AP42 Section:	11.3
Reference:	20
Title:	Building Brick And Structural Clay Wood Fired Brick Kiln, Emission Test Report, Chatham Brick And Tile Company, Gulf, NC, EMB Report 80-BRK-5, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1980.

United States
Environmental Protection
Agency

Office of Air Quality
Planning and Standards
Research Triangle Park NC 27711

EMB Report 80-BRK-5
October 1980

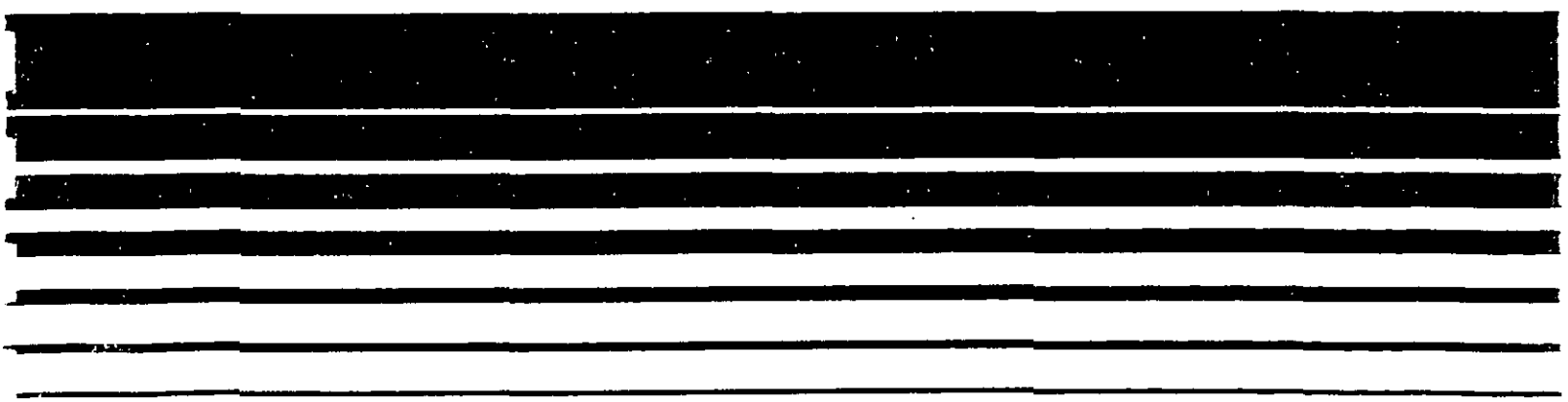
Air

AP-42 Section 11.3
Reference 20

EPA

Building Brick and Structural Clay Wood Fired Brick Kiln

Emission Test Report Chatham Brick and Tile Company Gulf, North Carolina



PARTICLE SIZING OF EMISSIONS FROM A SAWDUST-FIRED BRICK KILN, CHATHAM BRICK AND TILE COMPANY, GULF, NORTH CAROLINA

by

Mark D. Hansen

FINAL REPORT
October 1980

EPA Contract No. 68-02-2814, Work Assignment No. 42
MRI Project No. 4468-L(42)

For

Environmental Protection Agency
Emission Measurement Branch
Emission Standards and Engineering Division
MD-13
Research Triangle Park, North Carolina 27711

Attn: Mr. J. E. McCarley

PREFACE

The work reported herein was conducted by personnel from Midwest Research Institute (MRI), Energy and Environmental Analysis, Inc. (EEA), and the U.S. Environmental Protection Agency (EPA).

The scope of work issued under EPA Contract No. 68-02-2814, Work Assignment No. 42, was under the supervision of Dr. H. Kendall Wilcox, MRI Manager, Field Programs Section. Mr. Mark D. Hansen served as Field Task Leader and was assisted in the field by Mr. George R. Cobb. Messrs. Mark D. Hansen and George R. Cobb were responsible for summarizing the test data in this report.

Mr. Armando Sarasua of EEA was responsible for monitoring the process operations during the testing program. EEA personnel were also responsible for writing the Process Description and Operation Section (Section 3) of this report.

Members of the Chatham Brick and Tile Company, Gulf, North Carolina, whose assistance and guidance contributed greatly to the success of the test program, include Mr. Harold Stewart, Plant Manager, and Mr. Leonard Gunter, Assistant Plant Manager.

Mr. Frank R. Clay, Office of Air Quality Planning and Standards, Emission Measurement Branch, EPA, served as Technical Manager and was responsible for coordinating the emission test program.

Sincerely,

Ken Wilcox

Ken Wilcox, Head
Field Programs Section

Approved for:

MIDWEST RESEARCH INSTITUTE

M P Schrag

M. P. Schrag, Director
Environmental Systems Department

October 1980

CONTENTS

FIGURES

TABLES

SECTION 1

INTRODUCTION

Section III of the Clean Air Act of 1970 charges the Administrator of the U.S. Environmental Protection Agency (EPA) with the responsibility of establishing federal standards of performance for new stationary sources which may significantly contribute to air pollution. When promulgated, these standards of performance for new stationary sources are to reflect the degree of emission limitation achievable through application of the best demonstrated emission control technology.

EPA's Office of Air Quality Planning and Standards (OAQPS) selected the Chatham Brick and Tile Company at Gulf, North Carolina, as a site for an emission test program. The test program was designed to provide a portion of the emission data base required for new source performance standards (NSPS) for the process associated with the production of clay bricks. The Chatham Brick and Tile Company's manufacturing plant produces clay bricks for the building brick industry. The clay bricks are fired in two sawdust-fired kilns (Harrop Kilns Nos. 1 and 2). The two kilns are operated 24-hr a day and 7 days a week. The two kilns are located in one building and are parallel to each other.

The purpose of the testing program was to obtain particle size distribution data and CO_2 measurements of the kiln emissions. Results of measurements contained in this report were performed during times of normal operation of the production process.

Emissions sampling was conducted on the kiln exhaust stack and waste heat exhaust stack associated with each of the two Harrop Kilns. The production rate of fired bricks from each of the two kilns during sampling was approximately 5 tons/hr; or 10 tons/hr total.

Midwest Research Institute's (MRI's) Work Assignment No. 42 from EPA required one particle size distribution test from each of the two kiln exhaust stacks. Information from Chatham Brick and Tile Company personnel prior to the initiation of testing indicated that one of the two kilns was not fired exclusively with sawdust. The Harrop Kiln No. 1 on the west side of the kiln building was periodically "flashed" with natural gas in conjunction with the sawdust fuel. The east kiln (Harrop Kiln No. 2) was exclusively sawdust-fired during the field test. In concurrence with the EPA technical manager, the particle size distribution test on the Harrop Kiln No. 1 (west side) kiln exhaust stack was omitted. Instead, two particle size distribution tests were conducted on the Harrop Kiln No. 2 (east side) kiln exhaust stack. Each test was conducted at a different traverse point location.

The measurement program was conducted August 19, 1980. A copy of MRI's Work Assignmnt and Technical Directives is included in Appendix F.

The sequence of events performed during this sampling program are presented in Table 1-1 (Summary Log for Sampling Matrix).

The following sections of this report cover the summary of results (Section 2), process description and operation (Section 3), location of sampling points (Section 4), sampling and analytical procedures (Section 5), and appendices (Section 6). The appendices present copies of all field and laboratory data sheets, computer reduction of test data, and results of laboratory analyses.

TABLE 1-1. SUMMARY LOG FOR SAMPLING, AUGUST 19, 1980

Time (24-hr clock)	Production rate (tons/hr)[a]	Andersen particle size distribution - Harrop Kiln No. 2 (east) kiln exhaust stack	CO_2 emissions Harrop Kiln No. 2 (east) kiln exhaust stack	CO_2 emissions Harrop Kiln No. 1 (west) kiln exhaust stack	CO_2 emissions Harrop Kiln No. 1 (west) waste heat exhaust stack	CO_2 emissions Harrop Kiln No. 2 (east) waste heat exhaust stack
1630	NA[b]		Begin Test No. 1			
1645			Stop Test No. 1 Begin Test No. 2			
1700			Stop Test No. 2			
1730		Begin Test No. 1				
1830		Stop Test No. 1				
1940		Begin Test No. 2				
2015				Begin Test No. 1	Begin Test No. 1	
2030				Stop Test No. 1 Begin Test No. 2	Stop Test No. 1 Begin Test No. 2	
2045				Stop Test No. 2	Stop Test No. 2	
2110		Stop Test No. 2				
2200						Begin Test No. 1
2215						Stop Test No. 1 Begin Test No. 2
2230						Stop Test No. 2

[a] Production rate includes only the east kiln.

[b] Data not available.

SECTION 2

SUMMARY OF TEST RESULTS

The results of the testing program conducted at Chatham Brick and Tile Company are presented in Tables 2-1 through 2-3.

CARBON DIOXIDE EMISSION TEST DATA

The results of the eight CO_2 emission tests are presented in Table 2-1. The percent O_2, CO, and N_2, and dry molecular weight (lb/lb-mole) of the stack gas are also presented.

PARTICLE SIZE DISTRIBUTION TEST DATA

The results of the two particle size distribution tests at the Harrop Kiln No. 2 (east) kiln exhaust stack have been summarized in Tables 2-2 and 2-3. The results are shown graphically in Figures 2-1 and 2-2.

TABLE 2-1. AVERAGE NET VOLUME (PERCENT) CO_2, O_2, CO, AND N_2 DETERMINED BY ORSAT ANALYSIS FROM HARROP KILNS NOS. 1 AND 2

Test location	Run number and time	Average net volume (percent)[a]				Dry molecular weight of stack gas (lb/lb-mole)
		CO_2	O_2	CO	N_2	
Harrop Kiln No. 2 (east) kiln exhaust stack	1 (1630-1645)	2.37	17.9	0	79.7	29.087
Harrop Kiln No. 2 (east) kiln exhaust stack	2 (1645-1700)	2.5	17.03	0	80.47	29.082
Harrop Kiln No. 1 (west) kiln exhaust stack	1 (2015-2030)	2.6	14.8	0	82.6	29.008
Harrop Kiln No. 1 (west) kiln exhaust stack	2 (2030-2045)	1.67	16.07	0.6	81.67	28.913
Harrop Kiln No. 1 (west) waste heat exhaust stack	1 (2015-2030)	0.7	17.0	0.267	82.07	28.803
Harrop Kiln No. 1 (west) waste heat exhaust stack	2 (2030-2045)	0.433	16.97	0.4	82.2	28.749
Harrop Kiln No. 2 (east) waste heat exhaust stack	1 (2200-2215)	0.467	16.167	0	83.37	28.722
Harrop Kiln No. 2 (east) waste heat exhaust stack	2 (2215-2230)	0.467	17.4	0	82.13	28.773

[a] Percents are an average of three readings.

TABLE 2-2. ANDERSEN MARK III CASCADE IMPACTOR SAMPLING PARAMETERS AND RESULTS - HARROP KILN NO. 2 (EAST) KILN EXHAUST STACK, RUN NO. 1

INPUT DATA FOR FILE RUN1

TEST DATE - 8-19-80		% WATER=	7.3
PROJECT # - 4468-L42		% CARBON DIOXIDE=	2.37
TEST SITE - CHATHAM BRICK &TILE CO.		% CARBON MONOXIDE=	0
RUN ID - ONE		% OXYGEN=	17.9

ANDERSEN IMPACTOR

STACK TEMPERATURE=	315.0 DEGREES F.	SAMPLING TIME=	60.0 MIN.
BAR. PRESSURE=	29.70 INCHES HG	PRESSURE DROP=	0.00 INCHES HG
STATIC PRESSURE=	-0.34 INCHES H20	SAMPLER TEMP. =	315.0 DEGREES F.
AVE. DELTA P=	0.5 INCHES H20	PARTICLE DENS=	1
PITOT COEFF.=	.84	METER VOL.=	38.345 CUBIC FEET
METER TEMP.=	101.5 DEGREES F.	DELTA H=	1.3 INCHES H20
PROBE DIA.=	0.25 INCHES		

CALCULATED RESULTS

SAMPLE VOL.-DRY STD.=	35.893 CU. FT.	DRY MOLECULAR WT.=	29.10
SAMPLE VOL.-WET STD.=	38.719 CU. FT.	WET MOLECULAR WT.=	28.29
STACK VELOCITY=	2777.0 FT./MIN.	% ISOKINETIC=	100.9
NOZZLE VELOCITY=	2802.7 FT./MIN.	SAMPLING RATE-ACTUAL=	0.955 CU. FT/MIN
LOADING=	.004289 GRAIN/SCF	WEIGHT CORRECTION=	0.080 MG.
LOADING(DRY)=	.004626 GRAIN/SCF	MASS COLLECTED=	10.760 MG.

STAGE #	0	1	2	3	4	5	6	7	FILTER
FINAL WT (MG)	458.64	446.67	453.96	442.09	452.85	453.66	450.21	437.37	570.05
TARE WT (MG)	456.98	444.55	451.42	440.57	452.39	453.31	449.95	437.04	567.81
NET WT (MG) CORRECTED	1.58	2.04	2.46	1.44	0.38	0.27	0.18	0.25	2.16
FRACTION % OF TOTAL	14.68	18.96	22.86	13.38	3.53	2.51	1.67	2.32	20.07
CUM. % WITH FILTER	14.68	33.64	56.51	69.89	73.42	75.93	77.60	79.93	100.00
FRACTION % WITHOUT FILTER	18.37	23.72	28.60	16.74	4.42	3.14	2.09	2.91	
CUM. % WITHOUT FILTER	18.37	42.09	70.70	87.44	91.86	95.00	97.09	100.00	
JET VEL. (CM/SEC)	74	137	229	378	673	1628	2966	5932	
D50 SIZE (MICRONS)	11.57	7.21	4.87	3.31	2.11	1.04	0.63	0.41	<0.41
DM/DLOGD (GRAINS/SCF)		0.00396	0.00577	0.00341	0.00078	0.00035	0.00033	0.00055	
GEO MEAN (MICRONS)		9.13	5.93	4.02	2.64	1.48	0.81	0.51	<0.51
PARTICLE COUNT		5.4D+04	1.2D+05	1.1D+05	3.6D+04	2.9D+04	5.0D+04	1.3D+05	

TABLE 2-3. ANDERSEN MARK III CASCADE IMPACTOR SAMPLING PARAMETERS AND RESULTS - HARROP KILN NO. 2 (EAST) KILN EXHAUST STACK, RUN NO. 2

INPUT DATA FOR FILE RUN2

TEST DATE - 8-19-80		% WATER=	7.3
PROJECT # - 4468-L42		% CARBON DIOXIDE=	2.37
TEST SITE - CHATHAM BRICK &TILE CO.		% CARBON MONOXIDE=	0
RUN ID - TWO		% OXYGEN=	17.9

ANDERSEN IMPACTOR

STACK TEMPERATURE=	317.0 DEGREES F.	SAMPLING TIME=	90.0 MIN.
BAR. PRESSURE=	29.70 INCHES HG	PRESSURE DROP=	0.00 INCHES HG
STATIC PRESSURE=	-0.34 INCHES H2O	SAMPLER TEMP. =	317.0 DEGREES F.
AVE. DELTA P=	0.5 INCHES H2O	PARTICLE DENS=	1
PITOT COEFF.=	.84	METER VOL.=	58.230 CUBIC FEET
METER TEMP.=	100.5 DEGREES F.	DELTA H=	1.4 INCHES H2O
PROBE DIA.=	0.25 INCHES		

CALCULATED RESULTS

SAMPLE VOL.-DRY STD.=	54.614 CU. FT.	DRY MOLECULAR WT.=	29.10
SAMPLE VOL.-WET STD.=	58.915 CU. FT.	WET MOLECULAR WT.=	28.29
STACK VELOCITY=	2841.7 FT./MIN.	% ISOKINETIC=	100.3
NOZZLE VELOCITY=	2850.4 FT./MIN.	SAMPLING RATE-ACTUAL=	0.972 CU. FT/MIN
LOADING=	.004673 GRAIN/SCF	WEIGHT CORRECTION=	0.080 MG.
LOADING(DRY)=	.005041 GRAIN/SCF	MASS COLLECTED=	17.840 MG.

