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BUFFALO TESTING LABORATORIES
INCORPORATED

CHEMISTS - METALLURGISTS

902 Kenmore Ave.

BIOLOGISTS - ENGINEERS

Buffalo. N. Y. - 14216

Established 1927

Phone: (716) 873-2302

AP-42 Section 11.30
Reference 8
Report Sect. 4
Reference 5

REPORT NO. 64,354

ORDER NO.

December 8, 1972

Attn: Mr. Walter Schmidt
National Gypsum Company
325 Delaware Avenue
Buffalo, New York 14202

Re: Stack Test Report
Perlite Process
National Gypsum Company
Roll Road
Clarence Center, New York

Gentlemen:

Following are the results of the particulate emissions stack test conducted by Buffalo Testing Laboratories, Inc. on your Roll Road Perlite Process to determine if it complies with County and State regulations. The test was performed on October 25 and 26, 1972. All three (3) runs were performed using the approved E.P.A. Methods for source sampling.

If I can be of any further assistance, please feel free to contact me.

Very truly yours,

Arthur V. Allen

AVA/smi

ARTHUR V. ALLEN
Environmental Services Manager
BUFFALO TESTING LABORATORIES
INCORPORATED

To: Amy Lovaldi, NRI

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S74004

REPORT No. 64,354

ORDER No.

December 8, 1972

I hereby certify that the attached report, methods of analysis and calculated performance of the tests run and reported in the attached report on your Perlite Process, National Gypsum Company, Clarence Center, New York are in full compliance with the procedural requirements of the following specifications:

"Federal Register - Environmental Protection Agency - Standards of Performance for New Stationary Sources - Thursday - December 23, 1971 - Washington, D. C. - Volume 36 - Number 247".

I affirm that the tests, as run, comply in all respects with the methods, procedures, and the results required by the Specification used in the Testing Program.

STATE OF NEW YORK * LICENSED PROFESSIONAL ENGINEER * STANISLAW BOJARCZUK NO. 41102

Sincerely,

Stanislaw Bojarczuk

STANLEY BOJARCZUK, P.E.

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I Introduction

The following test was performed on the eighteen (18) inch diameter Perlite Stack at National Gypsum Company, Roll Road, Clarence Center, New York in order to show compliance with State and County emission regulations. The test was performed on October 25 and 26, 1972.

II Process Description

Perlite is a glassy volcanic rock consisting of oxides of silicon and aluminum combined by water of hydration. In the process known as exfoliation, the material is rapidly heated to release water of hydration and thus expand the spherules into low density particles used primarily as aggregate in plaster and concrete.

At the National Gyspsum Plant the raw perlite is fed to a Murdock and Stein Model 3S-360 Perlite Processing Unit. Essentially, the raw perlite is dried in a rotary drier, evacuated by a blower and the expanded product is separated by two cyclones in series. The effluent from the processing unit is fed to a 10B Sly Multi-Clean Collector before being vented to the atmosphere through the eighteen (18) inch Perlite Stack.

III Stack Testing

The test ports were located at least eight (8) diameters downstream and two (2) diameters upstream from any bend or obstruction. The Federal Register of December 23rd, 1971 was used to determine the correct number of traverse points for this situation. Since the stack was less than twenty-four (24) inches in diameter, eight (8) points - two-thirds the normal minimum (12) - were dictated for this situation.

A preliminary pitot traverse was run to obtain the correct nozzle size and to determine other test parameters. The pitot traverses were made along two (2) axes at 90° to each other. The stack area was divided into two (2) equal areas, therefore four (4) points were taken for the pitot traverse across each axis (see stack-cross section schematic, Figure No. 2).

Sampling was done using two (2) ports designated A and B. The sample was withdrawn isokinetically from the same points used for the initial pitot traverses. The test consisted of three (3) runs designated "preliminary", "1" and "2". All runs were conducted while the process was maintained at the specified maximum operating rate - 80 bags per hour.

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Particulate samples were obtained using the equipment and test procedures as stipulated in:

1) "Form AIR 100.7 (9-71)", New York State Department of Environmental Conservation, Albany, New York 12201.

2) "Federal Register, Environmental Protection Agency, Standards of Performance for New Stationary Sources, Thursday, December 23, 1971, Washington, D. C., Volume 36, Number 247, Part II".

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ANALYTICAL TECHNIQUES

Laboratory analyses were done on the collected samples from National Gypsum Company and were completed at the Buffalo Testing Laboratories, Inc., in Buffalo, New York. The determinations performed on the collected samples were as follows:

Container No. 1

The filter from this container was placed in a tared weighing dish and dessicated for 24 hours in a dessicator containing Drierite. The filter and weighing dish were weighed to a constant weight.

Container No. 2

The acetone washings from the probe, cyclone, cyclone flask and the front half of the filter holder were transferred from this container to a tared beaker. The washings were evaporated to dryness at ambient temperature and pressure. The solid remaining after the evaporation was dessicated for 24 hours and weighed to a constant weight.

Container No. 3

The water rinsings from the two gas wash bottles and the Greenburg-Smith impinger, the back half of the filter holder, the fritted glass support and all connectors were transferred to this sample container. The impinger and rinsing water was evaporated in a tared beaker and the residue weighed to a constant weight.

Container No. 4

The silica gel from the fourth gas wash bottle was reweighed to the nearest tenth of a gram. The amount of moisture absorbed by the silica gel during the test was determined. The amount of water so found was added to that condensed in the impingers for moisture calculations.

Container No. 5

The acetone washings from the back half of the filter holder, the fritted support, the connectors and the first two gas wash bottles, plus the Greenburg-Smith impinger, were transferred from this container to a tared beaker. The washings were evaporated to dryness at 100°F and ambient pressure. The residue was dessicated for 24 hours and weighed to a constant weight.

