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.

AP42 Section:	11.16
Reference:	11
Title:	Report To United States Gypsum Company On Particulate Emission Compliance Testing, Environmental Instrument Systems, Inc., South Bend, IN, November 1975. Unpublished.

1175

Ref No. 11 AP-112

A-82-39

II - A - 30

AP-42 Section 11.14
Reference 11
Report Sect.
Reference

REPORT TO
UNITED STATES GYPSUM COMPANY
SHOALS, INDIANA

on

PARTICULATE EMISSION COMPLIANCE TESTING

NOVEMBER 1975

by

ENVIRONMENTAL INSTRUMENT SYSTEMS, INC.
116 North Hill Street
South Bend, Indiana 46617

19

Table of Contents

Section	Page
1. Introduction	1-1
2. Procedure	2-1
2.1 Sampling Method	2-1
2.1.1 Particulate Matter	2-1
2.1.2 Stack Gas Composition	2-1
2.2 Analytical Procedures	2-1
2.2.1 Particulate Matter	2-1
2.2.2 Stack Gas Composition	2-3
3. Process Information	3-1
3.1 Description of Process	3-1
3.2 Process Operation During Sampling	3-1
3.3 Combustion Sources	3-1
3.4 Process Weight Rates	3-2
4. Sampling Information	4-1
4.1 Dryer	4-1
4.2 Raymond Mills	4-1
4.3 No. 1 Kettle	4-1
5. Allowable Emissions	5-1
5.1 Air Pollution Control Regulation (APC-5)	5-1
5.2 Calculation of Allowable Emission Rates	5-1
5.3 Table of Allowable and Actual Emission Rates	5-1
6. Results	6-1
6.1 No. 2 & No. 3 Raymond Mills	6-2
6.2 Dryer	6-3
6.3 No. 1 Kettle	6-4
7. Summary	7-1
Appendix	
A. Field Data Sheets	
B. Gas Composition Analysis	
C. Pitot Tube Calibration and Gas Meter Calibration	
D. Sample Calculations	

1. INTRODUCTION

Stack emission testing was conducted by Environmental Instrument Systems, Inc. at the United States Gypsum Company, Shoals, Indiana. The field sampling was performed on November 17, 18 and 19, 1975. The objective of the sampling was to determine the particulate emissions from the Flex-Kleen bag collectors controlling emissions from the Rock Dryer, the No. 2 and No. 3 Raymond Mills and the No. 1 Kettle.

2. PROCEDURE

2.1 Sampling Method

2.1.1 Particulate Matter

Sampling for particulates utilized the standard U.S. Environmental Protection Agency (EPA) train (Figure 1). The EPA train allows samples to be collected under isokinetic conditions.