STAGE #	0	1	2	3	4	5	6	7	FILTER
FINAL WT (MG)	443.53	425.11	447.49	429.15	438.70	424.36	443.39	424.54	543.73
TARE WT (MG)	441.40	423.01	443.45	427.18	438.02	423.31	442.55	423.47	539.05
NET WT (MG) CORRECTED	2.05	2.02	3.96	1.89	0.60	0.97	0.76	0.99	4.60
FRACTION % OF TOTAL	11.49	11.32	22.20	10.59	3.36	5.44	4.26	5.55	25.78
CUM. % WITH FILTER	11.49	22.81	45.01	55.61	58.97	64.41	68.67	74.22	100.00
FRACTION % WITHOUT FILTER	15.48	15.26	29.91	14.28	4.53	7.33	5.74	7.48	
CUM. % WITHOUT FILTER	15.48	30.74	60.65	74.92	79.46	86.78	92.52	100.00	
JET VEL. (CM/SEC)	75	140	233	385	684	1655	3017	6033	
D50 SIZE (MICRONS)	11.48	7.15	4.84	3.28	2.10	1.03	0.62	0.41	<0.41
DM/DLOGD (GRAINS/SCF)		0.00258	0.00611	0.00294	0.00081	0.00082	0.00090	0.00144	
GEO MEAN (MICRONS)		9.06	5.88	3.99	2.62	1.47	0.80	0.50	<0.50
PARTICLE COUNT		3.5D+04	1.3D+05	9.1D+04	3.8D+04	6.9D+04	1.4D+05	3.5D+05	

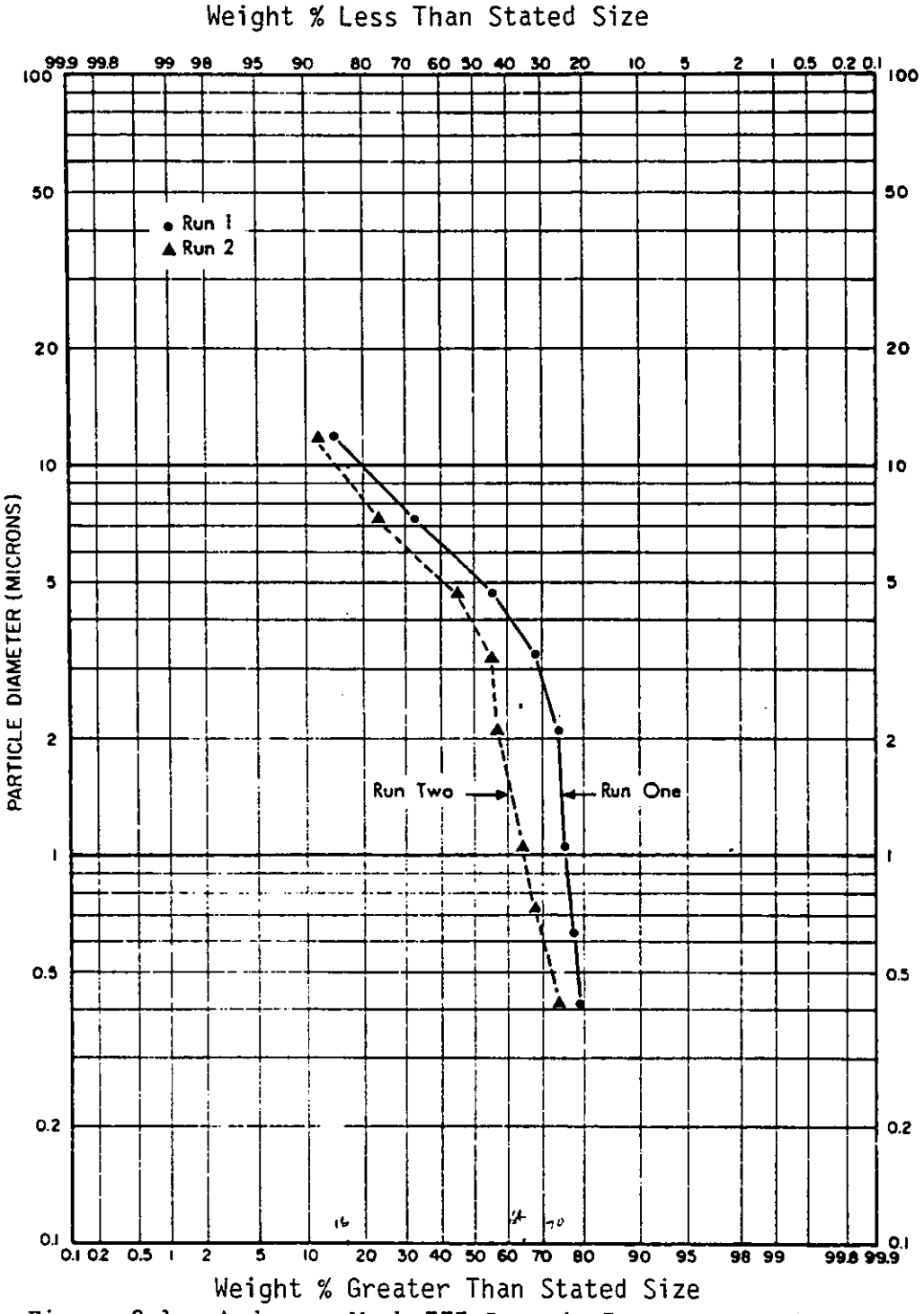


Figure 2-1. Andersen Mark III Cascade Impactor particle size results: particulate diameter versus percent weight less/greater than stated size - Harrop Kiln No. 2 (east) kiln exhaust stack, run Nos. 1 and 2.

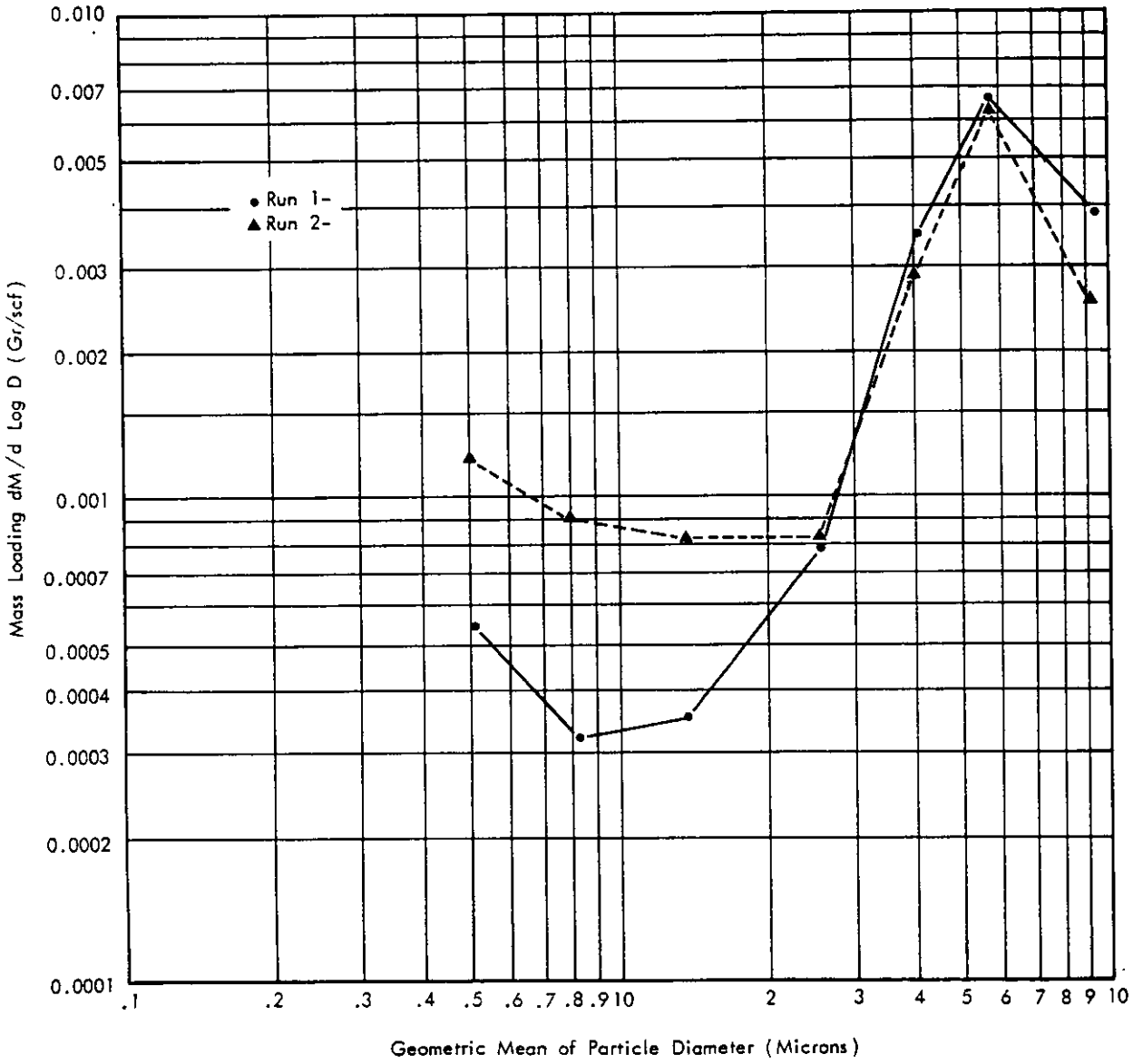


Figure 2-2. Andersen Mark III Cascade Impactor particle size results: differential mass-loading (dM/d Log D) versus particulate diameter - Harrop Kiln No. 2 (east) kiln exhaust stack, run Nos. 1 and 2.

SECTION 3

PROCESS DESCRIPTION AND OPERATION

Chatham Brick and Tile operates two building brick kilns which were rebuilt in 1951 and 1954 and have a total production capacity of 61,952 cored bricks per day. The firm produces standard-size cored and solid building brick with various surface finishes and textures as well as custom brick on special order.

PROCESS DESCRIPTION

Figure 3-1 shows the main steps of the manufacturing process at Chatham Brick and Tile Company and also indicates sampling locations during the testing program.

A belt conveyor carries the clay from the stockpile to the pug mill where sawdust and water are added until the mix contains about 23% sawdust and 4% water. The mix then moves through the deaerating section of the pug mill to remove any air bubbles and is extruded onto a conveyor in a continuous column through an appropriate die to obtain the desired size and shape. A cutting machine slices the column into individual bricks; odd-sized and otherwise defective bricks are returned by another conveyor to the pug mill for remixing. The unfired (green) bricks continue on a conveyor to the automatic hacker for stacking onto the kiln cars. Each kiln car holds 2,816 standard (3-1/2 in. x 8 in. x 2-1/4 in.) bricks. The loaded kiln cars are then moved to a holding area to await drying and firing in the kiln.

Chatham Brick has two tunnel kilns comprised of a drying section, a firing section, and a cooling section. Both kilns are 111 m (364 ft) long and are each equipped with 64 dual fuel burners which may use either No. 2 fuel oil or natural gas. In addition, a pneumatic system can feed sawdust to 38 alternative burners for firing. Due to rising fuel costs, the firm uses natural gas and oil solely for custom finishes on special orders. Sawdust is trucked in from local mills and stockpiled. Conveyors move the sawdust to a dryer and then to the fuel distribution system for firing at the rate of approximately 10 to 13.5 tons/day per kiln.

At full capacity, a kiln car is moved into the kiln drying section every 1-1/2 hr (16 cars per day) for solid brick and every hour and 5 min (22 cars per day) for cored brick. Hot air for drying is drawn from the cooling section of the kiln and used to reduce the moisture content of the brick to less than 1%. The cars are pushed from the drying section to the firing section, where the bricks are fired at about 1000°C (1830°F); the cars then proceed to the cooling section and from there to an automatic dehacker for restacking the bricks into marketable bundles which are stored outside to await shipment.

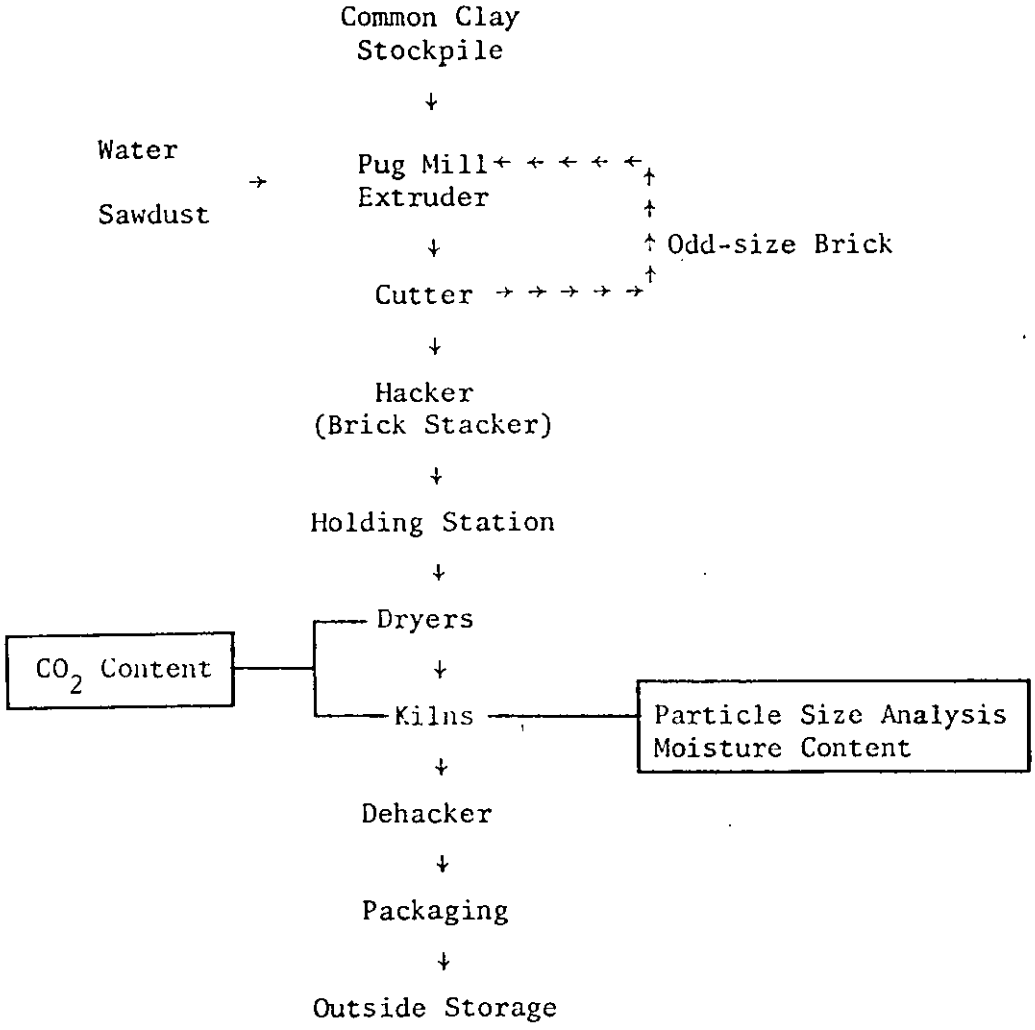


Figure 3-1. Chatham Brick and Tile Company, process flow diagram.

PROCESS OPERATIONS

The purpose of this test program was to determine the particle size distribution of emissions from a sawdust-fired building brick kiln.

Each kiln has two stacks, one exhausting the drying section (north stack), and one exhausting the firing section (south stack). An Orsat analysis was performed twice on each stack of both kilns. Kiln No. 1 (west kiln) was fired with gas due to a custom order requiring the brick to be manufactured as customary 15 years ago to obtain a special surface finish. Kiln No. 2 (east kiln) was fired exclusively with sawdust; a particle size analysis was performed on the stack from the firing section by means of an Andersen impactor. In addition, the moisture content of the exhaust gas stream from this stack was determined by EPA Method 4.

The kilns at Chatham Brick and Tile Company are equipped with flowmeters to monitor oil and gas flows and thermocouples to measure temperature. When firing with sawdust, the temperature reading controls the sawdust feed rate, however, no provisions exist to accurately measure the feed rate.

On August 19, 1980, process monitoring began at 10:45 AM; testing began shortly after 10:45 AM and was concluded at 11:00 PM. The kiln operators reported that there had been no process upsets, and the operation had been normal. During the day of the test, kiln No. 2 had a throughput of 16 cars, i.e., production of 45,056 standard cored bricks. This reduced production rate, down from 61,952 cored bricks per day, was due to a slow down in the building industry.

The average temperature was 1000°C (1830°F) which is the same as during full production. The reduced production was not believed to significantly affect the particle size distribution since kiln temperatures, and thus, sawdust firing rates, during the testing were in the normal ranges.

SECTION 4

LOCATION OF SAMPLING POINTS

This section presents detailed descriptions of the sampling locations used for the measurement of CO_2 emissions and particle size distribution. Each test location is discussed separately.