The total weight collected during each run was obtained by totaling the weights of the three individual sample components:

1) The gain in weight of the glass fiber filter

2) the residue from the water rinsings and impinger solutions

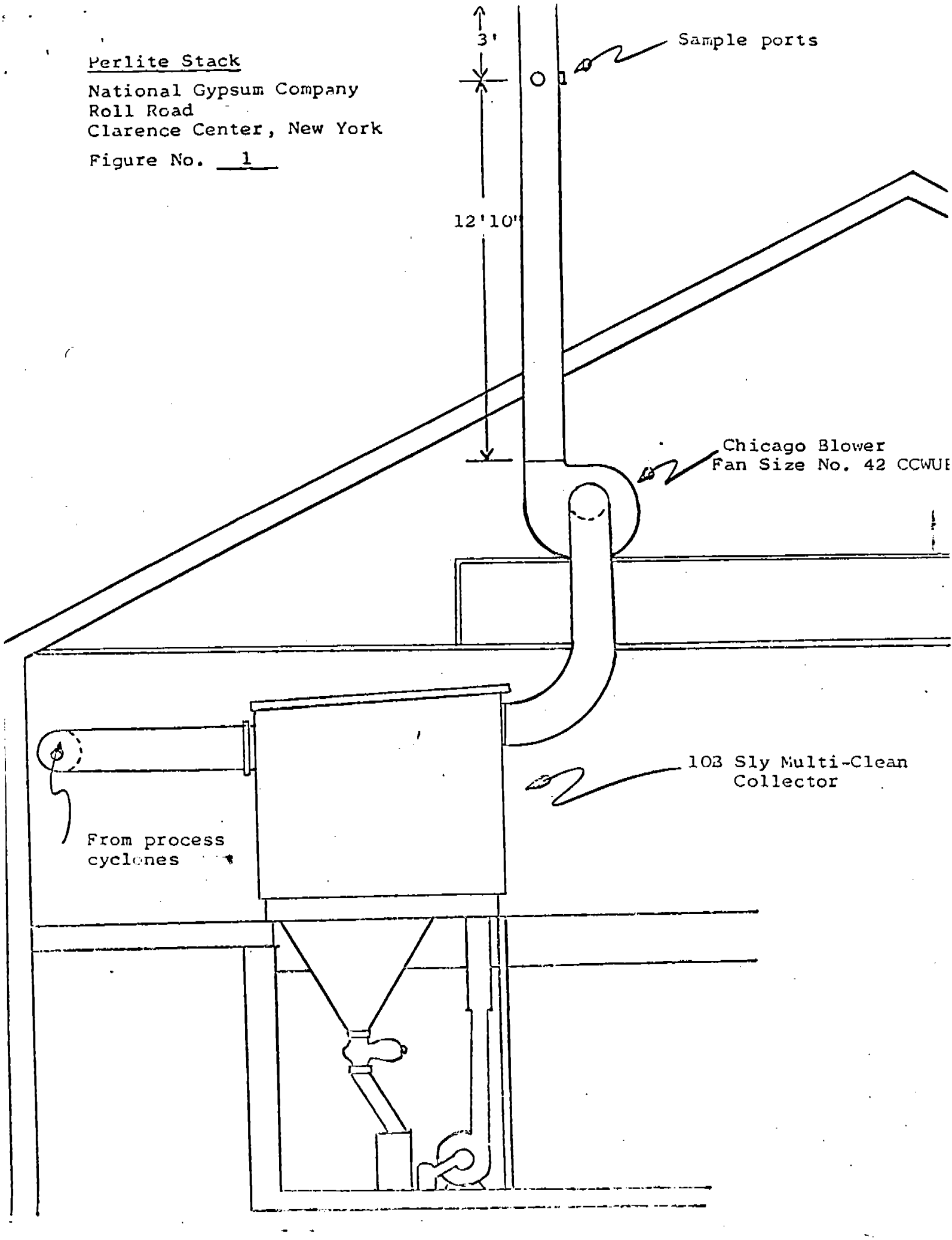
3) the residue from the acetone washings of the glassware and probe.

An Orsat analysis was performed on the integrated gas sample. The gas was collected in a glass gas collection bottle which contained a saturated solution of sodium chloride. The sodium chloride solution was allowed to drip from the bottle during the test, thus pulling the gas sample from the stack into the collecting bottle to replace the lost solution.

IV Discussion and Results

The results of our testing are included in the following pages. The first two pages of each run serve to summarize the data and calculations. Our test methods adhered to the acceptable stack test methods for solid particulates as stipulated in AIR 100.7 (9-71).

The Perlite Process was operated normally during all test runs.


Perlite Stack
National Gypsum Company
Roll Road
Clarence Center, New York
Figure No. 1
3'
12'10"
Sample ports
Chicago Blower
Fan Size No. 42 CCWUB
103 Sly Multi-Clean
Collector
From process
cyclones

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Stack Cross - Section at: National Gypsum Company
Roll Road, Clarence Center, New York - Perlite Stack