2.1.2 Stack Gas Composition

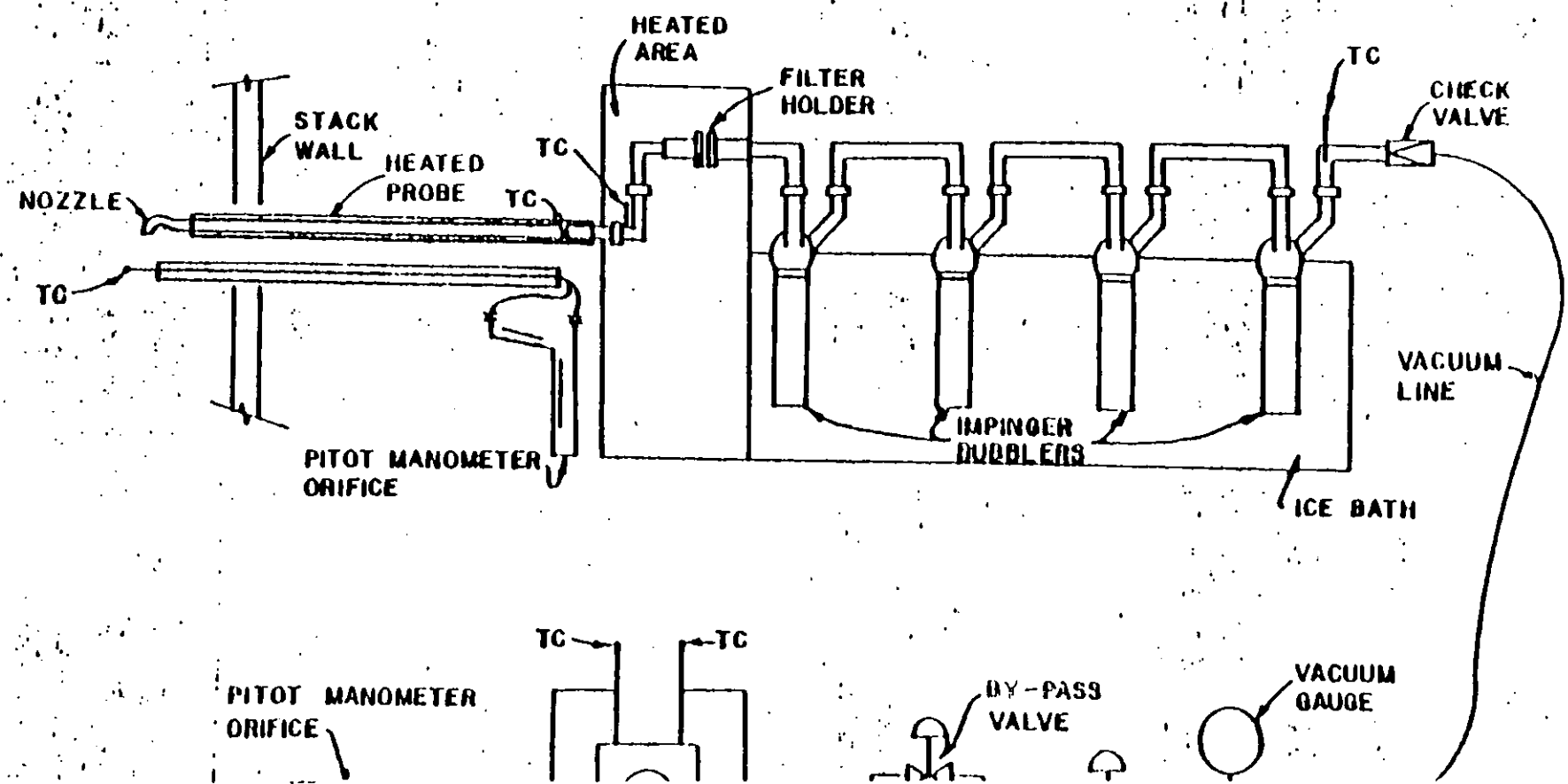
Analysis of exhaust stack gas composition was made using the Orsat Gas Analyzer. Minimum detectable concentrations with the analyzer is on the order of 2000 ppm.

2.2 Analytical Procedures

2.2.1 Particulate Matter

Pre-dried (at 105°C) and preweighed glass fiber filters were used for the collection of particulate matter. Following the sampling run, the filters were placed in petri dishes for transport back to the EIS laboratories for analysis. The interior of the probe and nozzle was washed with acetone to remove any entrained particulate matter. The washings were collected in clean dry bottles.

In the laboratory, the filters and probe and nozzle washings were transferred to separate weighing dishes, oven dried and desiccated to a constant weight. Results were


HEATED AREA
FILTER HOLDER
TC
CHECK VALVE
STACK WALL
HEATED PROBE
NOZZLE
TC
TC
TC
VACUUM LINE
IMPINGER BUBBLERS
PITOT MANOMETER ORIFICE
ICE BATH
TC
TC
PITOT MANOMETER ORIFICE
BY-PASS VALVE
VACUUM GAUGE

recorded to 0.1 mg using a single pan balance. Total particulate weight was then determined as a sum of the filter and probe and nozzle wash weights.

2.2.2 Stack Gas Composition

Analysis of exhaust stack gas composition with the Orsat Gas Analyzer involved the withdrawal of a known volume of stack gas into the analyzer, then sealing off the system from the atmosphere by means of a stopcock. The gas sample was then successively passed through liquid absorbants which chemically removed specific components. The volume of gas was measured before and after each specific chemical absorption. The decrease in gas volume at each absorbant stage represented the amount of that constituent which was present. The results were then recorded on a volume percentage basis. Volumetric percentage of N_2 is assumed to be the remaining gas volume after determination of CO_2, O_2, and CO.

3. PROCESS INFORMATION

3.1 Description of Process

Mined gypsum rock is fed through the Rock Dryer where surface moisture is evaporated, then through the Raymond Mills where the rock is crushed. The crushed rock is fed to the Kettles where it is calcined. A Flex-Kleen bag collector controls the particulate emissions from the Rock Dryer. Another Flex-Kleen bag collector controls the particulate emissions from the three Raymond Mills. The number of Mills in operation is dependent on the demand. The particulate emissions from the four Kettles are controlled by a Flex-Kleen collector on each Kettle.

3.2 Process Operation During Sampling

The processes are all continuous as the demand requires. Only two Raymond Mills were operated during the sampling period so that a constant process weight could be assured. The Dryer process weight varied during the sampling period with the rates and time being noted and recorded. The Kettle was operated at a constant rate throughout the sampling period.