A generalized overview of the kiln building complex is presented in Figure 4-1. Figure 4-2 presents a flowsheet of the brick making and kiln firing process at Chatham Brick and Tile Company. Heated air from the brick firing zone in the kilns is recycled back to the brick drying zone. Excess heated air recycled to the drying zone is exhausted to the atmosphere through a waste heat exhaust stack located at the north end of each of the kilns. Heated air from the brick firing zone that is not recycled to the drying zone, is exhausted to the atmosphere through a kiln exhaust stack at the southern end of each of the kilns (Figure 4-1). No emission control equipment presently exists on any of the four kiln building exhaust stacks.

HARROP KILN NO. 2 (EAST) KILN EXHAUST STACK SAMPLING LOCATIONS

This exhaust stack is rectangular in shape. A sheet metal rectangular stack extension with ports was provided by Chatham Brick and Tile Company for sampling purposes. The stack extension was placed on top of the rectangular brick exhaust stack. The location of the ports used to sample this exhaust stack is presented in Figure 4-3. View A is from the west side looking east. View B is from the south side looking north.

The five sampling ports are located in a 32-in. long by 29-in. wide rectangular vertical duct. The distance from the five ports to the nearest downstream disturbance; which is where the duct is reduced in size above the exhaust fan, is 286 cm (112.75 in.), or 3.76 duct diameters. The distance from the five ports to the nearest upstream disturbance; which is the top of the stack extension, is 66 cm (26 in.), or 0.87 duct diameters.

This sampling location did not meet the "8 and 2 diameter" criterion for particulate traverses for rectangular stacks as outlined in EPA Reference Method 1 (Federal Register, Vol. 42, No. 160, Thursday, August 18, 1977). Since the stack extension contained five sampling ports, nine sampling point locations were chosen for each port traverse for a total of 45 sampling points. An average stack gas velocity and temperature location was determined by EPA Reference Method 2 procedures for selection of the particle size distribution sample point location. Figure 4-4 shows the location of the traverse points and the sampling points selected for the two particle size distribution tests. Test No. 1 was conducted at traverse point No. 2-7, port No. 2. Test No. 2 was conducted at traverse point No. 3-3, port No. 3. The distance of the traverse points from the opening of the sample ports is presented in Table 4-1.

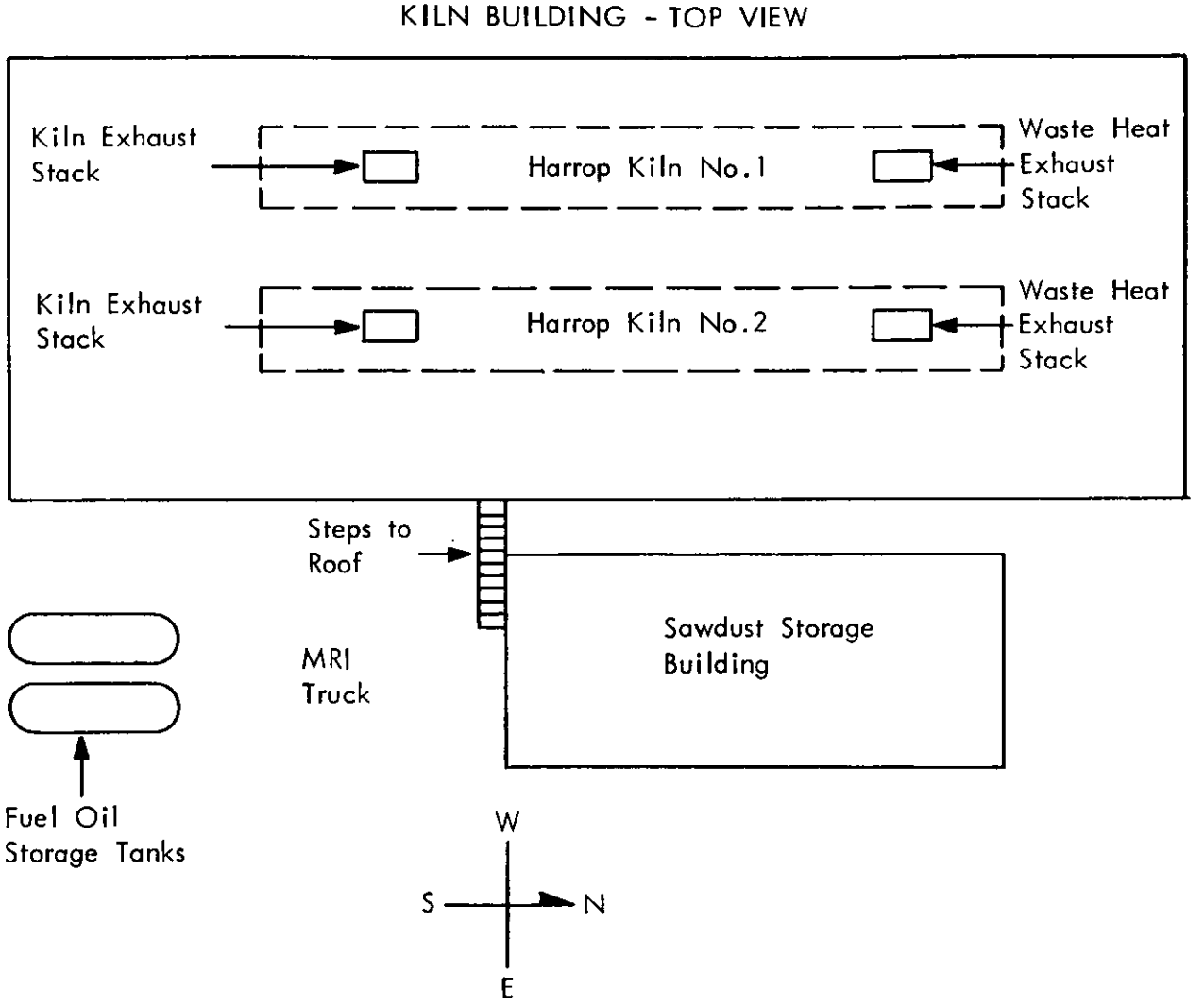


Figure 4-1. Overview of the Chatham Brick and Tile Company's Gulf, North Carolina, kiln building complex.

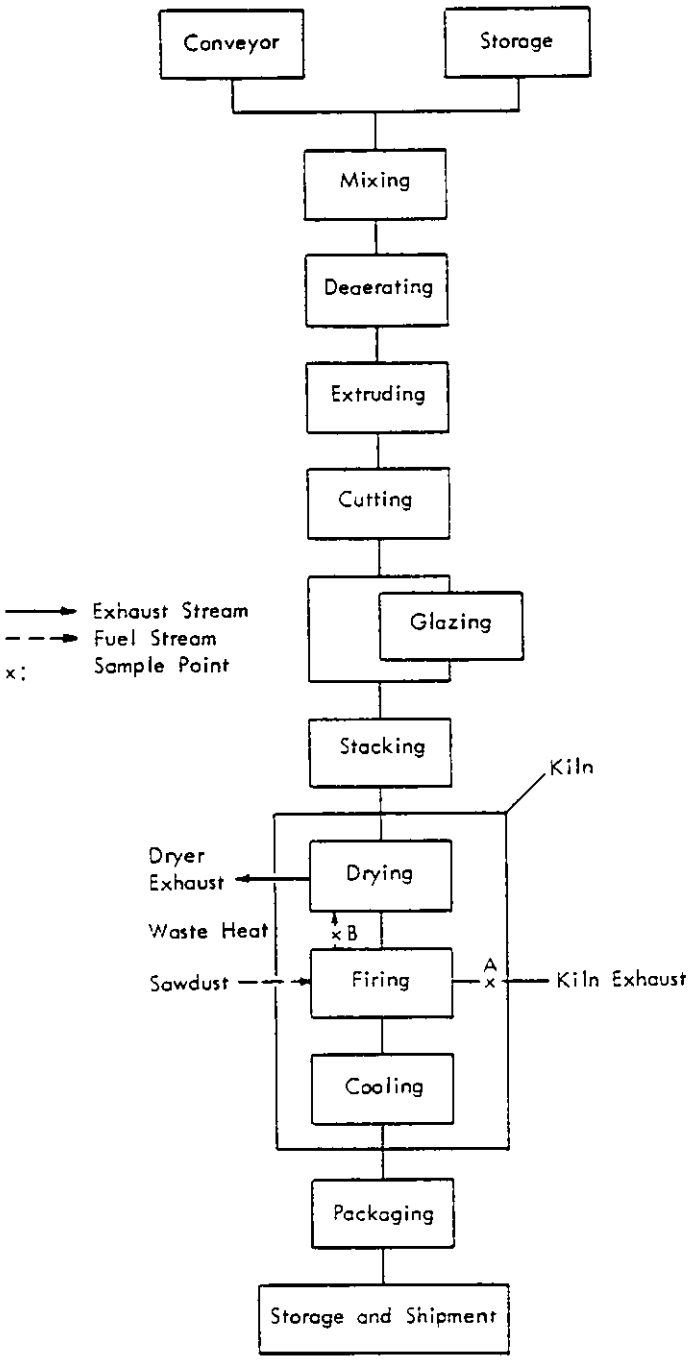


Figure 4-2. Chatham Brick and Tile Company flowsheet.

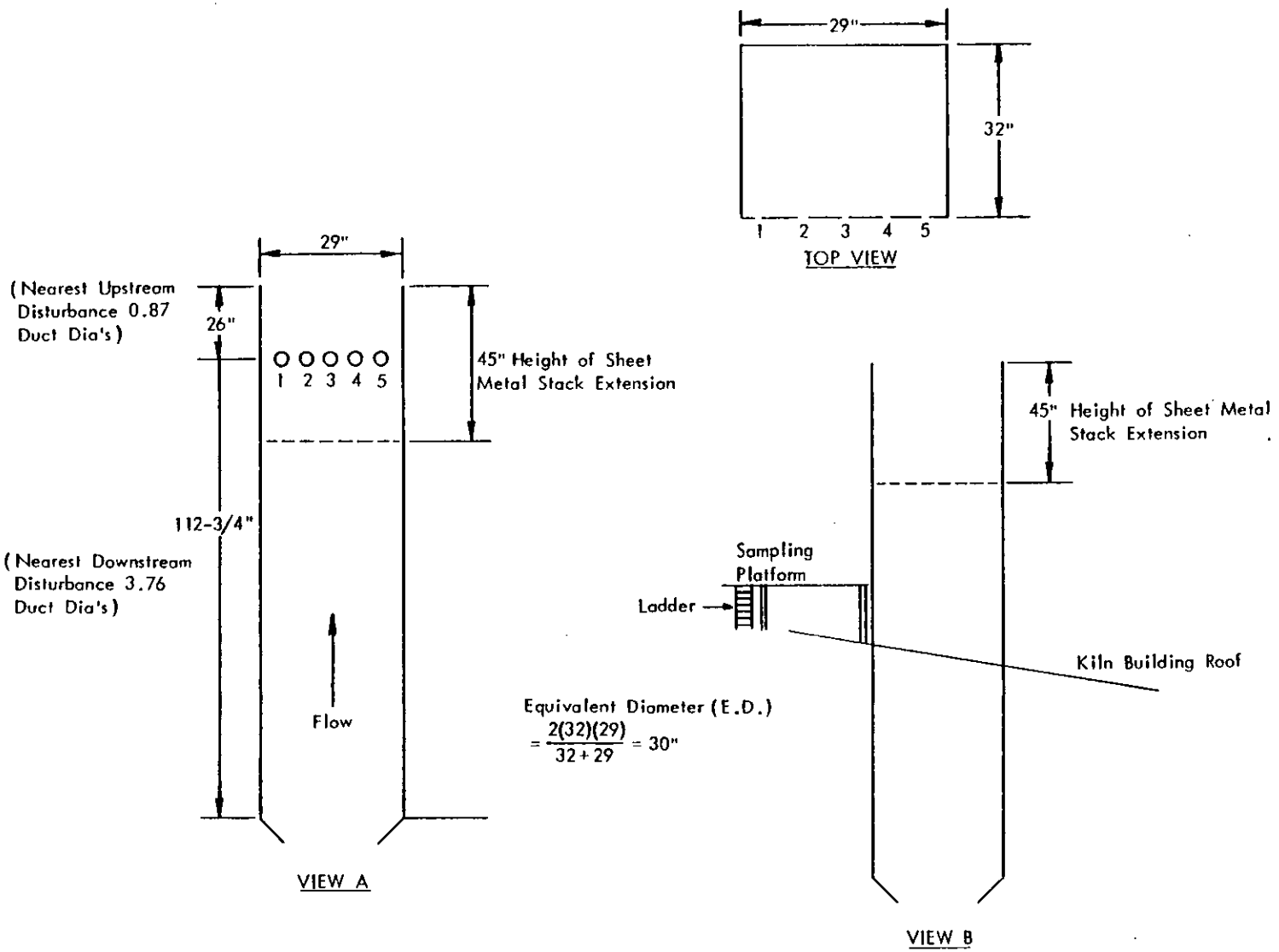


Figure 4-3. Schematic of sampling port locations used to sample the Harrop Kiln No. 2 (east) kiln exhaust stack.

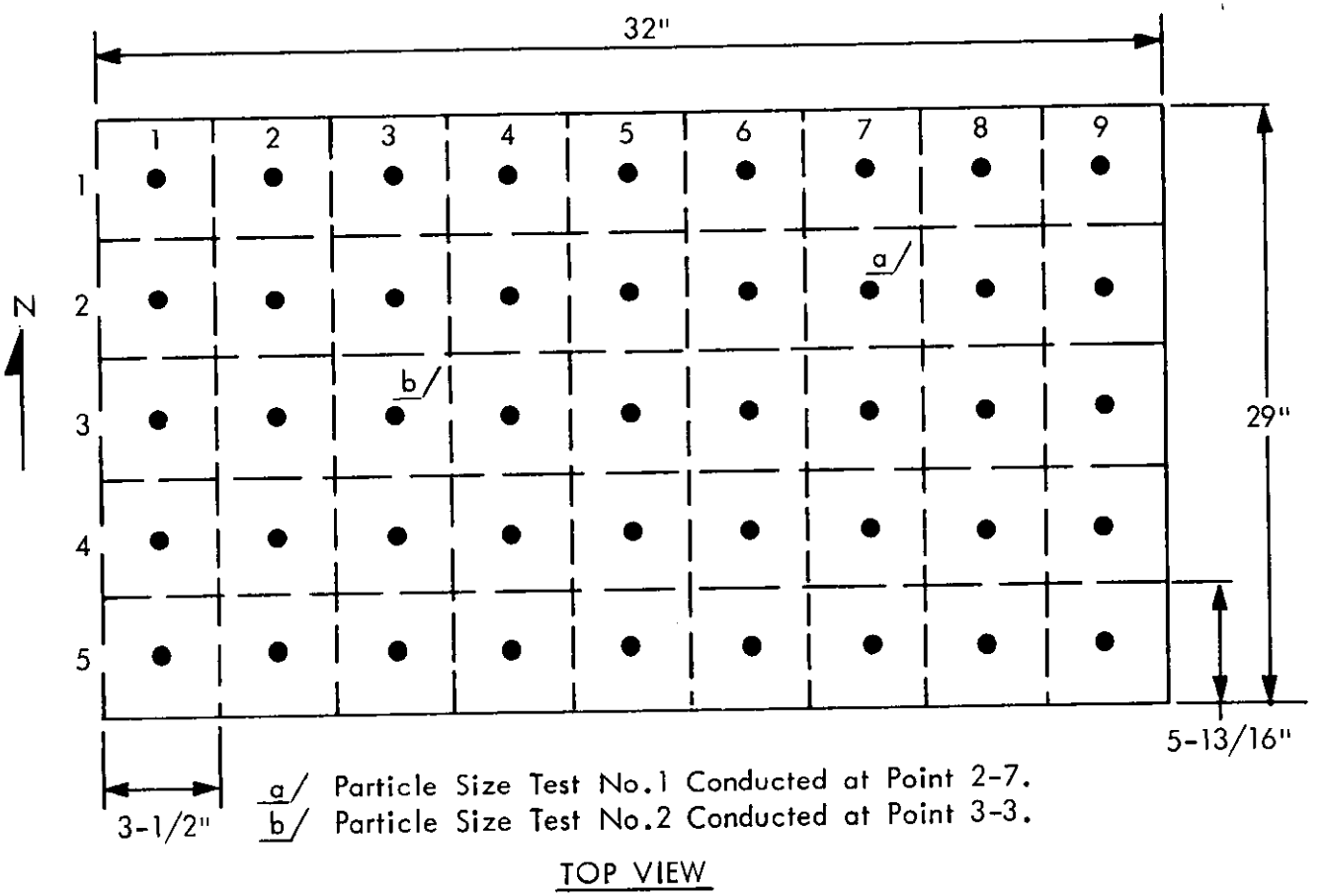


Figure 4-4. Sampling point locations at the Harrop Kiln No. 2 (east) kiln exhaust stack.