Tested: October 25 and 26, 1972

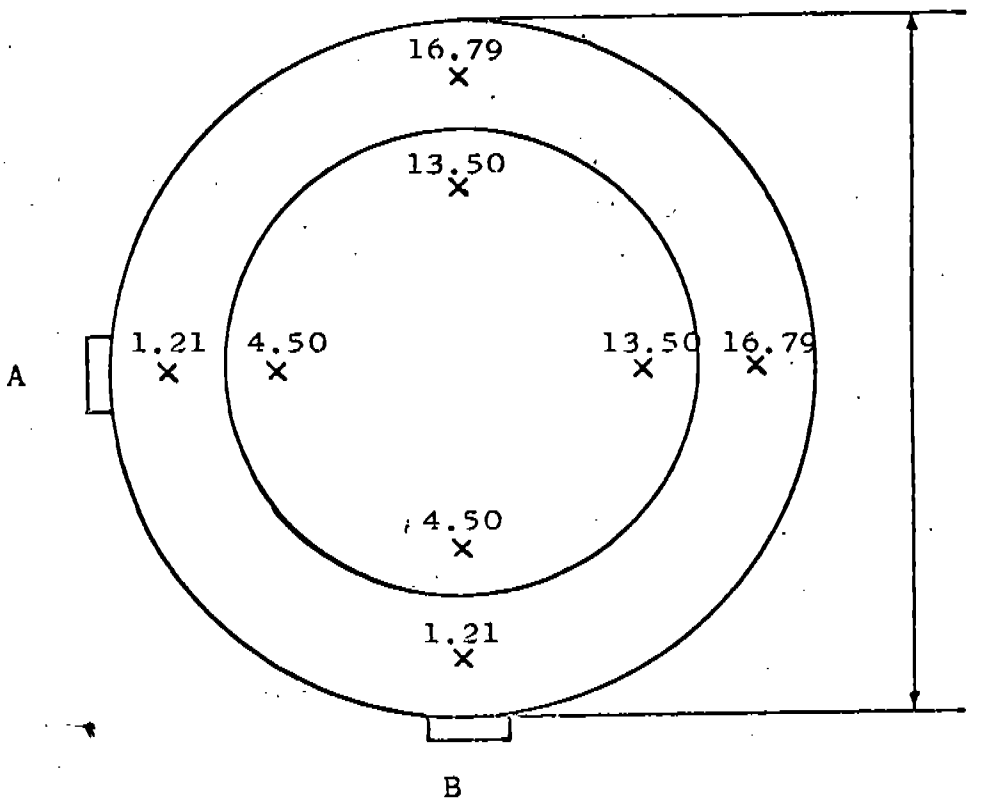
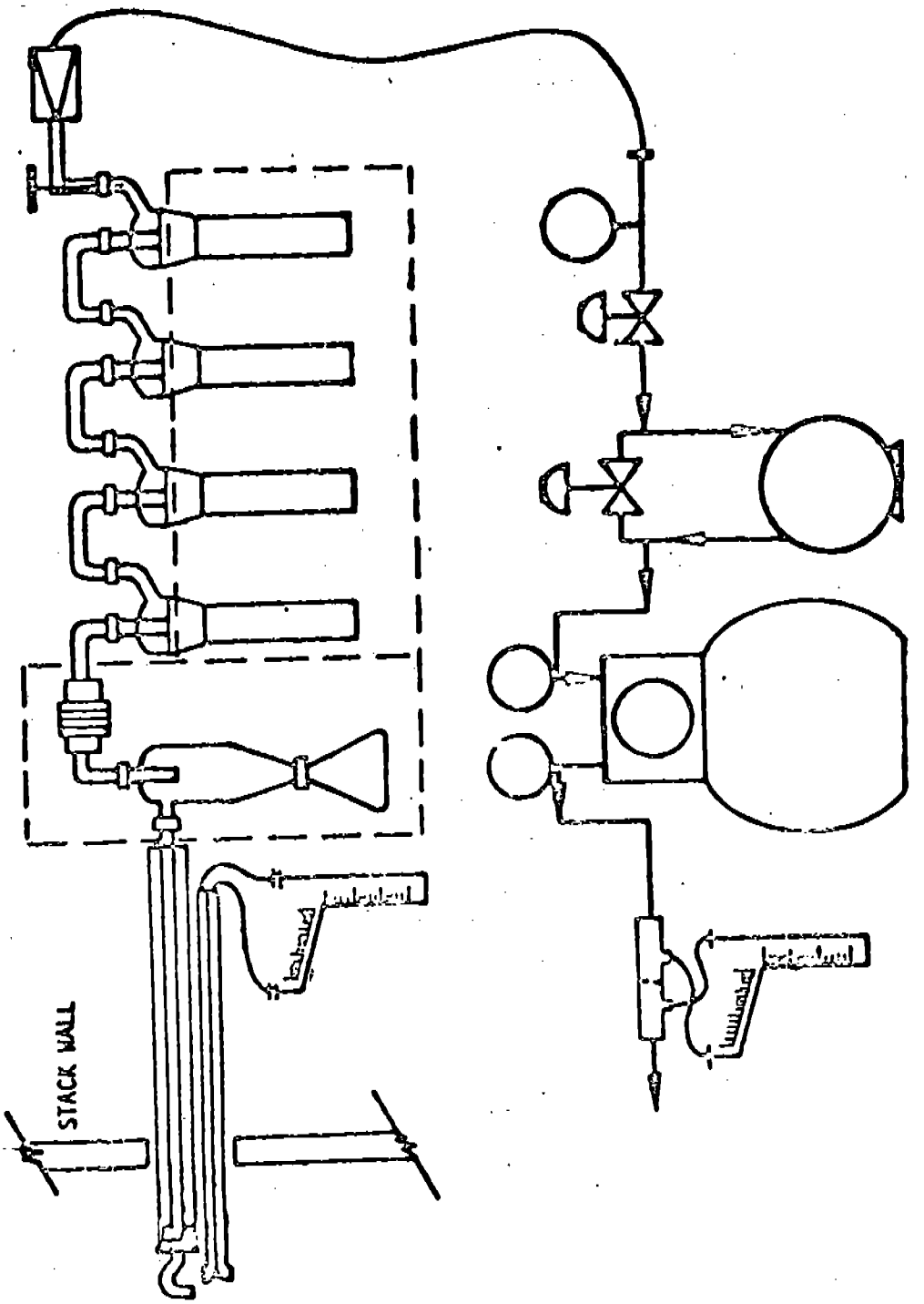


Figure No. 2



Schematic of Particulate Sampling Equipment

Figure No. 3

DEFINITIONS

Standard conditions - 70°F and 29.92 in. Hg

scf - Standard cubic foot of dry gas @ 70°F and 29.92 in. Hg

scfm - Standard cubic foot per minute of dry gas @ 70°F and 29.92 in. Hg

Stack conditions - stack temperature, pressure and moisture.

NM - Not Measured

LIST OF SYMBOLS

C_{am}, Particulate - probe and cyclone, grains/scf

C_{an}, particulate - probe, cyclone and filter, grains/scf

C_{ao}, Particulate - total, grains/scf

C_{as}, particulate - probe and cyclone, grains/scf @ stack conditions

C_{at}, particulate - probe, cyclone and filter, grains/cf @ stack conditio

C_{au}, particulate - total particulate, grains/cf @ stack conditions

C_{av}, particulate - probe and cyclone, lb/hr

C_{aw}, particulate - probe, cyclone and filter, lb/hr

C_{ax}, particulate - total, lb/hr

D_{av}, sampling nozzle diameter, in.