3.3 Combustion Sources

The Dryer was the only operation sampled with combustion gases vented through the collector. The Kettle is a double

walled vessel with combustion occurring in the outer section of the vessel and the calcined gypsum in the inner section. The combustion gases are vented out a separate stack.

3.4 Process Weight Rates

Following are process weight rates during the testing periods. The rate data was supplied by U.S. Gypsum staff.

Sample Run	Process	Operation	Process Weight Rate (tons/hour)
1	Rock Dryer	Drying	52.5
2	Rock Dryer	Drying	50
3	Rock Dryer	Drying	55
1	No. 2 & 3 Raymond Mills	Crushing	38.2
2	No. 2 & 3 Raymond Mills	Crushing	38.2
3	No. 2 & 3 Raymond Mills	Crushing	38.2
1	No. 1 Kettle	Calcining	13.1
2	No. 1 Kettle	Calcining	13.1
3	No. 1 Kettle	Calcining	13.1

4. SAMPLING INFORMATION

4.1 Dryer

Sample ports for the Dryer stack were located 9 diameters downstream and 6 diameters upstream from the nearest disturbances. Sixteen traverse points were used and three (3) one hour samples were collected.

4.2 Raymond Mills

Sample ports were located 5 diameters downstream and 3 diameters upstream from disturbances. Sixteen traverse points were used and three (3) one hour samples were collected.

4.3 No. 1 Kettle

Sample ports were located 6.5 diameters downstream and 1.5 diameters upstream from disturbances. Sixteen traverse points were used and three (3) one hour samples were collected.

The percent moisture of the No. 1 Kettle emissions ranged from 60 to 65 percent. The standard nomograph used to sample particulate emissions isokinetically as outlined by EPA Method 5 is limited to moisture of 50 percent or less. Run No. 1 was conducted by extrapolation of nomograph data. Runs No. 2 and 3 were conducted using the following equation supplied by the Indiana State Board of Health source sampling staff to obtain the orifice pressure required to maintain an isokinetic sampling rate.

$$\Delta H = \left[\pi (85.48)(C_t)(D_{noz})^2 (1-\% \text{ moist})(15\right.$$

$$\times \left[\left(\frac{\Delta H_m}{.92}\right)\left(\frac{T_m}{T_s}\right)\left(\frac{P_s}{P_m}\right)\left(\frac{\text{Dry Mol.}}{\text{Stack Mol.}}\right.\right.$$

Where ΔH = Factor applied to velocity pressur desired orifice pressure.

C_t = Pitot correction factor

D_{noz} = Nozzle diameter (inches)

ΔH_m = Meter ΔH

T_m = Average meter temperature (^oR)

T_s = Average stack temperature (^oR)

P_s = Pressure, stack conditions (in.Hg.)

P_m = Pressure, meter conditions (in.Hg.)

Using the data obtained from Run No. 1, were conducted within the limits of isokinetic

5. ALLOWABLE EMISSIONS

5.1 Air Pollution Control Regulation (APC-5)

Particulate emissions from the processes are subject to the limitations outlined in the Indiana Air Pollution Control Regulation (APC-5).

5.2 Calculation of Allowable Emission Rates

For process weight rates up to 30 tons per hour the allowable emission rate is determined by the equation:

$$E = 4.10P^{0.67}$$

For process weight rates in excess of 30 tons per hour the allowable rate is determined by use of the equation:

$$E = 55.0P^{0.11} - 40$$

Where E = rate of emission in lbs/hr

Where P = process weight in tons/hr

5.3 Table of Allowable and Actual Emission Rates

The following table presents the process weight rate, the particulate emission rate determined by the field testing and the allowable emission rate as set forth by APC-5.

ALLOWABLE AND ACTUAL EMISSION RATES

Process	Run Number	Process Weight Rate (tons/hr)	Particulate Emission Rate (lbs/hr)	Allowable Particulate Emission Rate (lbs/hr)
Dryer	1	52.5	2.6	45.0
Dryer	2	50	1.5	44.6
Dryer	3	55	3.0	45.5
No. 2 & No. 3 Raymond Mills	1	38.2	8.2	42.1
No. 2 & No. 3 Raymond Mills	2	38.2	4.6	42.1
No. 2 & No. 3 Raymond Mills	3	38.2	0.6	42.1
No. 1 Kettle	1	13.1	0.02	23.0
No. 1 Kettle	2	13.1	0.01	23.0
No. 1 Kettle	3	13.1	0.20	23.0