TABLE 4-1. HARROP KILN NO. 2 (EAST) KILN EXHAUST STACK SAMPLING POINT LOCATIONS

Point No.	Distance from outside edge of sample port (cm)	(in.)
1	4.4	1 3/4
2	13.3	5 1/4
3	22.2	8 3/4
4	31.1	12 1/4
5	40	15 3/4
6	48.9	19 1/4
7	57.8	22 3/4
8	66.7	26 1/4
9	75.6	29 3/4

Carbon dioxide emission tests were also conducted at this location and were accomplished using the stack extension and sample ports as described above. No specific sample point location or port was utilized for these tests.

HARROP KILN NO. 1 (WEST) KILN EXHAUST STACK SAMPLING LOCATIONS

This exhaust stack is rectangular in shape and is similar in dimension to the Harrop Kiln No. 2 (east) kiln exhaust stack. Therefore, the stack extension used at the Harrop Kiln No. 2 (east) kiln exhaust stack was also utilized at this sampling location.

No particle size distribution tests were conducted at this location because this kiln (Harrop Kiln No. 1) was not exclusively fired with sawdust. Carbon dioxide emission tests were conducted at this location utilizing the ports and stack extension.

HARROP KILN NO. 1 (WEST) AND HARROP KILN NO. 2 (EAST) WASTE HEAT EXHAUST STACK SAMPLING LOCATIONS

Both of these exhaust stacks are rectangular in shape. A sheet metal rectangular stack extension was provided by Chatham Brick and Tile Company for sampling purposes. The stack extension was placed on top of the rectangular brick exhaust stacks. This stack extension was 40-in. long by 27-in. wide and contained four sample ports.

The stack extension did not fit properly on the Harrop Kiln No. 1 (west) waste heat exhaust stack. The stack extension was slightly narrower (approximately 1 to 2 in.) than the opening of the stack. Since the pressure of the stack was positive, the improper fit of the stack extension was not considered to be a significant problem for use in testing this location. The stack extension did fit properly on the Harrop Kiln No. 2 (east) waste heat exhaust stack.

No particle size distribution tests were conducted on either of the waste heat exhaust stacks. Carbon dioxide emission tests were conducted at each of the waste heat exhaust stacks utilizing the stack extension and sample ports.

SECTION 5

SAMPLING AND ANALYTICAL PROCEDURES

This section describes the sampling equipment and analytical procedures used by MRI personnel to conduct and analyze data from the CO_2 emission and particle size distribution tests. All sampling equipment used during the test was provided by MRI unless otherwise specified.

FEDERAL REGISTER METHODS

Standard EPA methodologies as described in the Federal Register, Vol. 42, No. 160, Part II, Thursday, August 18, 1977, were used for Methods 1, 2, 3, and 4.

EPA METHOD 1 - SAMPLE AND VELOCITY TRAVERSES FOR STATIONARY SOURCES

Sample locations at the Harrop Kiln No. 2 (east) kiln exhaust stack were determined using the procedures described in Method 1. The field data are presented in Appendix A. Method 1 determinations were not required for sampling purposes at the other kiln exhaust stack locations.

The sample port locations at the Harrop Kiln No. 2 (east) kiln exhaust stack did not meet the Method 1 criteria of eight downstream and two upstream duct diameters. The five sample ports were located 3.76 duct diameters downstream and 0.87 duct diameters upstream from the nearest disturbances. These measurements did meet the minimum requirements of two downstream and 0.5 upstream duct diameters from the nearest disturbances.

EPA METHOD 2 - DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (TYPE S PITOT TUBE)

Velocity measurements were made at the Harrop Kiln No. 2 (east) kiln exhaust stack using standard Method 2 techniques and equipment. The field data are presented in Appendix A. The calibration data for the equipment used for these measurements are presented in Appendix E. Velocity measurements were not conducted at the other kiln exhaust stack locations. Carbon dioxide emission sampling at these locations did not require velocity measurements.

EPA METHOD 3 - GAS ANALYSIS FOR CARBON DIOXIDE, OXYGEN, EXCESS AIR, AND DRY MOLECULAR WEIGHT

All CO_2 emission measurements were made using standard Method 3 procedures and equipment. The sample probe was inserted into the stack extension a sufficient distance to obtain a representative sample. An Orsat analyzer was used to determine the percent CO_2, as well as the percent O_2,

CO, N_2, and dry molcular weight of the stack gas. The field data are presented in Appendix B.

The equipment used to collect and analyze the samples for these tests was provided by the Emission Measurement Branch, Emission Standards and Engineering Division, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina. The equipment provided by EPA included a stainless steel sample probe, diaphragm pumps with flow control and rate meter, integrated gas bags, and an Orsat analyzer. The Orsat analyzer had been charged with fresh chemicals just prior to the field test.

EPA METHOD 4 - DETERMINATION OF MOISTURE CONTENT IN STACK GASES

The moisture content of the stack gas at the Harrop Kiln No. 2 (east) kiln exhaust stack was determined using standard Method 4 equipment and techniques. A moisture determination was not required for sampling purposes at the other kiln exhaust stack locations. The field data are presented in Appendix A.

PARTICLE SIZE DISTRIBUTION TESTS

Testing for particle size distribution at the Harrop Kiln No. 2 (east) kiln exhaust stack was done using Andersen cascade impactors. The Andersen Cascade Impactor (Mark III), classifies particles into eight (8) size ranges. Figure 5-1 presents a schematic illustration of the Andersen sampling system in sampling position. Also shown in Figure 5-1 is the vacuum pump and sample rate indicating manometer used for controlling the sampling.

The Andersen impactor was preheated in an oven prior to the sampling run. The impactor and nozzle were preheated to a temperature sufficiently higher than stack temperature to prevent condensation in the sample line. The preheated impactor was transported from the oven to the stack wrapped in insulation material.

During sampling the flow was adjusted to the predetermined flow rate as indicated by the manometer monitoring the pressure drop across the impactor orifices. Sampling time for test Nos. 1 and 2 were 60 min and 90 min, respectively. At the conclusion of the sampling period, the impactor was withdrawn from the stack with a sample continuing to be drawn until the nozzle cleared the sample port, at which time the vacuum pump was turned off. The time required to perform this "sampling while withdrawing" was typically not more than 10 sec and is a negligible portion of the total sample period. This technique insures that the impacted sample particles remain in place during the withdrawal period. The field data for the two test runs are presented in Appendix A.

The collection substrates used for the particle size distribution tests consisted of the standard slotted, circular glass fiber filters manufactured by the cascade impactor manufacturer. The filters were tare-weighed and final-weighed in the field. A portable vacuum desiccation system was used to condition the filters. A digital electrobalance (Cahn Model 27) was used to weigh the filters.

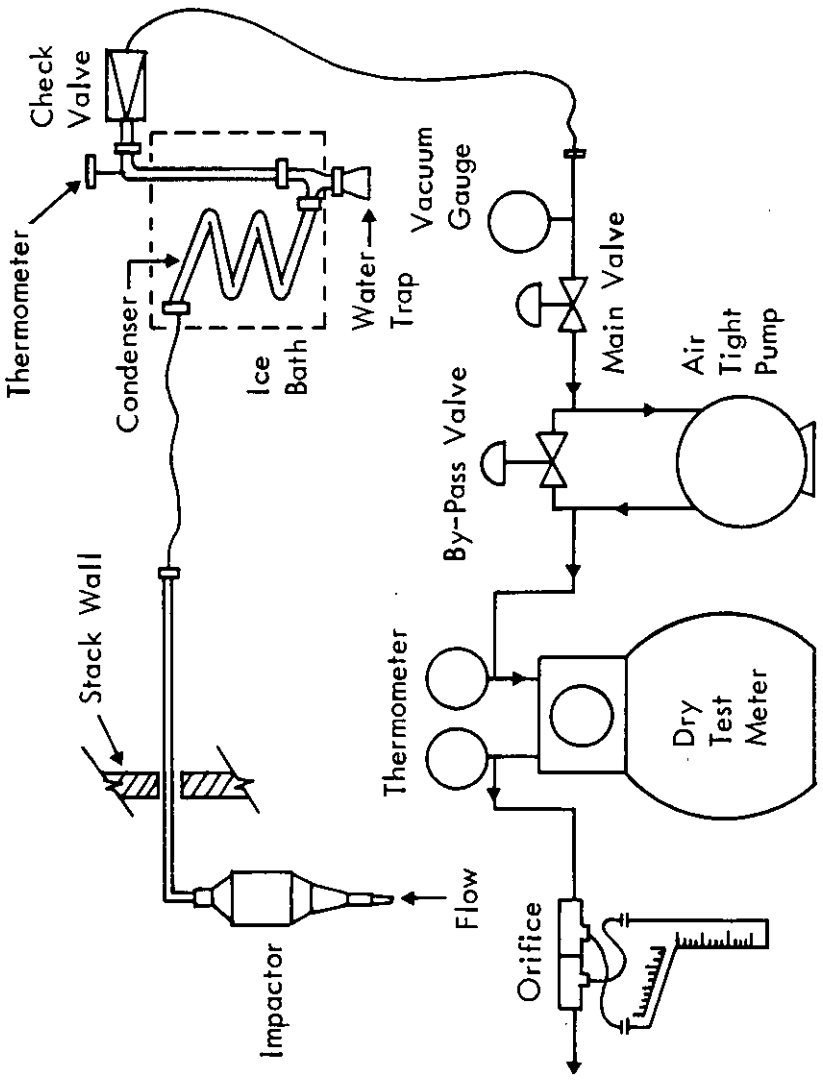


Figure 5-1. Schematic illustration of the Andersen Sampling System in sampling position.

Each set of collection substrates included eight slotted filters and one unslotted backup filter. Each filter was placed in a separate, marked square of aluminum foil and folded in half for weighing. The procedures used for weighing the filters are as follows:

1. Complete sets of filters and their numbered aluminum foil container were placed in the vacuum desiccation chamber and conditioned under vacuum for a period of 60 min. A mercury manometer was used to monitor the vacuum in the chamber. A vacuum of less than 1-in. Hg absolute was achieved.

2. The filter sets were removed from the vacuum chamber and placed in another chamber containing silica gel to prevent moisture accumulation during weighing.

3. A filter and its numbered aluminum foil container was placed on the balance pan. A period of 30 sec was monitored with a stop watch before a weight was recorded. Each filter and its aluminum foil container were weighed one time.

4. The filters and aluminum foil containers were returned to the vacuum desiccation chamber and placed under vacuum again for a period of 15 min.

5. The filters and aluminum foil containers were removed from the vacuum desiccation chamber and returned to the silica gel desiccation chamber. The filters and foil containers were weighed a second time, allowing 30 sec for the balance to stabilize before a weight was recorded.

6. The filters and aluminum foil containers were returned to the vacuum desiccation chamber and placed under vacuum for a period of 15 min.

7. The filters and aluminum foil containers were removed from the vacuum chamber and placed in the silica gel desiccation chamber. The filters and aluminum foil containers were weighed a final, third time, allowing 30 sec for the balance to stabilize before a weight was recorded.

Upon completion of each particle size test, the Andersen cascade impactor was held in an upright, vertical position to prevent movement of impacted particles. Both ends of the impactor were sealed during transportation from the test site to the field laboratory. The impactor was disassembled and the sample recovered according to the operation manual provided by the impactor manufacturer. The recovered filter stages were placed in their numbered aluminum foil containers.

Upon completion of the sample recovery, the filters were final weighed in the field laboratory according to the procedures previously described in this section. The results of the weighings are presented in Appendix A.

SECTION 6

APPENDICES

This section of the report presents copies of all field and laboratory data sheets, computer reduction of test data, results of laboratory analyses, and sampling equipment calibration data.

APPENDIX A

ANDERSEN CASCADE IMPACTOR PARTICLE SIZE DISTRIBUTION TEST DATA

A-1 Andersen Cascade Impactor Particle Size Size Distribution Test Computer Data Reduction Results

A-2 Andersen Cascade Impactor Particle Size Distribution Test Field Data Sheets

A-3 Andersen Cascade Impactor Particle Size Distribution Test Laboratory Weighing Data

A-1 Andersen Cascade Impactor Particle Size Distribution Test Computer Data Reduction Results

Andersen Mark III Cascade Impactor Sampling Parameters and Results - Harrop Kiln No. 2 (East) Kiln Exhaust Stack, Run No. 1

INPUT DATA FOR FILE RUN1

TEST DATE - 8-19-80		% WATER=	7.3
PROJECT # - 4468-L42		% CARBON DIOXIDE=	2.37
TEST SITE - CHATHAM BRICK &TILE CO.		% CARBON MONOXIDE=	0
RUN ID - ONE		% OXYGEN=	17.9

ANDERSEN IMPACTOR

STACK TEMPERATURE=	315.0 DEGREES F.	SAMPLING TIME=	60.0 MIN.
BAR. PRESSURE=	29.70 INCHES HG	PRESSURE DROP=	0.00 INCHES HG
STATIC PRESSURE=	-0.34 INCHES H2O	SAMPLER TEMP. =	315.0 DEGREES F.
AVE. DELTA P=	0.5 INCHES H2O	PARTICLE DENS=	1
PITOT COEFF.=	.84	METER VOL.=	38.345 CUBIC FEET
METER TEMP.=	101.5 DEGREES F.	DELTA H=	1.3 INCHES H2O
PROBE DIA.=	0.25 INCHES		

CALCULATED RESULTS

SAMPLE VOL.-DRY STD.=	35.893 CU. FT.	DRY MOLECULAR WT.=	29.10
SAMPLE VOL.-WET STD.=	38.719 CU. FT.	WET MOLECULAR WT.=	28.29
STACK VELOCITY=	2777.0 FT./MIN.	% ISOKINETIC=	100.9
NOZZLE VELOCITY=	2802.7 FT./MIN.	SAMPLING RATE-ACTUAL=	0.955 CU. FT/MIN
LOADING=	.004289 GRAIN/SCF	WEIGHT CORRECTION=	0.080 MG.
LOADING(DRY)=	.004626 GRAIN/SCF	MASS COLLECTED=	10.760 MG.

STAGE #	0	1	2	3	4	5	6	7	FILTER
FINAL WT (MG)	458.64	446.67	453.96	442.09	452.85	453.66	450.21	437.37	570.05
TARE WT (MG)	456.98	444.55	451.42	440.57	452.39	453.31	449.95	437.04	567.81
NET WT (MG) CORRECTED	1.58	2.04	2.46	1.44	0.38	0.27	0.18	0.25	2.16
FRACTION % OF TOTAL	14.68	18.96	22.86	13.38	3.53	2.51	1.67	2.32	20.07
CUM. % WITH FILTER	14.68	33.64	56.51	69.89	73.42	75.93	77.60	79.93	100.00
FRACTION % WITHOUT FILTER	18.37	23.72	28.60	16.74	4.42	3.14	2.09	2.91	
CUM. % WITHOUT FILTER	18.37	42.09	70.70	87.44	91.86	95.00	97.09	100.00	
JET VEL. (CM/SEC)	74	137	229	378	673	1628	2966	5932	
D50 SIZE (MICRONS)	11.57	7.21	4.87	3.31	2.11	1.04	0.63	0.41	<0.41
DM/DLOGD (GRAINS/SCF)		0.00396	0.00577	0.00341	0.00078	0.00035	0.00033	0.00055	
GEO MEAN (MICRONS)		9.13	5.93	4.02	2.64	1.48	0.81	0.51	<0.51
PARTICLE COUNT		5.4D+04	1.2D+05	1.1D+05	3.6D+04	2.9D+04	5.0D+04	1.3D+05	

Andersen Mark III Cascade Impactor Sampling Parameters and Results - Harrop Kiln No. 2 (East) Kiln Exhaust Stack, Run No. 2

INPUT DATA FOR FILE RUN2

TEST DATE - 8-19-80		% WATER=	7.5
PROJECT # - 4468-L42		% CARBON DIOXIDE=	2.37
TEST SITE - CHATHAM BRICK &TILE CO.		% CARBON MONOXIDE=	0
RUN ID - TWO		% OXYGEN=	17.9

ANDERSEN IMPACTOR

STACK TEMPERATURE=	317.0 DEGREES F.	SAMPLING TIME=	90.0 MIN.
BAR. PRESSURE=	29.70 INCHES HG	PRESSURE DROP=	0.00 INCHES HG
STATIC PRESSURE=	-0.34 INCHES H20	SAMPLER TEMP. =	317.0 DEGREES F.
AVE. DELTA P=	0.5 INCHES H20	PARTICLE DENS=	1
PITOT COEFF.=	.84	METER VOL.=	58.230 CUBIC FEET
METER TEMP.=	100.5 DEGREES F.	DELTA H=	1.4 INCHES H20
PROBE DIA.=	0.25 INCHES		

CALCULATED RESULTS

SAMPLE VOL.-DRY STD.=	54.614 CU. FT.	DRY MOLECULAR WT.=	29.10
SAMPLE VOL.-WET STD.=	58.915 CU. FT.	WET MOLECULAR WT.=	28.29
STACK VELOCITY=	2841.7 FT./MIN.	% ISOKINETIC=	100.3
NOZZLE VELOCITY=	2850.4 FT./MIN.	SAMPLING RATE-ACTUAL=	0.972 CU. FT/MIN
LOADING=	.004673 GRAIN/SCF	WEIGHT CORRECTION=	0.080 MG.
LOADING(DRY)=	.005041 GRAIN/SCF	MASS COLLECTED=	17.840 MG.