I_{ax}, percent isokinetic

M_{bj}, molecular weight of dry stack gas

M_{ca}, molecular weight of stack gas

M_{ch}, mole fraction of dry gas

P_{aa}, barometric pressure, in. Hg (Absolute)

P_{af}, orifice pressure drop, in. H_2O

P_{di}, stack pressure, in Hg (absolute)

P_{dj}, stack pressure, in. Hg (gage)

S_{dd}, stack area, in^2

S_{de}, average $\sqrt{\text{Velocity head x stack temperature}}$

T_{ad}, gas meter inlet temperature, ^oF

T_{ae}, gas meter exit temperature, ^oF

T_{ai}, average gas meter temperature, ^oF

T_{aw}, net time of test, minutes

T_{df}, stack temperature, ^oF

V_{ab}, volume of dry gas sampled @ standard conditions, ft^3

V_{ac}, volume of dry gas sampled @ meter conditions, ft^3

V_{bf}, % CO_2 (dry basis)

V_{bg}, % CO (dry basis)

V_{bh}, % O_2 (dry basis)

V_{bi}, % N_2 (dry basis)

V_{cb}, H_2O condensed in impingers, ml

V_{cd}, H_2O absorbed silica gel, ml

V_{ce}, total H_2O collected, ml

V_{cf}, volume of water vapor collected, cu ft @ standard conditions

V_{cg}, moisture in stack gas by volume, %

V_{db}, stack gas volume @ standard conditions, scfm

V_{dh}, stack velocity @ stack conditions, fpm

W_{aj}, particulate - probe and cyclone, mg

W_{ak}, particulate - probe, cyclone and filter, mg

W_{al}, particulate - total, mg

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SUMMARY OF RESULTS

EMISSION TEST

RUN NO. Preliminary

1. Name of Firm National Gypsum
2. Location of Plant Roll Road, Clarence, New York
3. Type of Unit Perlite Process
4. Control Equipment 10B Sly Multi-Clean Collector
5. Sampling Point Location Stack from Collector
6. Process Material Perlite
7. Process Wt. 2592 PPH
8. Pollutants Sampled Particulate

9. Time of Particulate Test:

   Date October 25, 1972, Begin 1:52, End 3:02

EMISSION DATA

10. Stack Flow Rate (V_{db}), scfm — 7687
11. Water Vapor in Stack Gas (V_{cg}), % by volume — 1.9

	Grains/cf at stack conditions	grains/scf	lb/hr
12. Particulate - Probe, cyclone	C_{as} = 0.0028	C_{am} = 0.0033	C_{av} = 0.2174
13. Particulate - Probe, cyclone, filter	C_{at} = 0.0028	C_{an} = 0.0033	C_{aw} = 0.2174
14. Total Particulate (Includes impinger catch)	C_{au} = 0.0034	C_{ao} = 0.0039	C_{ax} = 0.2569

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15. Percent isokinetic for particulate train	I_{ax} = 95.8
16. CO_2 in stack gas, % volume dry	V_{bf} = 1.5
17. O_2 in stack gas, % volume dry	V_{bh} = 15.6
18. CO in stack gas, % volume dry	V_{bg} = 1.0
19. N_2 in stack gas, % volume dry	V_{bi} = 81.9

SUMMARY OF TEST DATA
Particulate Sampling Train

1. Sampling nozzle diameter, in.	D_{av} = 0.25
2. Sampling Time, min.	T_{aw} = 64
3. Sampling gas volume - meter condition, cf	V_{ac} = 90.5
4. Average meter temperature, °F	T_{ai} = 78
5. Average orifice pressure drop, in. H_2O	P_{af} = 7.15
6. Particulate collected - probe and cyclone, mg	W_{aj} = 19.3
7. Particulate collected - probe, cyclone and filter, mg	W_{ak} = 19.3
8. Particulate collected - total, mg	W_{al} = 22.9

Velocity Traverse During Test

9. Stack area, $in.^2$	S_{dd} = 254
10. Average stack pressure, in. Hg (absolute)	P_{di} = 30.16
11. Average stack temperatures, °F	T_{df} = 169
12. Average $\sqrt{\text{velocity head x stack temperature}}$	S_{de} = 35.32

Stack Moisture Content

13. Total water collected by train, ml	V_{ce} = 37.5

Legend: NM = not measured
scf - standard cubic foot, i.e. dry gas at 70°F and 29.92 in. Hg
Stack conditions: Stack temperature and stack pressure including moisture.

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PARTICULATE SAMPLING TRAIN DATA AND CALCULATIONS

Nozzle diameter (D_{av}), in. = 0.25

Barometric pressure (P_{aa}), in. Hg = 30.16

Sampling Point location Stack Run No. Preliminary

Clock Time	Point No.	Gas Meter Reading (V_{ac}) cf	Gas Meter Temp. in °F	Gas Meter Temp. out °F	Orifice ΔP in. H_2O
1:52	1A	124.5	56	46	6.80
2:00	2A	135.2	78	50	7.60
2:08	3A	146.7	93	57	8.30
2:16	4A	158.9	102	63	7.10
2:24	stop	170.3			
2:30	1B	170.3	86	66	5.40
2:38	2B	180.2	100	70	6.20
2:46	3B	190.9	106	74	7.90
2:54	4B	202.8	111	77	7.90
3:02	stop	215.0			

Net time min (T_{aw}) = 64 Net (V_{ac}) = 90.5 Average (T_{ad}) = 92 Average (T_{ae}) = 63 Average (P_{af}) = 7.15

(1) A. Average meter temperature = $\frac{T_{ad} + T_{ae}}{2} = T_{ai}$ = 78

(2) B. Dry gas sample volume at standard conditions, cf

$$= 17.7 \times V_{ac} \times \frac{P_{aa} + \frac{P_{af}}{13.6}}{(T_{ai} + 460)} = V_{ab} =$$ 91.4

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Laboratory Data

Particulate - probe and cyclone (W_{aj}), mg = 19.3

Particulate - probe, cyclone and filter (W_{ak}), mg = 19.3

Particulate - total (includes impinger washings) (W_{al}), mg = 22.9

Particulate Concentration Calculations

In grains/scf

(3) A. Particulate - probe and cyclone, grains/scf

$$C_{am} = 0.0154 \times \frac{W_{aj}}{V_{ab}} =$$ 0.0033

(4) B. Particulate - probe, cyclone and filter, grains/scf

$$C_{an} = \frac{0.0154 \times W_{ak}}{V_{ab}} =$$ 0.0033

(5) C. Particulate - total , grains/scf

$$C_{ao} = \frac{0.0154 \times W_{al}}{V_{ab}} =$$ 0.0039

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In grains/cf at stack conditions