6000 ACFM
120 SQ.FT. [illegible] 7.3/1 RATIO

6.1 NO. 2 & NO. 3 RAYMOND MILLS - FLEX-KLEEN COLLECTOR

Date: November 17, 1975	Run 1	Run 2	Run 3
Stack Cross Sectional Area (sq.ft.)	2.0739	2.0739	2.0739
Average Stack Temperature (°F)	153	148	140
Average Stack Velocity (ft./sec.)	51.4	50.6	50.2
Flow Rate, Stack Conditions (cfm)	6394	6297	6249
Flow Rate, Standard Conditions (scfm)	5376	5331	5364
Total Sampled Volume, Standard Conditions (scf)	32.50	32.72	32.74
Percent Moisture	1.7	1.8	1.7
Isokineticity (%)	99	101	102
Barometric Pressure (in.Hg.)	29.6	29.6	29.6
Stack Pressure (in.Hg.)	29.6	29.6	29.6
Sampling Time (minutes)	65.9	65.7	64.8
Total Particulate Weight (grams)	0.3751	0.2126	0.0276
Particulate Concentration, Standard Conditions (grains/scf)	0.0178	0.1003	0.0130
Particulate Concentration, Stack Conditions (grains/acf)	0.1497	0.0849	0.0112
Particulate Emissions (lbs./hr.)	0.2	4.6	0.6

4.47 #/hr

$\frac{4.47}{2} = 2.23$ #/hr

10,000 ACFM
1600 SQ FT CLOTH } 6.25/1 RATIO

6.2 DRYER - FLEX-KLEEN COLLECTOR

	Run 1	Run 2	Run 3
Date: November 18, 1975			
Stack Cross Sectional Area (sq.ft.)	3.1416	3.1416	3.1416
Average Stack Temperature (°F)	190	189	188
Average Stack Velocity (ft./sec.)	59.8	59.1	59.8
Flow Rate, Stack Conditions (cfm)	11,267	11,147	11,271
Flow Rate, Standard Conditions (scfm)	8,599	8,544	8,476
Total Sampled Volume, Standard Conditions (scf)	34.52	34.15	34.05
Percent Moisture	5.4	5.2	7.1
Isokineticity (%)	102	100	102
Barometric Pressure (in.Hg.)	29.6	29.6	29.6
Stack Pressure (in.Hg.)	29.6	29.6	29.6
Sampling Time (minutes)	64.7	65.4	64.6
Total Particulate Weight (grams)	0.0796	0.0442	0.0919
Particulate Concentration, Standard Conditions (grains/scf)	0.0356	0.0200	0.0416
Particulate Concentration, Stack Conditions (grains/acf)	0.0271	0.0153	0.0313
Particulate Emissions (lbs./hr.)	2.6	1.5	3.0

2.4 AV

4000 ACFM
800 SQFT. CLOTH AREA

5/1 RATIO

6.3 NO. 1 KETTLE - FLEX-KLEEN COLLECTOR

Date: November 19, 1975	Run 1	Run 2	Run 3	
Stack Cross Sectional Area (sq.ft.)	0.7854	0.7854	0.7854	
Average Stack Temperature (^{o}F)	245	245	244	
Average Stack Velocity (ft./sec.)	39.4	39.8	39.8	
Flow Rate, Stack Conditions (cfm)	1856	1877	1877	
Flow Rate, Standard Conditions (scfm)	472	492	544	
Total Sampled Volume, Standard Conditions (scf)	16.33	21.97	22.39	
Percent Moisture	65.6	64.6	60.8	
Isokineticity (%)	121	102	94	
Barometric Pressure (in.Hg.)	29.5	29.5	29.4	
Stack Pressure (in.Hg.)	29.5	29.5	29.4	
Sampling Time (minutes)	65.6	64.8	64.5	
Total Particulate Weight (grams)	0.0068	0.0044	0.0485	
Particulate Concentration, Standard Conditions (grains/scf)	0.0064	0.0031	0.0334	0.01[illegible]
Particulate Concentration, Stack Conditions (grains/acf)	0.0016	0.0008	0.0097	
Particulate Emissions (lbs./hr.)	0.02	0.01	0.2	0.077

7. SUMMARY

Analysis of the test data indicate tha emissions from the Rock Dryer, the No. 2 and Mills and the No. 1 Kettle are all well with tions set forth by APC-5.

The Raymond Mill collector was tested d operation of 2 out of 3 Mills. The emission icantly below the allowable limitations and operation of all three Mills would not be exp change these results. During normal process number of Mills in operation is variable depe demand.

The test results from the No. 1 Kettle w to compare to those from the other three Kett processes are identical and all have identica