STAGE #	0	1	2	3	4	5	6	7	FILTER
FINAL WT (MG)	443.53	425.11	447.49	429.15	438.70	424.36	443.39	424.54	543.73
TARE WT (MG)	441.40	423.01	443.45	427.18	438.02	423.31	442.55	423.47	539.05
NET WT (MG) CORRECTED	2.05	2.02	3.96	1.89	0.60	0.97	0.76	0.99	4.60
FRACTION % OF TOTAL	11.49	11.32	22.20	10.59	3.36	5.44	4.26	5.55	25.78
CUM. % WITH FILTER	11.49	22.81	45.01	55.61	58.97	64.41	68.67	74.22	100.00
FRACTION % WITHOUT FILTER	15.48	15.26	29.91	14.28	4.53	7.33	5.74	7.48	
CUM. % WITHOUT FILTER	15.48	30.74	60.65	74.92	79.46	86.78	92.52	100.00	
JET VEL. (CM/SEC)	75	140	233	385	684	1655	3017	6033	
D50 SIZE (MICRONS)	11.48	7.15	4.84	3.28	2.10	1.03	0.62	0.41	<0.41
DM/DLOGD (GRAINS/SCF)		0.00258	0.00611	0.00294	0.00081	0.00082	0.00090	0.00144	-
GEO MEAN (MICRONS)		9.06	5.88	3.99	2.62	1.47	0.80	0.50	<0.50
PARTICLE COUNT		3.5D+04	1.3D+05	9.1D+04	3.0D+04	6.9D+04	1.4D+05	3.5D+05	

A-2 Andersen Cascade Impactor Particle Size Distribution Test Field Data Sheets

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN one

MRI Project Number 4468-2(42)
Field Dates 8-18 thru 8-20-80
Plant Chatham Brick & Tile Co.
Sampling Location Kiln Exhaust Stack - East
Sampling Date 8-19-80

FIELD CREW

Crew Chief: Mark D. Hansen

Testing Engineer: 1 George Cobb; 2; 3

Engr. Technician: 1; 2; 3

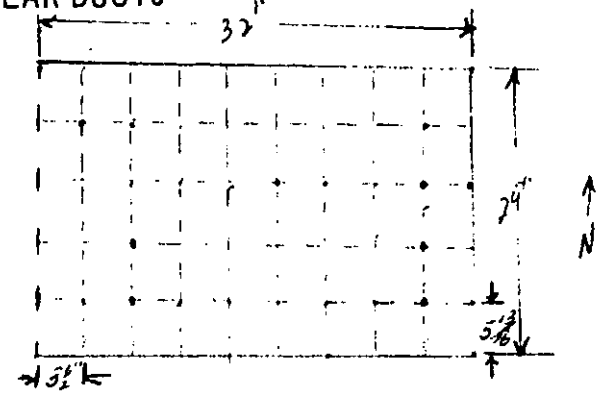
Lab Technician: 1 Mark D. Hansen; 2 George Cobb; 3

Process Engineer: 1; 2

Other: 1; 2

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT Chatham Brick & Tile Co.
DATE 8-19-80
SAMPLING LOCATION Kiln Exhaust - East
INSIDE OF FAR WALL TO
OUTSIDE OF NIPPLE. (DISTANCE A) N/A
INSIDE OF NEAR WALL TO
OUTSIDE OF NIPPLE. (DISTANCE B) N/A
STACK I.D., (DISTANCE A - DISTANCE B) 32" - 29"
NEAREST UPSTREAM DISTURBANCE 26"
NEAREST DOWNSTREAM DISTURBANCE ~~112 3/4"~~
CALCULATOR N.H.

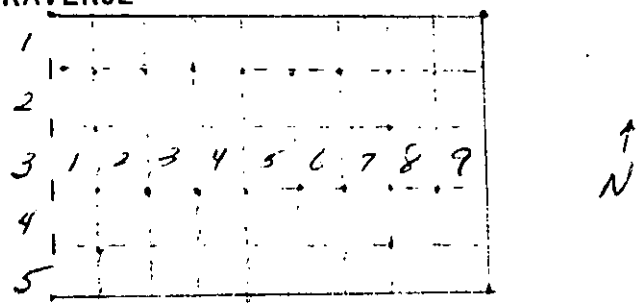


SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1 8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
9	N/A	32"	N/A	N/A	29 3/4"
8					26 1/2"
7					22 3/4"
6					19 1/4"
5					15 3/4"
4					12 1/4"
3					8 3/4"
2					5 1/4"
1		1"			1 3/4"

PRELIMINARY VELOCITY TRAVERSE

PLANT Chatham Brick & Tile Co.
DATE 8-19-80
LOCATION Kiln Exhaust - East
STACK I.D. 32" x 29"
BAROMETRIC PRESSURE, in. Hg 29.80
STACK GAUGE PRESSURE, in. H_2O -0.34
OPERATORS M.H & E.C.



SCHEMATIC OF TRAVERSE POINT LAYOUT

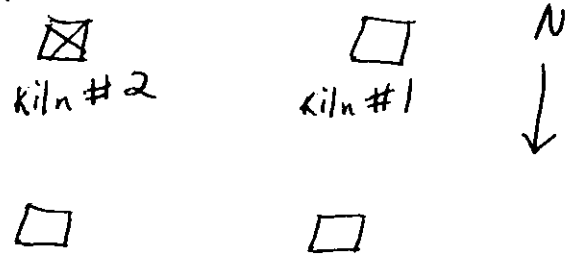
TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
1-9	.34	302
8	.57	310
7	.66	314
6	.66	320
5	.66	320
4	.51	320
3	.42	317
2	.28	312
1	.22	305
2-9	.49	305
8	.63	310
7	.71	315
6	.69	320
5	.62	320
4	.56	322
3	.51	319
2	.42	316
1	.29	307
3-9	.49	315
8	.58	319
7	.59	320
6	.62	322
5	.60	323
4	.55	322
AVERAGE		

TRAVERSE POINT NUMBER	VELOCITY HEAD (Δp_s), in. H_2O	STACK TEMPERATURE (T_s), °F
3-3	.47	317
2	.40	310
1	.28	298
2-9	.36	308
8	.42	314
7	.45	315
6	.46	316
5	.48	316
4	.46	317
3	.41	306
2	.31	294
1	.21	287
1-9	.25	301
8	.26	307
7	.30	308
6	.33	314
5	.35	317
4	.37	316
3	.36	308
2	.32	304
1	.15	290
AVERAGE	0.447	311.96

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick & Tile Company
DATE 8-19-80
SAMPLING TIME (24-hr CLOCK) 1630
SAMPLING LOCATION Outlet East Kiln (No. 2)
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 93
OPERATOR G. Cobb

COMMENTS: Track



RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	2%	2	2.1%	2.1	3%	3	2.37	44/100	1.043
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	21%	19	19.8%	17.7	20	17	17.9	32/100	5.728
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	21	0	19.8%	0	20	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100	79	100	80.2	100	80	79.7	28/100	22.316
								TOTAL	29.087

EPA (Dur) 230
4/72

Run Number One

Date 8-19-80

MIDWEST RESEARCH INSTITUTE
PRELIMINARY
MOISTURE DETERMINATION

Recorded by MDH

Assisted by GC.

NOTE: Same as Run No. _____

A. Condensor and/or Silica Gel Method

Barometric Pressure, P_B = ~~29.80~~ 29.70 in. Hg

☐ Barometer Location Plant

Reading Time ~~1200~~ 1635 by MDH

☐ Elevation _____

In out

	Clock Time	Dry Gas Meter Reading(cf)	Flowmeter Setting	Dry Gas Meter Temp (°F)	Impinger Water Volume (ml)
Final	1409	39.92	.75cfm	111 102	236
	1351	27.01		106 96	
Initial	1335	14.92	.75cfm	95 95	203
Difference	34 min,	Vm = 25.0			Wc = 33

Tube No.	Weight (Grams)		
	Final	Initial	Difference
1	224.8	218.3	6.5
			~~6.5~~
Total Moisture Adsorbed:			Wa = 6.5

Meter Pressure, $P_B \approx Pm$ = ~~29.80~~ 29.70 in. Hg

Average Meter Temperature, Tm = 97.7 °F

Total Weight of Moisture Collected, Wc + Wa = Wm = 39.5 gm

$$\text{Moisture Content} = \frac{100}{1 + \left[375 \frac{Pm\,Vm}{(Tm+460)\,Wm}\right]} = 7.3 \text{ \% by Volume}$$

B. Wet/Dry Bulb Method

Dry Bulb Temperature = _____ °F

Wet Bulb Temperature = _____ °F

Moisture Content (from Ref. Table) = _____ % by Volume

C. Predetermined Value

% Moisture _____ Basis _____

ANDERSEN SAMPLING CALCULATIONS

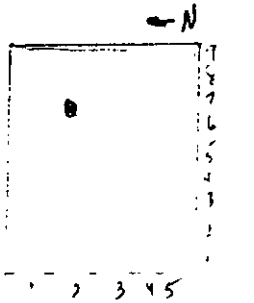
Plant Chatham Brick & Tile Co. Date 8-19-80
Sampling Location Kiln Exhaust Stack (East) Initial MDH
Test No. One

Velocity head at sampling location, in. H_2O	ΔPs	.45
Stack temperature at sample point, °F	Ts	315
Barometric pressure, in. Hg	Pb	~~29.80~~ MDH 29.70
Static pressure in stack, in. Hg (Pb) ± (0.074 x gage pressure, in. H_2O) -0.34	Ps	~~29.83~~ MDH 29.73
Percent moisture in gas stream by volume	% H_2O	7.3
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	.927
Molecular wt. dry stack gas, lb/lb-mole ($\% CO_2$ x 0.44) + ($\% O_2$ x 0.32) + ($\% N_2$ + % CO x 0.28)	Md	29.087
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	28.28
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	2775
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.182 .223
Actual nozzle diameter, in.	D_{n_a}	.250
Assumed meter temperature, °F	Tm	105
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	0.945
Calculated meter flow rate, ft^3/min $Fs\left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)$ (Mf)	Fm	.639

FIELD DATA - ANDERSEN

PLANT Chatham Brick & Tile Co.
DATE 8-19-80
SAMPLING LOCATION Kiln Exhaust stack (East)
SAMPLE TYPE Particle Size - Anderson
RUN NUMBER One
OPERATOR Hansen
AMBIENT TEMPERATURE 95
BAROMETRIC PRESSURE 29.90
STATIC PRESSURE, (P_s) -0.34
Filter Set 21

Leak CK: Inital at 15" Hg, CFM N/A
Final at ___ Hg, CFM N/A



SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Calculated ACFM (desired) .639
Probe Tip Diameter .250
CO_2 2.37
O_2 17.9
CO 0
N_2 79.7
% H_2O 7.3

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)		GAS METER READING (V_m), ft^3 44.60		VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	0	1730	Desired	Actual	.45	DESIRED	ACTUAL	315	INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F		N/A	N/A
2-7	5	1735	47.80	47.64		1.2	1.15		97	94	8.5		
	10	1740	50.99	50.69			1.2		100	95	9		
	15	1745	54.19	53.83			1.25		101	95	9.5		
	20	1750	57.38	57.04			1.3		101	96	9.5		
	25	1755	60.58	60.30			1.35		104	96	10		
	30	1800	63.77	63.70			1.45		105	97	10.5		
	35	1805	66.97	67.00			1.4		104	98	10		
	40	1810	70.16	70.30			1.35		104	99	9.5		
	45	1815	73.36	73.51			1.3		108	100	9.0		
	50	1820	76.55	76.72			1.3		109	101	9.0		
	55	1825	79.75	79.80			1.25		110	102	9.0		
	60	1830	82.94	82.945			1.25		108	102	9.0		
			V_m = 38.345			ΔH =	1.246		T_m =	101.5			

COMMENTS

ISOKINETIC PERFORMANCE WORKSHEET

Plant Chatham Brick & Tile Co. Date 8-19-80
Sampling Location Kiln Exhaust - East Initial MH
Test Number One

Isokinetic equation:

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

Average stack temperature, °F	Ts_{avg}	315
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $T_m = 101.5$ $V_m = 38.345$ $\Delta H = 1.296$	Vm_{std}	~~38.345~~ 35.893
Mole fraction dry gas, $\frac{100-\% H_2O}{100}$	Mf	.927
Molecular wt. dry stack gas, lb/lb-mole $(\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 + \%CO \times 0.28)$	Md	29.087
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	28.28
Static pressure in stack, absolute, in. Hg (Pb) ± (0.074 x stack gage pressure, in H_2O)	Ps	29.73
Stack velocity, fpm $5,128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{PsxMs}}$	Vs	2775
Total sample time, minutes	θ	60
Nozzle diameter, inches	Dn	.250
$\frac{1,039\ (315 + 460)(35.893)}{(2775)(60)(29.73)(.927)(.25^2)}$	% I	100.78

SAMPLING TASK LOG

Plant Chatham Brick & Tile Company
Date 8-19-80
Project No. 44168-L(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test - Harrop Kiln No. 2	1	Port No. 2, Point	Particulate	1730			
(East) Kiln Exhaust Stack		No. 2-7	(Particle				
			Size)				
Stop - Test complete	1				1830	60	

MIDWEST RESEARCH INSTITUTE

Particle Sizing - Andersen

RUN 1 & 2

MRI Project Number 4468-142
Field Dates 8-18 thru 8-20-80
Plant Chattanooga Brick & Tile
Sampling Location Kiln Exhaust - East
Sampling Date 8-19-80

FIELD CREW

Crew Chief		M. Hanson
Testing Engineer	1	M. Hanson
	2	
	3	
Engr. Technician	1	
	2	
	3	
Lab Technician	1	M. Hanson
	2	E. Cobb
	3	
Process Engineer	1	
	2	
Other	1	
	2	

MIDWEST RESEARCH INSTITUTE

Run Number Two | PRELIMINARY | Recorded by M.H.