(20) G. Particulate - probe and cyclone, grains/cf at stack conditions

$$C_{as} = \frac{17.7 \times C_{am} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0028$$

(21) H. Particulate - probe, cyclone and filter, grains/cf at stack conditions

$$C_{at} = \frac{17.7 \times C_{an} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0028$$

(22) I. Particulate - total, grains/cf at stack conditions

$$C_{au} = \frac{17.7 \times C_{ao} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0034$$

In lb/hr

(23) J. Particulate - probe and cyclone, lb/hr

$$C_{av} = 0.00857 \times C_{am} \times V_{db} = \quad 0.2174$$

(24) K. Particulate - probe, cyclone and filter, lb/hr

$$C_{aw} = 0.00857 \times C_{an} \times V_{db} = \quad 0.2174$$

(25) L. Particulate - total, lb/hr

$$C_{ax} = 0.00857 \times C_{ao} \times V_{db} = \quad 0.2569$$

(26) M. % isokinetic $= \frac{1032 \times (T_{df} + 460) \times V_{ab}}{V_{dh} \times T_{aw} \times P_{di} \times M_{ch} \times (D_{av})^2} = I_{ax} = \quad 95.8$

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VELOCITY DATA AND CALCULATION SHEET FOR TEST

Date October 25, 1972 Time 1:52

Sampling Point Location Perlite Stack Run No. Preliminary

Stack area (S_{dd}), in.^{2} 254

Note: Calculations for S-Type pitot tube, C = 0.85

Point No.	Distance from ref. point, in.	Stack press. (P_{dj}) in. Hg (gage)	Stack Temperature (T_{df}), °F	Stack Temperature (T_{df} + 460), °R	Velocity head (V_b), in. H_2O	$V_b \times (T_{df} + 460)$	$\sqrt{V_b \times (T_{df} +}$
1A	1.21	0	138	598	1.90	1136.2	33.71
2A	4.50	0	151	611	2.15	1313.7	36.24
3A	13.50	0	162	622	2.30	1430.6	37.82
4A	16.79	0	172	632	2.00	1264.0	35.55
1B	1.21	0	180	640	1.50	960.0	30.98
2B	4.50	0	182	642	1.70	1091.4	33.03
3B	13.50	0	184	644	2.20	1416.8	37.64
4B	16.79	0	182	642	2.20	1412.4	37.58
		Avg. = 0	Avg. =169				Avg. (S_{de}) = 35.32

in. Hg abs) =

(P_{di}) = P_{dj} + P_{aa} = 30.16

P_{aa} from particulate sampling train sheet

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(13) A. Stack velocity at P_{di} and T_{df} (stack conditions), fpm

$$= 4350 \times S_{de} \times \left[\frac{1}{P_{di} \times M_{ca}}\right]^{1/2} = V_{dh}$$ 5229

(14) B. Stack volume at standard conditions, scfm

$$= 0.123 \times \frac{V_{dh} \times S_{dd} \times M_{ch} \times P_{di}}{(T_{df} + 460)} = V_{db} =$$ 7687

Orsat Analysis for Test

Date Oct.25,1972 Time 1:52 PM Run No. Preliminary

Sampling Point Location Perlite Stack

	Analysis 1	Analysis 2	Analysis 3	Avg.	mole wt. x =	wt/mol (dry)
CO_2 (V_{bf}) % vol (dry)	1.5	NM	NM	1.5	44/100	0.6
CO (V_{bg}) % vol (dry)	1.0	NM	NM	1.0	28/100	+ 0.2
O_2 (V_{bh}), % vol (dry)	15.6	NM	NM	15.6	32/100	+ 4.9
N_2 (V_{bi}), % vol (dry)	81.9	NM	NM	81.9	28/100	+ 22.9
				M_{bj} = Avg. molecular wt of dry stack gas =		28.8

POUNDS PER HOUR EMISSION CALCULATION

Total particulate collected by train, grams W_{la} = 0.0229

Area of sampling nozzle, in.^{2} W_{lb} = 0.0491

Area of stack, in.^{2} W_{lc} = 254

Time of particulate test, min. W_{ld} = 64

Emissions, lbs/hr

$$= \frac{0.132 \times W_{la} \times W_{lc}}{W_{lb} \times W_{ld}} =$$ C_{ay} = 0.246

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STACK MOISTURE CONTENT DATA AND CALCULATIONS FOR TEST

Date October 25, 1972

Run No.	Preliminary
H_2O condensed in impingers (V_{cb}), ml	18.0
H_2O absorbed by silica gel (V_{cd}), ml	19.5
Total H_2O collected = $V_{ce} = (V_{cb} + V_{cd})$, ml	37.5
Vol. of H_2O vapor at 70 °F and 29.92 in. Hg = 0.0474 x V_{ce} = (V_{cf}), cf	1.78
Moisture in stack gas = (V_{cg}), % (from formula below)	1.9
Mole fraction dry gas, = (M_{ch}) (from formula below)	.981
Molecular weight of stack gas (M_{ca}) (from formula below)	28.65

(6) A. Moisture in stack gas (V_{cg}), %

$$= \frac{100 \times V_{cf}}{V_{ab} + V_{cf}}$$

(7) B. Mole fraction dry gas (M_{ch})

$$= \frac{100 - V_{cg}}{100}$$

(8) C. Molecular wt. of stack gas

$$M_{ca} = M_{bj} \times M_{ch} + 18\ (1 - M_{ch})$$

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LABORATORY WORK SHEET

NATIONAL GYPSUM

RUN: PRELIMINARY

OCTOBER 25, 1972

Container No. 1

0.3678
0.3678
0.0000 g

Container No. 2

92.3516
92.3323
0.0193 g

Container No. 3

97.2244
97.2227
0.0017 g

Container No. 4

231.3
211.8
19.5 g

Container No. 5

93.7352
93.7333
0.0019

Total

Particulate - probe, cyclone	19.3 mg
Particulate - probe, cyclone, filter	19.3 mg
Total Particulate - (includes impinger catch)	22.9 mg

mbient Temp. °F 41

irometric Press. " Hg. 30.16

oisture, % 1.9

obe Heater Setting 250

mpling Probe Dia. In. 0.25

obe Length, Ft. 3

Box Heater Setting 250

PARTICULATE FIELD DATA

Date October 25, 1972

Run No. Preliminary

Location Perlite Stack

Operator Arthur V. Allen
Joseph P. Turski

Equip. Train E.P.A.

