186	.184	.186	.185	
0.250	.256	.258	.258	.257	
0.3125	.307	.308	.308	.308	
0.375	.373	.375	.375	.374	FERRULE LOOSE
0.500	.506	.505	.504	.505	

510924

APPLICABLE REGULATIONS

APPENDIX E

(c) No person shall cause, suffer, or permit the emission into the outdoor atmosphere of particulate matter from any process not listed in Table 1 in such a manner that the concentration of particulate matter in the effluent gas, at any time, exceeds:

(1) 0.04 grains per dry standard cubic foot, when the effluent gas volume is less than 150,000 dry standard cubic feet per minute.

(2) The rate determined by the formula:

$A = 6000E^{-1}$, where:
A = Allowable emissions in grains per dry standard cubic foot, and
E = Effluent gas volume in dry standard subic feet per minute,

when E is equal to or greater than 150,000 but less than 300,000.

(3) 0.02 grains per dry standard cubic foot, when the effluent gas volume is greater than 300,000 dry standard cubic feet per minute.

Allowable emissions under this subsection are graphically indicated in Figure 3 appended to this Chapter.

TABLE 1

Process	Process Factor, F
1. Carbon black mfg.	500 lbs./ton of product
2. Charcoal mfg.	400 lbs./ton of product
3. Crushers or grinders or screens	20 lbs./ton of feed
4. Paint mfg.	0.05 lbs./ton of pigment handled
5. Phosphoric acid mfg.	6 lbs./ton of phosphorous burned
6. Detergent drying	30 lbs./ton of product
7. Alfalfa dehydration	30 lbs./ton of product
8. Grain elevators:	
Loading or unloading	90 lbs./ton of grain
9. Grain screening and cleaning	300 lbs./ton of grain
10. Grain drying	200 lbs./ton of product
11. Meat smoking	0.01 lbs./ton of meat
12. Ammonium nitrate mfg.:	
Granulator	0.1 lbs./ton of product
13. Ferroalloy production furnace	0.3 lbs./ton of product
14. Primary iron and/or steel making:	
Iron production	100 lbs./ton of product
Sintering: windbox	20 lbs./ton of dry solids feed
Steel production	40 lbs./ton of product
Scarfing	20 lbs./ton of product
15. Primary lead production:	
Roasting	0.004 lbs./ton of ore feed
Sintering: windbox	0.2 lbs./ton of sinter
Lead reduction	0.5 lbs./ton of product
16. Primary zinc production:	
Roasting	3 lbs./ton of ore feed
Sintering: windbox	2 lbs./ton of product
Zinc reduction	10 lbs./ton of product
17. Secondary aluminum production:	
Sweating	50 lbs./ton of aluminum product
Melting and refining	10 lbs./ton of aluminum feed
18. Brass and bronze production:	
Melting and refining	20 lbs./ton of product