Date 8-19-80 | MOISTURE DETERMINATION | Assisted by _____

NOTE: Same as Run No. One

A. Condensor and/or Silica Gel Method

Barometric Pressure, P_B = _____ in. Hg

☐ Barometer Location _____

Reading Time _____ by _____

☐ Elevation _____

	Clock Time	Dry Gas Meter Reading(cf)	Flowmeter Setting	Dry Gas Meter Temp (°F)	Impinger Water Volume (ml)
Final					
Initial					
Difference		Vm =			Wc =

Tube No.	Weight (Grams)		
	Final	Initial	Difference
Total Moisture Adsorbed:			Wa =

Meter Pressure, $P_B \approx Pm$ = _____ in. Hg

Average Meter Temperature, Tm = _____ °F

Total Weight of Moisture Collected, Wc + Wa = Wm = _____ gm

$$\text{Moisture Content} = \frac{100}{1 + \left[375 \frac{Pm\,Vm}{(Tm+460)\,Wm}\right]} = \text{_____ \% by Volume}$$

B. Wet/Dry Bulb Method

Dry Bulb Temperature = _____ °F

Wet Bulb Temperature = _____ °F

Moisture Content (from Ref. Table) = _____ % by Volume

C. Predetermined Value

% Moisture _____ Basis _____

ANDERSEN SAMPLING CALCULATIONS

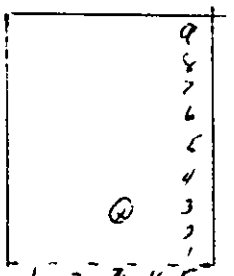
Plant Chatham Brick & Tile Co. Date 8-19-80
Sampling Location Kiln Exhaust-East Initial MDH
Test No. two

Velocity head at sampling location, in. H_2O	ΔPs	.47
Stack temperature at sample point, °F	Ts	317
Barometric pressure, in. Hg	Pb	29.70
Static pressure in stack, in. Hg (Pb) $\pm$ (0.074 x gage pressure, in. H_2O) −0.34	Ps	29.73
Percent moisture in gas stream by volume	% H_2O	7.3
Mole fraction, dry gas $\frac{100 - \% H_2O}{100}$	Mf	~~29.087~~ .927
Molecular wt. dry stack gas, lb/lb-mole (% CO_2 x 0.44) + (% O_2 x 0.32) + (% N_2 + % CO x 0.28)	Md	29,087
Molecular wt. stack gas, lb/lb-mole (Md) (Mf) + 18(1 - Mf)	Ms	28.28
Stack velocity, fpm $5{,}128.8\ (Cp)\left(\sqrt{\Delta Ps}\right)\sqrt{\frac{Ts + 460}{Ps \times Ms}}$	Vs	2839
Calculated nozzle diameter, in. $24\sqrt{\frac{Fs/Vs}{\pi}}$, where Fs = 0.5 to 0.75 ft^3/min	D_{n_c}	.180 .220
Actual nozzle diameter, in.	D_{n_a}	.250
Assumed meter temperature, °F	Tm	100
Isokinetic sample rate, stack conditions, ft^3/min $Vs\ (0.00694)\ (\pi)\left(\frac{Dn_a}{2}\right)^2$	Fs	.967
Calculated meter flow rate, ft^3/min $Fs\left(\frac{Tm+460}{Ts+460}\right)\left(\frac{Ps}{Pb}\right)(Mf)$	Fm	.647

FIELD DATA - ANDERSEN

PLANT Chatham Brick & Tile Co,
DATE 8-19-80
SAMPLING LOCATION Kiln Exhaust Stack (East)
SAMPLE TYPE Particle Size Andersen
RUN NUMBER Two
OPERATOR Hansen
AMBIENT TEMPERATURE 87
BAROMETRIC PRESSURE 29.70
STATIC PRESSURE, (P_s) -0.34
Filter Set 14

Leak CK: Inital at 15" Hg, CFM NA
Final at ___ Hg, CFM NA



SCHEMATIC OF TRAVERSE POINT LAYOUT with Dimensions

Calculated ACFM (desired) .647
Probe Tip Diameter .250
CO_2 2.37
O_2 17.9
CO 0
N_2 79.7
% H_2O 7.3

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK) 0 / 1940	GAS METER READING (V_m), ft^3 83.80 Desired	Actual	VELOCITY HEAD (Δp_s), in H_2O .47	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F 317	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F NA	IMPINGER TEMPERATURE, °F NA
3-3	5	1945	87.04	86.93		1.3	1.3		88	86	9.5		
	10	1950	90.27	90.07			1.3		95	87	9.0		
	15	1955	93.51	93.23			1.3		99	89	9.5		
	20	2000	96.74	96.43			1.35		101	90	10.0		
	25	2005	99.98	99.71			1.40		102	91	10.5		
	30	2010	103.21	103.04			1.40		105	93	11.0		
	35	2015	106.45	106.34			1.40		109	95	10.5		
	40	2020	109.68	109.64			1.40		110	96	10.5		
	45	2025	112.92	112.92			1.40		110	97	10.5		
	50	2030	116.15	116.18			1.40		109	97	10.5		
	55	2035	119.39	119.45			1.40		109	98	10.5		
	60	2040	122.62	122.74			1.40		110	99	10.5		
	65	2045	125.86	125.95			1.35		109	99	10.5		
	70	2050	129.09	129.17			1.35		109	99	10.5		
	75	2055	132.33	132.36			1.35		109	99	10.5		
	80	2100	135.56	135.54			1.3		109	99	10.5		
	85	2105	138.80	138.73			1.3		110	100	10.5		
	90	2110	142.03	142.03			1.3		110	100	10.5		
		V_m=	58.23			ΔH=	1.356		T_m=	100.4	7		

COMMENTS

ISOKINETIC PERFORMANCE WORKSHEET

Plant Chatham Brick & Tile Co. Date 8-19-80
Sampling Location Kiln Exhaust - East Initial MOH
Test Number Run

Isokinetic equation:

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

Average stack temperature, °F	Ts_{avg}	317
Meter volume (std), $\frac{17.64(Vm)\left(Pb+\frac{\Delta H_{avg}}{13.6}\right)}{Tm+460}$ $V_m=58.23$ $\Delta H=1.356$ $T_m=100.47$	Vm_{std}	54.614
Mole fraction dry gas, $\frac{100-\%\ H_2O}{100}$	Mf	.927
Molecular wt. dry stack gas, lb/lb-mole $(\%CO_2 \times 0.44) + (\%O_2 \times 0.32) + (\%N_2 + \%CO \times 0.28)$	Md	29.087
Molecular wt. stack gas, lb/lb-mole $(Md)(Mf) + 18(1 - Mf)$	Ms	28.28
Static pressure in stack, absolute, in. Hg $(Pb) \pm (0.074 \times$ stack gage pressure, in $H_2O)$	Ps	29.73
Stack velocity, fpm $5,128.8\ (Cp)\left(\sqrt{\Delta Ps_{avg}}\right)\sqrt{\frac{Ts+460}{Ps \times Ms}}$	Vs	2839
Total sample time, minutes	θ	90
Nozzle diameter, inches	Dn	.250
$\frac{1,039\ (317 + 460)(54.614)}{(2839)(90)(29.73)(.927)(.25^2)}$	% I	100.18

SAMPLING TASK LOG

Plant Chatham Brick & Tile Company
Date 8-19-80
Project No. 4468-L (42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test - Harrop Kiln No. 2	2	Port No. 3, Point	Particulate	1940			
(East) Kiln Exhaust Stack		No. 3-3					
Stop - Test Complete	2				2110	90	

A-3 Andersen Cascade Impactor Particle Size Distribution
Test Laboratory Weighing Data

Project No. 4468-142 Date of Work: 8-18-20 Work Performed by: J.C. + M.H.

Title or Purpose: Anderson Tare Weights Continued From:

Filter Set #21

Filter No	1st	2nd	3rd	Avg
21-0	.45703	.45696	.45696	.45698
-1	.44453	.44455	.44458	.44455
-2	.45141	.45140	.45144	.45142
-3	.44055	.44057	.44058	.44057
-4	.45239	.45237	.45240	.45239
-5	.45333	.45329	.45331	.45331
-6	.44996	.44994	.44995	.44995
-7	.43704	.43702	.43705	.43704
-F	.56782	.56780	.56781	.56781

Filter Set #14

Filter No	1st	2nd	3rd	Avg
14-0	.44143	.44132	.44145	.44140
-1	.42301	.42298	.42304	.42301
-2	.44346	.44343	.44347	.44345
-3	.42718	.42719	.42717	.42718
-4	.43804	.43800	.43802	.43802
-5	.42334	.42328	.42332	.42331
-6	.44256	.44253	.44255	.44255
-7	.42349	.42346	.42347	.42347
-F	.53899	.53908	.53908	.53905

Continued To: Disclosed To And Understood By Me:

Entered By: P.F. Cobb Date:

Date: Date:

Project No. 4468-42 Date of Work: 8-18-80 Work Performed by: S.C. + M.H.

Title or Purpose: Anderson Tare Weights Continued From: p. 1

Filter Set # 17

Filter No.	1st	2nd	3rd	Avg.
17-0	.44882	.44872	.44875	.44876
-1	.43102	.43101	.43104	.43102
-2	.44677	.44670	.44673	.44673
-3	.43344	.43349	.43348	.43347
-4	.44569	.44570	.44575	.44571
-5	.43159	.43155	.43158	.43157
-6	.44324	.44319	.44320	.44321
-7	.42483	.42487	.42487	.42486
-F	.55742	.55744	.55741	.55742

Filter Set # 18

Filter No.	1st	2nd	3rd	Avg.
18-0	.44938	.44936	.44937	.44937
-1	.44817	.44819	.44820	.44819
-2	.44953	.44948	.44949	.44950
-3	.43342	.43349	.43347	.43346
-4	.44990	.44997	.44995	.44994
-5	.43655	.43666	.43661	.43661
-6	.45574	.45573	.45575	.45574
-7	.43439	.43437	.43435	.43437
-F	.56992	.56998	.56996	.56995

Continued To: Disclosed To And Understood By Me:

Entered By: Date:

Date: Date:

Project No. 4468.242 Date of Work: 8-19-80 Work Performed by: GC 7 MH

Title or Purpose: Field Test Continued From:

Filter set #21 Run One
Filter Set #14 Run Two
Filter Sets #17 and #18 Blanks

Continued To:

Entered By:

Date:

Disclosed To And Understood By Me:

Date:

Date:

Project No. 1468-142 Date of Work: 5-26-93 Work Performed by: EC + MH

Title or Purpose: Final Weights Continued From:

Filter Set #21

Filter No.	1st	2nd	3rd	Avg
21-0	.45866	.45863	.45862	.45864
-1	.44672	.44664	.44665	.44667
-2	.45400	.45393	.45395	.45396
-3	.44215	.44204	.44208	.44209
-4	.45285	.45286	.45284	.45285
-5	.45365	.45366	.45368	.45366
-6	.45019	.45023	.45021	.45021
-7	.43741	.43734	.43736	.43737
-F	.57002	.57009	.57002	.57005

Filter Set # 14

Filter No.	1st	2nd	3rd	Avg
14-0	.44357	.44351	.44351	.44353
-1	.42513	.42511	.42510	.42511
-2	.44752	.44752	.44744	.44749
-3	.42914	.42914	.42917	.42915
-4	.43877	.43867	.43866	.43870
-5	.42443	.42435	.42430	.42436
-6	.44342	.44341	.44334	.44339
-7	.42454	.42455	.42452	.42454
-F	.54379	.54371	.54369	.54373

Continued To: p. 5

Entered By:

Date:

Disclosed To And Understood By Me:

Date:

Date:

Project No. 4468-142 Date of Work: 8-20-80 Work Performed by: GC + MH

Title or Purpose: Final Weights Continued From: p. 4

F:Hunset #17

F:Hunfile	1st	2nd	3rd	Avg
17-0	.44877	.44880	.44880	.44879
-1	.43118	.43117	.43114	.43116
-2	.44674	.44675	.44677	.44675
-3	.43348	.43353	.43354	.43352
-4	.44571	.44575	.44578	.44575
-5	.43157	.43165	.43165	.43162
-6	.44318	.44322	.44324	.44321
-7	.42488	.42493	.42493	.42491
-F	.55749	.55749	.55750	.55749

F:Hunset #18

F:Hunfile	1st	2nd	3rd	Avg
18-0	.44944	.44945	.44944	.44944
-1	.44822	.44829	.44826	.44826
-2	.44962	.44971	.44966	.44966
-3	.43352	.43362	.43357	.43357
-4	.45003	.45006	.45011	.45007
-5	.43663	.43672	.43669	.43668
-6	.45583	.45591	.45594	.45589
-7	.43441	.43456	.43451	.43449
-F	.57007	.57012	.57017	.57012

Continued To: Disclosed To And Understood By Me:

Entered By: Date:

Date: Date:

Project No. 1468-L42 Date of Work: 8-20-80 Work Performed by: BC & MH

Title or Purpose: Sample Weights Continued From:

Filter Set # 21
Run ONE

21-0	1.66 mg.
-1	2.12
-2	2.54
-3	1.52
-4	0.46
-5	0.35
-6	0.26
-7	0.33
-F	2.24

Filter Set # 14
Run TWO

14-0	2.13 mg.
-1	2.10
-2	4.04
-3	1.97
-4	0.68
-5	1.05
-6	0.84
-7	1.07
-F	4.68

Filter Set # 18
Blank

18-0	.07 mg
-1	.07
-2	.16
-3	.11
-4	.13
-5	.07
-6	.15
-7	.12
-F	.17

Filter Set # 8
Blank

8-0	.03 mg.
-1	.14
-2	.02
-3	.05
-4	.04
-5	.05
-6	0.0
-7	.05
-F	.07

Avg. Blank error = 0.08 mg.

Continued To: Disclosed To And Understood By Me:

Entered By: Date:

Date: Date:

Project No. 4468-42 Date of Work: 8-18 & 8-20-80 Work Performed by: BC VMH

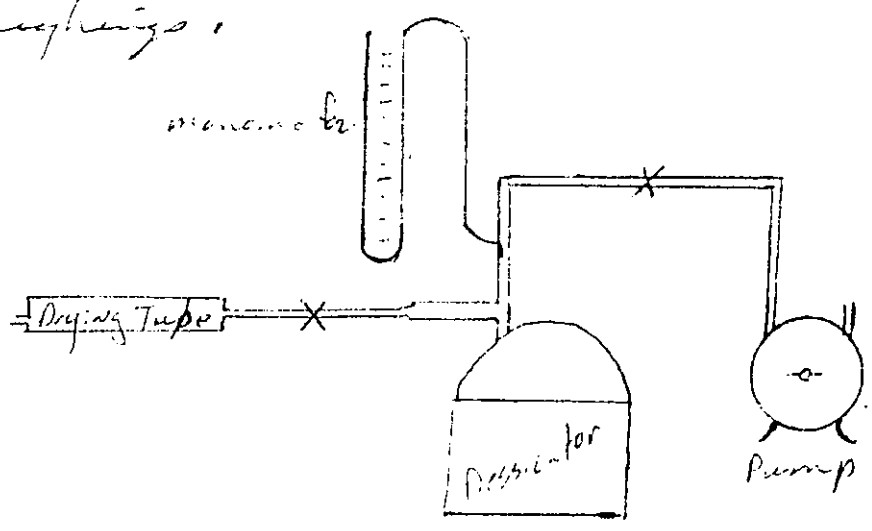
Title or Purpose: Weighing Procedure Continued From:

1) Zero & calibrate balance

2) Vacuum desiccate Filter for ~~two~~ one (MOH) hours @ 30" Hg

3) Remove filter and weigh allowing 30 sec. for balance to stabilize

4) Return to vacuum desiccator and desiccate for 15 more ~~hours~~ hours and re-weigh.



Cahn Electro Balance Model 27

Continued To: Disclosed To And Understood By Me:

Entered By: Date:

Date: Date:

ANDERSEN PARTICLE SIZE ANALYSIS

Test No. One
Date 8-19-80
Time 1730
Location Chatham Brick & Tile Co.

Final Weights 8-20-80
By C.C Date 8-20-80
Location Duncan, N.C. motel

Tare Weights 8-18-80
By CC & MH Date 8-18-80
Location Duncan, N.C. motel

Stage No.	Filter No.	Final wt (mg)	Tare wt (mg)	Sample wt (mg)[a]	% of total wt[c]	Cumulative % of total wt[c]	Dp μ
0	21-0	458.64	456.98	1.56			
1	21-1	446.67	444.55	2.04			
2	21-2	453.96	451.42	2.46			
3	21-3	442.09	440.57	1.44			
4	21-4	452.85	452.39	0.38			
5	21-5	453.66	453.31	0.27			
6	21-6	450.21	449.95	0.18			
7	21-7	437.37	437.04	0.25			
F	21-F	570.05	567.81	2.16			
			Total with filter				
			Total without filter				

Note: Andersen flow rate =

a/ Includes blank correction.

b/ Value used for calculations.

c/ Calculations based on total sample weight with filter are entered on first line; calculations based on total sample weight without filter are entered on second line for each stage.

ANDERSEN PARTICLE SIZE ANALYSIS

Test No. TWO
Date 8-19-80
Time
Location Kraft Chem. Bldg. Rm 6.

Final Weights 8-20-80
By CC Date 8-20-80
Location Durham, NC. metal

Tare Weights 8-18-80
By CCHAM Date 8-18-80
Location Durham, N.C. Metal

Stage No.	Filter No.	Final wt (mg)	Tare wt (mg)	Sample wt (mg)[a]	% of total wt[c]	Cumulative % of total wt[c]	Dp μ
0	14-0	443.53	441.40	2.05			
1	14-1	425.11	423.01	2.02			
2	14-2	447.49	443.45	3.96			
3	14-3	429.15	427.16	1.89			
4	14-4	438.70	438.02	0.60			
5	14-5	424.36	423.31	0.97			
6	14-6	443.39	442.55	0.76			
7	14-7	424.54	423.47	0.99			
F	14-F	543.73	539.05	4.60			
			Total with filter				
			Total without filter				

Note: Andersen flow rate =

a/ Includes blank correction.

b/ Value used for calculations.

c/ Calculations based on total sample weight with filter are entered on first line; calculations based on total sample weight without filter are entered on second line for each stage.