Silica Gel - Gross 231.3
Tare 211.8
Net 19.5

H_2O - Impingers

No.1 260 - 250 = 10

No.2 158 - 150 = 8

No.3 0 - 0 = 0

Total 37.5

Point	Clock Time	Dry Gas Meter CF	Pitot in.H_2O ΔP	Orifice ΔH in. H_2O		Dry Gas Temp. °F		Pump Vacuum in. Hg. Gauge	Box Temp. °F	Impinger Temp. °F	Stack Press. in. Hg.	Stack Temp. °F
				desired	actual	T_1 inlet	T_2 outlet					
1A	1:52	124.5	1.90	6.80	6.80	56	46	7.0	250	50	0	138
2A	2:00	135.2	2.15	7.60	7.60	78	50	7.5	250	50	0	151
3A	2:08	146.7	2.30	8.30	8.30	93	57	8.5	250	55	0	162
4A	2:16	138.9	2.00	7.10	7.10	102	63	7.0	250	55	0	172
stop	2:24	170.3										
1B	2:30	170.3	1.50	5.40	5.40	86	66	5.0	250	50	0	180
2B	2:38	180.2	1.70	6.20	6.20	100	70	6.0	250	55	0	182
3B	2:46	190.9	2.20	7.90	7.90	106	74	8.0	250	55	0	184
4B	2:54	202.8	2.20	7.90	7.90	111	77	8.0	250	55	0	182
stop	3:02	215.0										

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SUMMARY OF RESULTS

EMISSION TEST

RUN NO. 1

1. Name of Firm National Gypsum
2. Location of Plant Roll Road, Clarence, New York
3. Type of Unit Perlite Process
4. Control Equipment 10B Sly Multi-Clean Collector
5. Sampling Point Location Stack from Collector
6. Process Material Perlite
7. Process Wt. 2592 PPH
8. Pollutants Sampled Particulate
9. Time of Particulate Test:

   Date October 26, 1972, Begin 10:23 AM, End 11:43 AM

EMISSION DATA

10. Stack Flow Rate (V_{db}), scfm — 7790
11. Water Vapor in Stack Gas (V_{cg}), % by volume — 1.9

	Grains/cf at stack conditions	grains/scf	lb/hr
12. Particulate - Probe, cyclone	C_{as} = 0.0016	C_{am} = 0.0020	C_{av} = 0.1335
13. Particulate - Probe, cyclone, filter	C_{at} = 0.0023	C_{an} = 0.0028	C_{aw} = 0.1869
14. Total Particulate (Includes impinger catch)	C_{au} = 0.0054	C_{ao} = 0.0066	C_{ax} = 0.4406

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15. Percent isokinetic for particulate train	I_{ax} = 96.02
16. CO_2 in stack gas, % volume dry	V_{bf} = 1.5
17. O_2 in stack gas, % volume dry	V_{bh} = 15.6
18. CO in stack gas, % volume dry	V_{bg} = 1.0
19. N_2 in stack gas, % volume dry	V_{bi} = 81.9

SUMMARY OF TEST DATA
Particulate Sampling Train

1. Sampling nozzle diameter, in.	D_{av} = 0.25
2. Sampling Time, min.	T_{aw} = 64
3. Sampling gas volume - meter condition, cf	V_{ac} = 92.3
4. Average meter temperature, °F	T_{ai} = 79
5. Average orifice pressure drop, in. H_2O	P_{af} = 7.50
6. Particulate collected - probe and cyclone, mg	W_{aj} = 12.2
7. Particulate collected - probe, cyclone and filter, mg	W_{ak} = 16.9
8. Particulate collected - total, mg	W_{al} = 39.5

Velocity Traverse During Test

9. Stack area, $in.^2$	S_{dd} = 254
10. Average stack pressure, in. Hg (absolute)	P_{di} = 30.06
11. Average stack temperatures, °F	T_{df} = 181
12. Average $\sqrt{\text{velocity head x stack temperature}}$	S_{de} = 36.57

Stack Moisture Content

13. Total water collected by train, ml	V_{ce} = 38.1

Legend: NM = not measured
scf - standard cubic foot, i.e. dry gas at 70°F and 29.92 in. Hg
Stack conditions: Stack temperature and stack pressure including moisture.

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PARTICULATE SAMPLING TRAIN DATA AND CALCULATIONS

Nozzle diameter (D_{av}), in. = 0.25

Barometric pressure (P_{aa}), in. Hg = 30.06

Sampling Point location Stack Run No. 1

Clock Time	Point No.	Reading (V_{ac}) cf	Gas Meter Temp. in °F	Gas Meter Temp. out °F	Orifice ΔP in. H_2O
10:23	1A	215.4	74	50	5.40
10:31	2A	225.0	78	52	7.70
10:39	3A	236.5	94	59	8.60
10:47	4A	248.9	106	66	8.50
10:55	stop	261.3			
11:11	1B	261.3	77	68	6.20
11:19	2B	271.9	98	70	6.90
11:27	3B	283.1	106	73	8.20
11:35	4B	295.3	110	77	8.50
11:43	stop	307.7			

Net time min | Net | Average | Average | Average

(T_{aw}) = 64 (V_{ac}) = 92.3 (T_{ad}) = 93 (T_{ae}) = 64 (P_{af}) = 7.50

(1) A. Average meter temperature = $\frac{T_{ad} + T_{ae}}{2} = T_{ai}$ = 79

(2) B. Dry gas sample volume at standard conditions, cf

$$= 17.7 \times V_{ac} \times \frac{P_{aa} + \frac{P_{af}}{13.6}}{(T_{ai} + 460)} = V_{ab} =$$ 92.8

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Laboratory Data

Particulate - probe and cyclone (W_{aj}), mg = 12.2

Particulate - probe, cyclone and filter (W_{ak}), mg = 16.9

Particulate - total (includes impinger washings) (W_{al}), mg = 39.5

Particulate Concentration Calculations

In grains/scf

(3) A. Particulate - probe and cyclone, grains/scf

$$C_{am} = 0.0154 \times \frac{W_{aj}}{V_{ab}} =$$ 0.0020

(4) B. Particulate - probe, cyclone and filter, grains/scf

$$C_{an} = \frac{0.0154 \times W_{ak}}{V_{ab}} =$$ 0.0028

(5) C. Particulate - total , grains/scf

$$C_{ao} = \frac{0.0154 \times W_{al}}{V_{ab}} =$$ 0.0066

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In grains/cf at stack conditions

(20) G. Particulate - probe and cyclone, grains/cf at stack conditions

$$C_{as} = \frac{17.7 \times C_{am} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0016$$

(21) H. Particulate - probe, cyclone and filter, grains/cf at stack conditions

$$C_{at} = \frac{17.7 \times C_{an} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0023$$

(22) I. Particulate - total, grains/cf at stack conditions

$$C_{au} = \frac{17.7 \times C_{ao} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0054$$

In lb/hr

(23) J. Particulate - probe and cyclone, lb/hr

$$C_{av} = 0.00857 \times C_{am} \times V_{db} = \quad 0.1335$$

(24) K. Particulate - probe, cyclone and filter, lb/hr

$$C_{aw} = 0.00857 \times C_{an} \times V_{db} = \quad 0.1869$$

(25) L. Particulate - total, lb/hr

$$C_{ax} = 0.00857 \times C_{ao} \times V_{db} = \quad 0.4406$$

(26) M. % isokinetic $= \frac{1032 \times (T_{df} + 460) \times V_{ab}}{V_{dh} \times T_{aw} \times P_{di} \times M_{ch} \times (D_{av})^2} = I_{ax} =$ 96.02

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VELOCITY DATA AND CALCULATION SHEET FOR TEST

Date October 26, 1972 Time 10:23 AM

Sampling Point Location Perlite Stack Run No. 1

Stack area (S_{dd}), in.^{2} 254

Note: Calculations for S-Type pitot tube, C = 0.85

Point No.	Distance from ref. point, in.	Stack press. (P_{dj}) in. Hg (gage)	Stack Temperature (T_{df}), °F	Stack Temperature (T_{df} + 460), °R	Velocity head (V_b), in. H_2O	$V_b \times (T_{df} + 460)$	$\sqrt{V_b \times (T_{df} + 460)}$
1A	1.21	0.0	180	640	1.50	960.0	30.98
2A	4.50	0.0	180	640	2.15	1376.0	37.10
3A	13.50	0.0	181	641	2.45	1570.0	39.63
4A	16.79	0.0	182	642	2.40	1540.8	39.25
1B	1.21	0.0	180	640	1.70	1088.0	32.99
2B	4.50	0.0	180	640	1.90	1216.0	34.87
3B	13.50	0.0	185	645	2.30	1483.5	38.52
4B	16.79	0.0	182	642	2.40	1540.8	39.25
		Avg. = 0.0	Avg. 181				Avg. (S_{de}) = 36.57

in. Hg abs) =

(P_{di}) = P_{dj} + P_{aa} = 30.06

P_{aa} from particulate sampling train sheet

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(13) A. Stack velocity at P_{di} and T_{df} (stack conditions), fpm

$$= 4350 \times S_{de} \times \left[\frac{1}{P_{di} \times M_{ca}}\right]^{1/2} = V_{dh}$$ 5420

(14) B. Stack volume at standard conditions, scfm

$$= 0.123 \times \frac{V_{dh} \times S_{dd} \times M_{ch} \times P_{di}}{(T_{df} + 460)} = V_{db} =$$ 7790

Orsat Analysis for Test

Date Oct. 26,1972 Time 10:23 AM Run No. 1

Sampling Point Location Perlite Stack

	Analysis 1	Analysis 2	Analysis 3	Avg.	mole wt. × =	wt/mol (dry)
CO_2 (V_{bf}) % vol (dry)	1.5	NM	NM	1.5	44/100	0.66
CO (V_{bg}) % vol (dry)	1.0	NM	NM	1.0	28/100	+ 0.28
O_2 (V_{bh}), % vol (dry)	15.6	NM	NM	15.6	32/100	+ 4.99
N_2 (V_{bi}), % vol (dry)	81.9	NM	NM	81.9	28/100	+ 23.93
					M_{bj} = Avg. molecular wt of dry stack gas =	28.86

POUNDS PER HOUR EMISSION CALCULATION

Total particulate collected by train, grams W_{1a} = 0.0395

Area of sampling nozzle, in.^{2} W_{1b} = 0.0491

Area of stack, in.^{2} W_{1c} = 254

Time of particulate test, min. W_{1d} = 64

Emissions, lbs/hr

$$= \frac{0.132 \times W_{1a} \times W_{1c}}{W_{1b} \times W_{1d}} =$$ C_{ay} = 0.421

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STACK MOISTURE CONTENT DATA AND CALCULATIONS FOR TEST

Date October 26, 1972

Run No.	1
H_2O condensed in impingers (V_{cb}), ml	16.0
H_2O absorbed by silica gel (V_{cd}), ml	22.1
Total H_2O collected = $V_{ce} = (V_{cb} + V_{cd})$, ml	38.1
Vol. of H_2O vapor at 70 °F and 29.92 in. Hg = 0.0474 x V_{ce} = (V_{cf}), cf	1.81
Moisture in stack gas = (V_{cg}), % (from formula below)	1.9
Mole fraction dry gas, = (M_{ch}) (from formula below)	0.981
Molecular weight of stack gas (M_{ca}) (from formula below)	28.65

(6) A. Moisture in stack gas (V_{cg}), %

$$= \frac{100 \times V_{cf}}{V_{ab} + V_{cf}}$$

(7) B. Mole fraction dry gas (M_{ch}).

$$= \frac{100 - V_{cg}}{100}$$

(8) C. Molecular wt. of stack gas

$$M_{ca} = M_{bj} \times M_{ch} + 18\ (1 - M_{ch})$$

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Buffalo, N. Y. - 14216

LABORATORY WORK SHEET

NATIONAL GYPSUM

RUN: #1

OCTOBER 26, 1972

Container No. 1

0.3712
0.3665
0.0047 g

Container No. 2

94.9115
94.8993
0.0122 g

Container No. 3

92.8028
92.7958
0.0070 g

Container No. 4

234.5
212.4
22.1 g

Container No. 5

92.2606
92.2450
0.0156

Total

Particulate - probe, cyclone	12.2 mg
Particulate - probe, cyclone, filter	16.9 mg
Total Particulate - (includes impinger ctach)	39.5 mg

ibient Temp. °F 41

rometric Press. " Hg. 30.06

isture, % 1.9

obe Heater Setting 250

mpling Probe Dia. In. .25

obe Length, Ft. 3

Box Heater Setting 250

PARTICULATE FIELD DATA

Date October 26, 1972

Run No. 1

Location Perlite Stack
Arthur V. Allen

Operator Joseph P. Turski

Equip. Train E.P.A.