APPENDIX B

CARBON DIOXIDE, OXYGEN, CARBON MONOXIDE, AND NITROGEN EMISSION TEST DATA

B-1 Field Data Sheets

B-1 Field Data Sheets

MIDWEST RESEARCH INSTITUTE

RUN one & two

MRI Project Number 4468-L(42)
Field Dates 8-18 to 8-20-80
Plant Chatham Brick & Tile Co.
Sampling Location Kiln Exhaust - East
Sampling Date 8-19-80

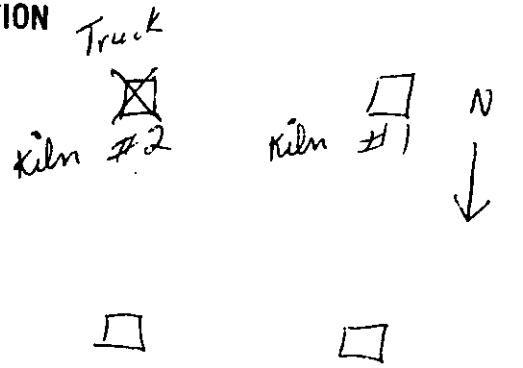
FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	G. Cobb
	2	
	3	
Engr. Technician	1	
	2	
	3	
Lab Technician	1	
	2	
	3	
Process Engineer	1	
	2	
Other	1	
	2	

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick + Tile
DATE 8-12-80
SAMPLING TIME (24-hr CLOCK) 16:30-16:45 Run No. 1
SAMPLING LOCATION Outlet East Kiln (No. 2)
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 93
OPERATOR K. Cobb

COMMENTS:



GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	2%	2	2.1%	2.1	3%	3	2.37	44/100	1.043
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	21%	19	19.8%	17.7	20	17	17.9	32/100	5.728
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	21	0	19.8%	0	20	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100	79	100	80.2	100	80	79.7	28/100	22.316
								TOTAL	29.087

B-4

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick & Tile

DATE 8-19-80

SAMPLING TIME (24-hr CLOCK) 16:45-17:20 Run No. 2

SAMPLING LOCATION Final Stack (No. 2) Kiln Exhaust-East

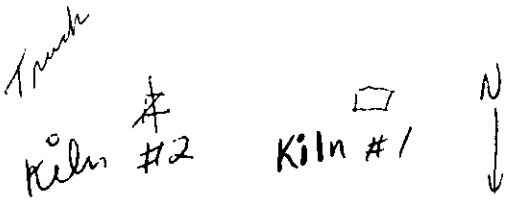
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Integrated

ANALYTICAL METHOD Orsat

AMBIENT TEMPERATURE 95

OPERATOR B Cobb

COMMENTS: 1 mile



Run One w/ Anderson Run One

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	3	3	2.5	2.5	2	2	2.5	44/100	1.1
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	20.6	17.6	19.4	16.9	18.6	16.6	17.03	32/100	5.450
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	20.6	0	19.4	0	18.6	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100.0	79.4	100	80.6	100	81.4	80.47	28/100	22.532
								TOTAL	29.082

B-5

EPA (Dur) 230
4/72

SAMPLING TASK LOG

Plant Chatham Brick & Tile Company
Date 8-19-80
Project No. 4468-L(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test	1	Harrop Kiln No. 2	CO_2	1630			
		(East) Kiln Exhaust					
		Stack					
Stop - Test Complete	1				1645	15	
Begin Test	2	"	CO_2	1645			
Stop - Test Complete	2				1700	15	

MIDWEST RESEARCH INSTITUTE

RUN One & two

MRI Project Number 4468-L (42)
Field Dates 8-18 to 8-20-80
Plant Chatham Brick & Tile Co.
Sampling Location Kiln Exhaust - West
Sampling Date 8-19-80

FIELD CREW

Crew Chief M. Hansen

Testing Engineer 1 G. Cobb
2
3

Engr. Technician 1
2
3

Lab Technician 1
2
3

Process Engineer 1
2

Other 1
2

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick & Tile
DATE 8-19-80 Run No. 1
SAMPLING TIME (24-hr CLOCK) 20:15 to 20:30
SAMPLING LOCATION Kiln Exhaust-West
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 85
OPERATOR E Robb

COMMENTS: Truck ☐ ☆ N ↓
Kiln #2 Kiln #1
☐ ☐

Bag leaked

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	2.6	2.6	2.6	2.6	2.6	2.6	2.6	44/100	1.144
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	18.2	15.6	17	14.4	17	14.4	14.8	32/100	4.736
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	18.2	0	17	0	17	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100	81.8	100	83	100	83	82.6	28/100	23.128
							TOTAL		29.008

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick and Tile Co.
DATE 8-19-80 Run No. 2
SAMPLING TIME (24-hr CLOCK) 2030-2045
SAMPLING LOCATION West Kiln Exhaust Stack
SAMPLE TYPE (BAG, (INTEGRATED) CONTINUOUS GRAB) _____
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 85
OPERATOR Hansen

COMMENTS: Truck

Bag Leaked

GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	1.8	1.8	1.4	1.4	1.8	1.8	1.67	44/100	0.735
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	18.6	16.8	16.8	15.4	17.8	16.0	16.07	32/100	5.142
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	18.8	0.2	17.2	0.4	19.0	1.2	0.6	28/100	0.168
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100	81.2	100	82.8	100	81.0	81.67	28/100	22.868
								TOTAL	28.913

EPA (Dur) 230
4/72

SAMPLING TASK LOG

Plant Chatham Brick & Tile Company
Date 8-19-80
Project No. 4468-LC42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test	1	Harrop Kiln No. 1 (West) Kiln Exhaust Stack	CO_2	2015			
Stop - Test Complete	1				2030	15	
Begin Test	2	"	CO_2	2030			
Stop Test Complete	2				2045	15	

MIDWEST RESEARCH INSTITUTE

RUN One & two

MRI Project Number 4468-L(42)
Field Dates 8-18 to 8-20-80
Plant Chatham Brick & Tile Co.
Sampling Location Waste Heat Exhaust - West
Sampling Date 8-19-80

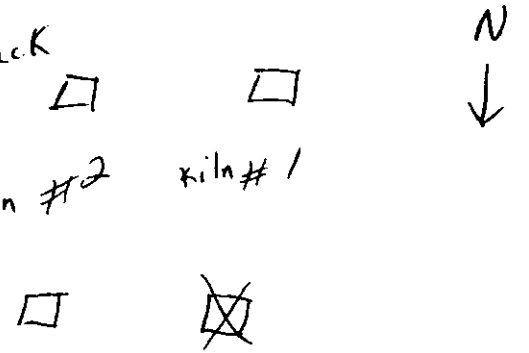
FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	G Cobb
	2	
	3	
Engr. Technician	1	
	2	
	3	
Lab Technician	1	
	2	
	3	
Process Engineer	1	
	2	
Other	1	
	2	

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick and Tile Co.
DATE 8-19-80 Run No. 1
SAMPLING TIME (24-hr CLOCK) 2015 - 2030
SAMPLING LOCATION West Wast Heat Exhaust Stack
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 87
OPERATOR D. Cobb

COMMENTS: Truck



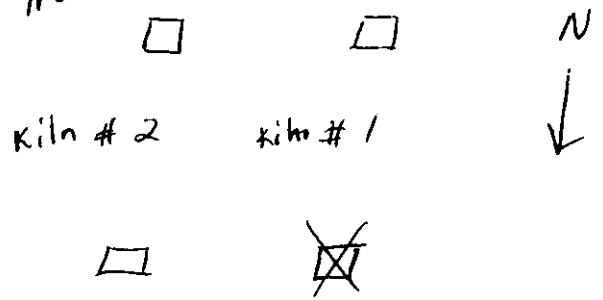
GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	.8	.8	.9	.9	.4	.4	.7	44/100	0.308
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	16	15.2	18.4	17.5	18.6	18.2	17.0	32/100	5.44
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	16.4	.4	18.4	0	19.0	.4	0.267	28/100	0.075
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100	83.6	100	81.6	100	81	82.07	28/100	22.98
								TOTAL	28.803

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick and Tile Co.
DATE 8-19-80 Run No. 2
SAMPLING TIME (24-hr CLOCK) 2030 - 2045
SAMPLING LOCATION West Waste Heat Exhaust Stack
SAMPLE TYPE (BAG, (INTEGRATED) CONTINUOUS GRAB) Integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 87
OPERATOR D. Cobb

COMMENTS: Truck



GAS \ RUN	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	0.4	.4	.3	.3	.6	.6	0.433	44/100	0.191
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	18.6	18.2	17.0	16.7	16.6	16	16.97	32/100	5.430
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	18.8	.2	17.4	.4	17.2	.6	.4	28/100	0.112
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100	81.2	100	82.6	100	82.8	82.2	28/100	23.016
								TOTAL	28.749

EPA (Dur) 230
4/72

SAMPLING TASK LOG

Plant Chatham Brick & Tile Company
Date 8-19-80
Project No. 4468-2(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test	1	Harrop Kiln No. 1	CO_2	2015			
		(West) Waste					
		Heat Exhaust					
		stack					
Stop - Test Complete	1				2030	15	
Begin Test	2	"	CO_2	2030			
Stop - Test Complete	2				2045	15	

MIDWEST RESEARCH INSTITUTE

RUN one & two

MRI Project Number 4468-L(42)
Field Dates 8-18 to 8-20-80
Plant Chatham Brick & Tile Co.
Sampling Location Waste Heat Exhaust - East
Sampling Date 8-19-80

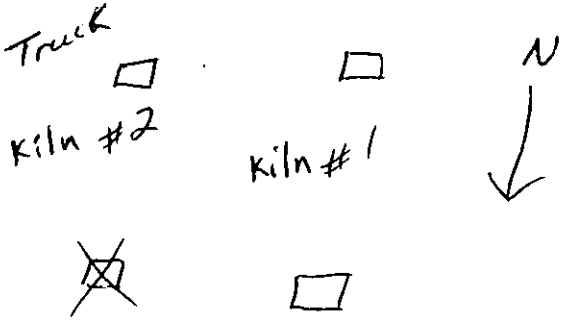
FIELD CREW

Crew Chief		M. Hansen
Testing Engineer	1	G. Cobb
	2	
	3	
Engr. Technician	1	
	2	
	3	
Lab Technician	1	
	2	
	3	
Process Engineer	1	
	2	
Other	1	
	2	

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick and Tile Co.
DATE 8-19-80 (Run One)
SAMPLING TIME (24-hr CLOCK) 2200 - 2215
SAMPLING LOCATION East Waste Heat Exhaust Stack
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS GRAB) Integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 85
OPERATOR G. Cobb

COMMENTS:



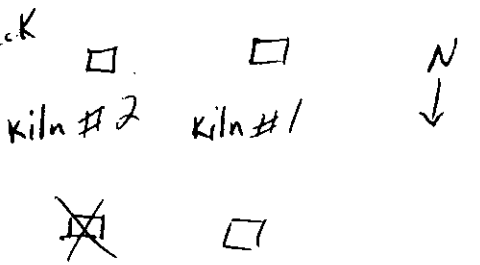
RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	.4	.4	.4	.4	.6	.6	.467	44/100	.205
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	14.5	14.1	17.2	16.8	18.2	17.6	16.167	32/100	5.173
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	14.5	0	17.2	0	18.2	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100	85.5	100	82.8	100	81.8	83.37	28/100	23.344
								TOTAL	28.722

EPA (Dur) 230
4/72

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Chatham Brick and Tile Co.
DATE 8-19-80 Run No. 2
SAMPLING TIME (24-hr CLOCK) 2215 - 2230
SAMPLING LOCATION East West Heat Exhaust Stack
SAMPLE TYPE (BAG, (INTEGRATED) CONTINUOUS GRAB) Integrated
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 85
OPERATOR G. Cobb

COMMENTS:



RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	.4	.4	.4	.4	.6	.6	.467	44/100	0.205
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	18.2	17.8	17.2	16.8	18.2	17.6	17.4	32/100	5.568
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)	18.2	0	17.2	0	18.2	0	0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)	100	81.8	100	82.8	100	81.8	82.13	28/100	23.00
								TOTAL	28.773

EPA (Dur) 230
4/72

SAMPLING TASK LOG

Plant Chatham Brick & Tile Company
Date 8-19-80
Project No. 4468-L(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test	1	Harrop Kiln No.2 (East) Waste Heat Exhaust Stack	CO_2	2200			
Stop - Test Complete	1				2215	15	
Begin Test	2	"	CO_2	2215			
Stop - Test Complete	2				2230	15	

APPENDIX C

PROJECT PARTICIPANTS

Midwest Research Institute
Energy and Environmental Analysis, Inc.
Chatham Brick and Tile Company
U.S. Environmental Protection Agency

PROJECT PARTICIPANTS

MIDWEST RESEARCH INSTITUTE

H. Kendall Wilcox, Manager, Field Programs Section - Project Manager

Mark D. Hansen, Associate Environmental Scientist - Project Engineer/Crew Chief

George R. Cobb, Associate Chemist - Assistant Project Scientist

ENERGY AND ENVIRONMENTAL ANALYSIS, INC.

Armando Sarasua, Environmental Engineer - Process Engineer

CHATHAM BRICK AND TILE COMPANY

Harold Stewart, Plant Manager

Leonard Gunter, Assistant Plant Manager

U.S. EPA EMISSION MEASUREMENT BRANCH

Frank R. Clay, Technical Manager

APPENDIX D

FIELD SAMPLING TASK LOGS

D-1 Andersen Cascade Impactor Particle Size Distribution Tests

D-2 Carbon Dioxide, Oxygen, Carbon Monoxide, and Nitrogen Emission Tests

D-2-1 Harrop Kiln No. 2 (East) Kiln Exhaust Stack

D-2-2 Harrop Kiln No. 1 (West) Kiln Exhaust Stack

D-2-3 Harrop Kiln No. 1 (West) Waste Heat Exhaust Stack

D-2-4 Harrop Kiln No. 2 (East) Waste Heat Exhaust Stack

D-1 Andersen Cascade Impactor Particle Size Distribution Tests

SAMPLING TASK LOG

Plant Chatham Brick & Tile Company
Date 8-19-80
Project No. 4468-L(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test - Harrop Kiln No. 2	1	Port No. 2, Point	Particulate	1730			
(East) Kiln Exhaust Stack		No. 2-7	(Particle				
			Size)				
Stop - Test Complete	1				1830	60	

SAMPLING TASK LOG

Plant Chatham Brick and Tile Company
Date 8-19-80
Project No. 4468-L(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test - Harrop Kiln	2	Port No. 3, Point	Particulate	1940			
No. 2 (East) Kiln Exhaust		No. 3-3	(Particle				
Stack			Size)				
Stop - Test Complete	2				2110	90	

D-2 Carbon Dioxide, Oxygen, Carbon Monoxide, and Nitrogen Emission Tests

D-2-1 Harrop Kiln No. 2 (East) Kiln
Exhaust Stack

SAMPLING TASK LOG

Plant Chatham Brick and Tile Company
Date 8-19-80
Project No. 4468-L(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test	1	Harrop Kiln No. 2 (East) Kiln Exhaust Stack	CO_2	1630			
Stop - Test Complete	1				1645	15	
Begin Test	2	"	CO_2	1645			
Stop - Test Complete	2				1700	15	

D-2-2 Harrop Kiln No. 1 (West) Kiln
Exhaust Stack

SAMPLING TASK LOG

Plant Chatham Brick & Tile Company
Date 8-19-80
Project No. 4468-2(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test	1	Harrop Kiln No. 1	CO_2	2015			
		(West) Kiln					
		Exhaust Stack					
Stop - Test Complete	1				2030	15	
Begin Test	2	"	CO_2	2030			
Stop - Test Complete	2				2045	15	

D-2-3 Harrop Kiln No. 1 (West) Waste Heat Exhaust Stack

SAMPLING TASK LOG

Plant Chatham Brick and Tile Company
Date 8-19-80
Project No. 4468-4(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test	1	Harrop Kiln No. 1 (West) Waste Heat Exhaust stack	CO_2	2015			
stop - Test Complete	1				2030	15	
Begin Test	2	"	CO_2	2030			
Stop - Test Complete	2				2045	15	

D-2-4 Harrop Kiln No. 2 (East) Waste Heat Exhaust Stack

SAMPLING TASK LOG

Plant Chatham Brick and Tile Company
Date 8-19-80
Project No. 4468-L(42)

Plant Location Gulf, North Carolina
Recorded by M. Hansen

Comments	Run	Sampling Location (Port)	Pollutant	Clock Time Began	Clock Time Ended	Elapsed Time (min)	Sample Nos.
Begin Test	1	Harrop Kiln No. 2	CO_2	2200			
		(East) Waste					
		Heat Exhaust					
		stack					
Stop - Test Complete	1				2215	15	
Begin Test	2	"	CO_2	2215			
Stop - Test Complete	2				2230	15	

APPENDIX E

SAMPLING TRAIN CALIBRATION DATA

E-1 Sample Orifice Calibration

E-1-1 Pretest Calibration

E-1-2 Posttest Calibration

E-2 Nozzle Measurements

E-3 Pitot Tube Calibration

E-1 Sample Orifice Calibration

E-1-1 Pretest Calibration

CALIBRATION-ORIFICE AND METER

ΔH and ΔY

Console No. 6 Date 5-19-80

Operator RCS

Use This Sample to Test Program Once, After Loading

1.0	86	28.90	75.3	9.1	5	Answer 1.90

Man. Orifice	OT_d	P_b	T_w	t	CF_w	ΔH
0.5						
1.0						
4.0						
6.0						
2.0	74.5	29.067	70.7	13.023	10	1.906

$$\Delta H@ = \frac{.0231(\Delta H)}{P_b(OT_d+460)}\left[\frac{(T_w+460)\,t}{CF_w}\right]^2$$

Use This Sample to Test Program Once, After Loading

1.0	26.90	5.13	75.3	97	86	28.90	5	Answer 1.00

Man. Orifice	P_b	CF_d	T_w	IT_d	OT_d	P_b	CF_w	ΔY
0.5								
1.0								
4.0								
6.0								
2.0	29.067	10.232	70.7	90.5	74.5	29.067	10	0.994

$$\Delta Y = \frac{(CF_w)(P_b)(Td_{avg}+460)}{CF_d\left(P_b+\frac{\Delta H}{13.6}\right)(T_w+460)}$$

Tolerances

ΔY	0.99	1.00	1.01
ΔH	1.6	1.84	2.1

CONSOLE NO. 6 DATE 5-19-80 INITIAL RCS

BAROMETRIC PRESSURE 29.067

Time M	Time S	Man. Inches H_2O	CFd	CFw	ITd	OTd	Tw
				0			
				1			
		Finish		2			
		Start		3			
		Total		4			
				5			
			Averages				
				0			
				1			
				2			
		Finish		3			
		Start		4			
		Total		5			
			Averages				
792.15 sec		2.0		0	82	72	70.7
				2	86	73	70.7
				4	89	74	70.7
13,023 min		Finish 910.632		6	92	75	70.7
		Start 900.400		8	96	76	70.7
		Total 10.232		10	98	77	70.7
					90.5	74.5	70.7
			Averages		82.5		
				0			
				2			
				4			
		Finish		6			
		Start		8			
		Total		10			
			Averages				

RAC CALIBRATION AND CHECKLIST

Date 5-15-80 Console No. 6 Operator RCS
Pump Cleaned
Pump oil OK
Clean quick connects ✓ Valves OK
Manometers Leak Ck. OK
Dry test meter Leak Check OK
Thermometers Calibrated Telephones
Lights OK Buzzer OK ; Timer and Timer Gears OK
Electrical check - Amphenol OK 110 v recept.
Variac OK
Vacuum gauge Check Thermocouple Switch OK
Leak check at 27 in. Hg - leakage = Less than 0.02 cmf Zero CFM
Remarks 25.5" Vaccum is Max

RAW CALIBRATION DATA

P_b _____

Man. Orifice	CF_w	CF_d	T_w	IT_d	OT_d	Time t
0.5						
1.0						
2.0						
4.0						
6.0						
8.0						

t = time minutes
P_b = barometric pressure
CF_w = volume wet test meter
CF_d = volume (RAC) dry test meter
T_w = temperature (°F) wet test meter
IT_d = inlet temperature (°F) dry test meter
OT_d = outlet temperature (°F) dry test meter

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-15-80 Thermocouple number Console #6

Ambient temperature — °C Barometric pressure — in. Hg

Calibrator RCS Reference: mercury-in-glass Yes

other

Reference point number[a]	Source[b] (specify)	Reference thermometer temperature, °F	Thermocouple potentiometer temperature, °F	Temperature difference,[c] %
Inlet	Ice Bath	32°	33	
Outlet	"	"	32	
Inlet	Water Bath	100	99	
Outlet	"	"	99	
Inlet	"	123	122	
Outlet	"	"	124	
Inlet	"	130	129	
Outlet	"	"	130	

[a] Every 30°C (50°F) for each reference point.

[b] Type of calibration system used.

[c] $\left[\frac{(\text{ref temp, °C} + 273) - (\text{test thermom temp, °C} + 273)}{\text{ref temp, °C} + 273}\right] 100 \leq 1.5\%$.

E-1-2 Posttest Calibration

POSTTEST METER CALIBRATION DATA FORM (English units)

Test numbers _____ Plant Chatham Brick & Tile Co. and Columbia Nitrogen

Date 9-5-80 Meter box number 6 Pretest Y 0.994 @ 2" ΔH

Barometric pressure, P_b = 29.13 in. Hg Dry gas meter number _____

Wet Meter Static Press. In. H2O Dm	Orifice manometer setting, (ΔH), in H_2O	Gas volume wet test meter (V_w), ft^3 *	Gas volume dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter Inlet (t_{d_1}), °F	Temperature: Dry gas meter Outlet (t_{d_o}), °F	Temperature: Dry gas meter Average[a] (t_d), °F	Time (θ), min	Vacuum setting, in. Hg	Y_i	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$	ΔHe i
-5.6	1.20	~~4.929~~	5.052	69.97	91.5	77.5	84.5	8.362	8	.999	4.929×29.13 (84.5+460) / 5.052×(29.13+1.2/13.6)(69.97+460)	1.964
-5.6	1.20	~~4.929~~	5.067	70.00	93.5	79.8	86.7	8.398	8	1.000		1.973
-5.6	1.20	~~4.929~~	5.085	70.00	97.7	81.8	89.75	8.398	8	1.002		1.965
										Y=	1.000	1.967

6-3

[a] If there is only one therometer on the dry gas meter, record the temperature under t_d.

where

V_w = Gas volume passing through the wet test meter, ft^3.

V_d = Gas volume passing through the dry test meter, ft^3.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_1} = Temperature of the inlet gas of the dry test meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry test meter, °F.

t_d = Average temperature of the gas in the dry test meter, obtained by the average of t_{d_1} and t_{d_o}, °F.

ΔH = Pressure differential across orifice, in H_2O.

Y_i = Ratio of accuracy of wet test meter to dry test meter for each run.

Y = Average ratio of accuracy of wet test meter to dry test meter for all three runs.
Tolerance = Pretest Y ±0.05Y

P_b = Barometric pressure, in. Hg.

R = Time of calibration run, min.

Quality Assurance Handbook M8-2.4A

* $V_w = \left[\frac{P_b + (Dm/13.6)}{P_b}\right] \times$ Indicated Wet Volume

E-2 Nozzle Measurements

We were unable to locate recent calibration data for the straight sampling nozzles to be used for this work assignment (EPA Contract No. 68-02-2814, Work Assignment No. 42, MRI Project No. 4468-L(42)) prior to the field test at Chatham Brick and Tile Company, Gulf, North Carolina, (August 18 to 20, 1980). All nozzles to be used during this work assignment were checked for damage at MRI prior to the field test. Approximate measurements were taken in the field and were used to determine the nozzle diameter needed for the calculated nozzle size required for testing purposes. Subsequent post-test measurements at MRI yielded the following measurements of the two nozzles used for this work assignment:

Particle Size Test No.	Nozzle No.	Diameter 1	Diameter 2	Diameter 3	Average
1	A1	0.244 in.	0.244 in.	0.244 in.	0.244 in.
2	A2	0.246 in.	0.244 in.	0.246 in.	0.245 in.

E-3 Pitot Tube Calibration

MIDWEST RESEARCH INSTITUTE

PITOT TUBE CALIBRATION FORM

MRI-31

Pitot Tube Number: From ~~Probe~~ Probe #4-2 Calibrated by: RCS

Date: 6-6-79 C_{pstd} = 0.99

ΔP_{std} ≈ 0.55 or as required

	Side "A" (in. H_2O)				Side "B" (in. H_2O)			
Run No.	ΔP_{std}	$\Delta P_{(s)}$	$C_{p(s)}$	Dev.	ΔP_{std}	$\Delta P_{(s)}$	$C_{p(s)}$	Dev.
1	0.565	0.810	0.827	0	0.569	0.825	0.822	.002
2	0.565	0.811	0.826	.001	0.570	0.820	0.825	.001
3	0.565	0.810	0.827	0	0.570	0.820	0.825	.001
		Average A	0.827			Average B	0.824	

C_{Pstd} = Pitot tube coefficient of standard type pitot tube

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

Dev. = $C_{p(s)} - \bar{C}_p$ (must be ≤ 0.01)

C_p(difference) = $|\text{Average}_A - \text{Average}_B|$ = 0.003 (must be ≤ 0.01)

$$\sigma \text{ (side A or B)} = \sum_1^3 \frac{|C_{p(s)} - \bar{C}_p \text{ (A or B)}|}{3}$$

0.0003 for A

0.0013 for B

APPENDIX F

SCOPE OF WORK

F-1 Copy of U.S. EPA Work Assignment and Sampling and Analysis Schedule

F-1 Copy of U.S. EPA Work Assignment and Sampling and Analysis Schedule

WORK ASSIGNMENT

ENVIRONMENTAL PROTECTION AGENCY

Research Triangle Park, N.C. 27711

EPA CONTRACT NO: 68-02-2814

CONTRACTOR: Midwest Research Institute

ASSIGNMENT NO: 42

ASSIGNMENT AMENDMENT NO:

TITLE: Source Test of Brick Kiln

DATE: 13 AUG 1980

DESCRIPTION

The Contractor shall perform a source test in accordance with the basic contract scope of work for the Emission Measurement Branch, and as set forth in the attached "Source Sampling and Analysis Schedule" at the following site:

Company Name: Chatham Brick and Tile
Location: Gulf, North Carolina
Industry: Building Brick and Structural Clay
Project No.: 80-BRK-5

The Emission Measurement Branch's Technical Manager is Frank Clay, Mail Drop 13, EMB, ESED, OAQPS, Research Triangle Park, North Carolina 27711.

Upon notification of approval of the proposed source test report, the Contractor shall provide 15 copies of the final report with appendices and 15 copies as a summary without appendices.

All pretest survey, proposed final, and final source test reports and SOTDAT Data Forms shall be submitted directly to J. E. McCarley, Emission Measurement Branch, ESED, Mail Drop 13, Research Triangle Park, North Carolina 27711.

All samples shall be shipped to: N/A

ESTIMATE OF	GOVERNMENT ESTIMATE	CONTRACTOR ESTIMATE
LABOR HOURS	300	
DURATION OF WORK	2 months	
COMPLETION DATE	September 30, 1980	

REQUESTER'S SIGNATURE	ORG CODE	TELEPHONE	DATE
Frank Clay Frank Clay	ESED/EMB	(919) 541-5243	8/6/80

APPROVALS (if applicable)	SIGNATURE	DATE
BRANCH CHIEF	R. Jean Hanna for Kent Berry Welch	Aug 7, 1980
DIVISION CHIEF	Robert L. Chaney	8/7/80
PROJECT MANAGER	Thomas M. Bibb	8/7/80
CONTRACTING OFFICER	[illegible]	8/13/80

CONTRACTOR'S REPRESENTATIVE AUTHORIZED TO NEGOTIATE

SIGNATURE	TITLE	DATE
Robert Donaldson	Robert Donaldson Manager, Contract Department	8/28/80

EPA(RTP)395

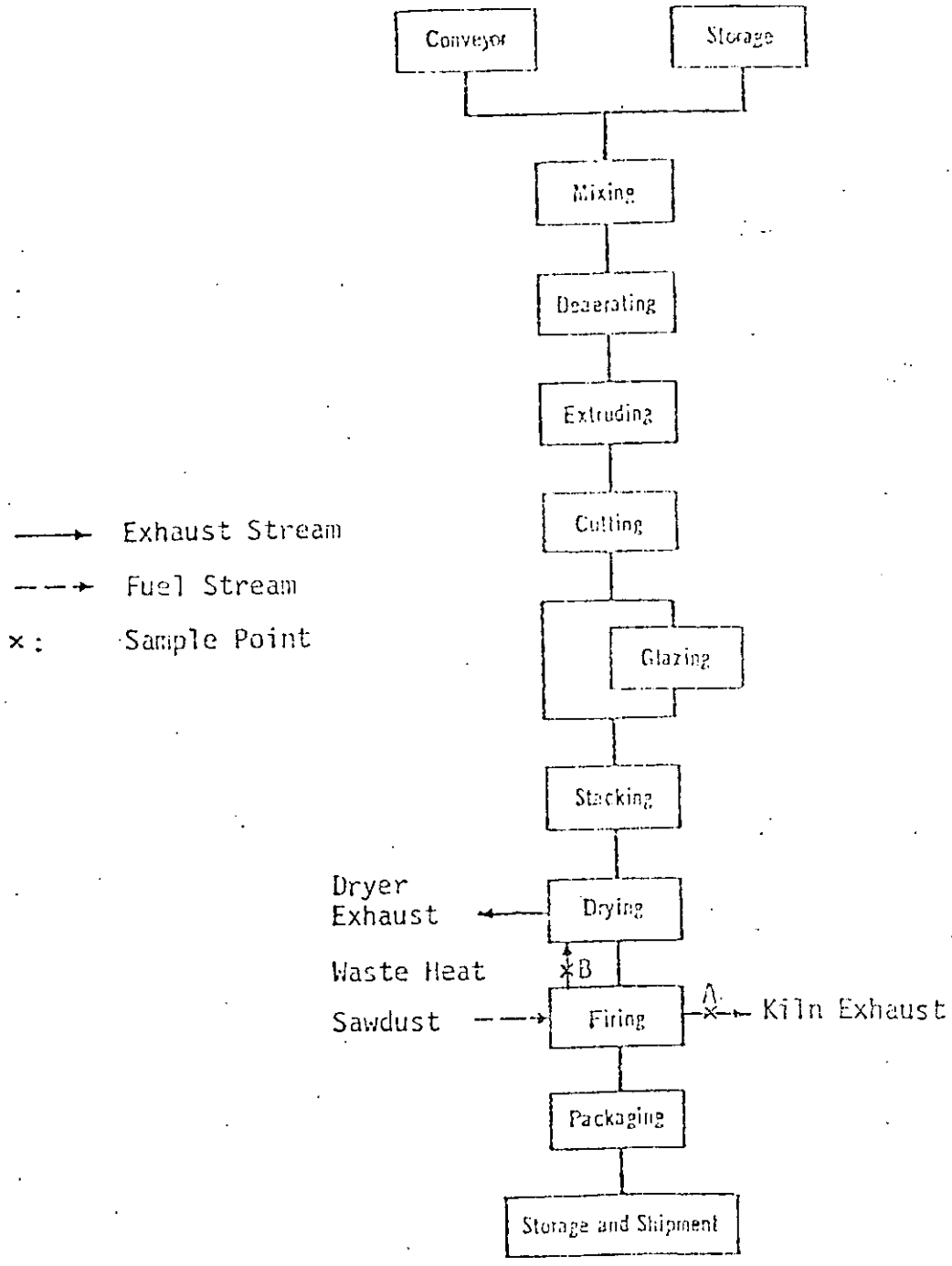


Figure 1. Chatham Brick and Tile Company flowsheet.

SOURCE SAMPLING AND ANALYSIS SCHEDULE

Contract No.: 68-02-2814

Company Name: Chatham Brick and Tile Company

Company Location: Gulf, North Carolina

Industry: Building Brick

Process: Brick Kiln

Control Equipment: None

Sampling Point Figure	Total No. of Samples	Sample Type	Sampling Method	Sample Collected By	Minimum Sampling Time	Minimum Gas Volume Sampled ft^3	Initial Analysis Type	Initial Analysis Method	Initial Analysis By	Final Analysis Type	Final Analysis Method	Final Analysis By
1/A	1	Particle Size	In-stack Impactor	CTR	1 hr	N/A				Distribution Size	Gravimetric	CTR
1/A	2	CO_2 Emissions	EPA-3	CTR	15 min	N/A				% CO_2	ORSAT	CTR
1/B	2	CO_2 Emissions	EPA-3	CTR	15 min	N/A				% CO_2	ORSAT	CTR
2/A	1	Particle Size	In-stack Impactor	CTR	1 hr	N/A				Distribution Size	Gravimetric	CTR
2/A	2	CO_2 Emissions	EPA-3	CTR	15 min	N/A				% CO_2	ORSAT	CTR
2/B	2	CO_2 Emissions	EPA-3	CTR	15 min	N/A				% CO_2	ORSAT	CTR
	1	Sawdust Sample										
	Sites 1A and 2A are kiln exhausts to dryer											
	Sites 1B to 2B are waste heat ducts to predryer											

REMARKS:

1. Sampling shall be performed with ± 10% isokinetic conditions.