Silica Gel - Gross 234.5
Tare 212.4
Net 22.1

H_2O - Impingers

No.1 257 -250 = 7

No.2 159 -150 = 9

No.3 0 - 0 = 0

Total 38.1

int	Clock Time	Dry Gas Meter CF	Pitot in.H_2O ΔP	Orifice ΔH in. H_2O		Dry Gas Temp. °F		Pump Vacuum in. Hg. Gauge	Box Temp. °F	Impinger Temp. °F	Stack Press. in. Hg.	Stack Temp. °F
				desired	actual	T_1 inlet	T_2 outlet					
A	10:23	215.4	1.50	5.40	5.40	74	50	5.0	250	50	0	180
A	10:31	225.0	2.15	7.70	7.70	78	52	8.0	250	50	0	180
A	10:39	236.5	2.45	8.60	8.60	94	59	9.5	250	55	0	181
A	10:47	248.9	2.40	8.50	8.50	106	66	9.0	250	55	0	182
top	10:55	261.3										
B	11:11	261.3	1.70	6.20	6.20	77	68	6.0	250	50	0	180
B	11:19	271.9	1.90	6.90	6.90	98	70	7.0	250	50	0	180
B	11:27	283.1	2.30	8.20	8.20	106	73	8.0	250	50	0	185
B	11:35	295.3	2.40	8.50	8.50	110	77	9.0	250	55	0	182
top	11:43	307.7										

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SUMMARY OF RESULTS

EMISSION TEST

RUN NO. 2

1. Name of Firm National Gypsum
2. Location of Plant Roll Road, Clarence, New York
3. Type of Unit Perlite Stack
4. Control Equipment 10B Sly Multi-Clean Collector
5. Sampling Point Location Stack from Collector
6. Process Material Perlite
7. Process Wt. 2592 PPH
8. Pollutants Sampled Particulate

9. Time of Particulate Test:

Date October 26, 1972, Begin 1:35PM, End 2:51 PM

EMISSION DATA

10. Stack Flow Rate (V_{db}), scfm — 7377
11. Water Vapor in Stack Gas (V_{cg}), % by volume — 2.1

	Grains/cf at stack conditions	grains/scf	lb/hr
12. Particulate - Probe, cyclone	C_{as} = 0.0029	C_{am} = 0.0036	C_{av} = 0.2276
13. Particulate - Probe, cyclone, filter	C_{at} = 0.0036	C_{an} = 0.0045	C_{aw} = 0.2845
14. Total Particulate (Includes impinger catch)	C_{au} = 0.0046	C_{ao} = 0.0057	C_{ax} = 0.3604

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15.	Percent isokinetic for particulate train	I_{ax} = 96.70
16.	CO_2 in stack gas, % volume dry	V_{bf} = 1.5
17.	O_2 in stack gas, % volume dry	V_{bh} = 15.6
18.	CO in stack gas, % volume dry	V_{bg} = 1.0
19.	N_2 in stack gas, % volume dry	V_{bi} = 81.9

SUMMARY OF TEST DATA
Particulate Sampling Train

1.	Sampling nozzle diameter, in.	D_{av} = 0.25
2.	Sampling Time, min.	T_{aw} = 64
3.	Sampling gas volume - meter condition, cf	V_{ac} = 90.0
4.	Average meter temperature, °F	T_{ai} = 88
5.	Average orifice pressure drop, in. H_2O	P_{af} = 6.86
6.	Particulate collected - probe and cyclone, mg	W_{aj} = 21.0
7.	Particulate collected - probe, cyclone and filter, mg	W_{ak} = 25.7
8.	Particulate collected - total, mg	W_{al} = 33.0

Velocity Traverse During Test

9.	Stack area, $in.^2$	S_{dd} = 254
10.	Average stack pressure, in. Hg (absolute)	P_{di} = 30.06
11.	Average stack temperatures, °F	T_{df} = 185
12.	Average $\sqrt{\text{velocity head x stack temperature}}$	S_{de} = 34.90

Stack Moisture Content

13.	Total water collected by train, ml	V_{ce} = 39.8

Legend: NM = not measured
scf - standard cubic foot, i.e. dry gas at 70°F and 29.92 in. Hg
Stack conditions: Stack temperature and stack pressure including moisture.

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PARTICULATE SAMPLING TRAIN DATA AND CALCULATIONS

Nozzle diameter (D_{av}), in. = 0.25

Barometric pressure (P_{aa}), in. Hg = 30.06

Sampling Point location Stack Run No. 2

Clock Time	Point No.	Gas Meter Reading (V_{ac}) cf	Gas Meter Temp. in °F	Gas Meter Temp. out °F	Orifice ΔP in. H_2O
1:35	1B	307.8	64	63	5.20
1:43	2B	317.5	89	65	6.30
1:51	3B	328.2	103	70	7.90
1:59	4B	340.1	111	75	8.10
2:07	stop	352.2			
2:19	1A	352.2	90	77	4.70
2:27	2A	362.4	106	80	6.90
2:35	3A	373.6	114	82	7.90
2:43	4A	385.7	119	87	7.90
2:51	stop	397.8			

Net time min | Net | Average | Average | Average

(T_{aw}) = 64 (V_{ac}) = 90.0 (T_{ad}) = 100 (T_{ae}) = 75 (P_{af}) = 6.86

(1) A. Average meter temperature = $\frac{T_{ad} + T_{ae}}{2} = T_{ai}$ = 88

(2) B. Dry gas sample volume at standard conditions, cf

$$= 17.7 \times V_{ac} \times \frac{P_{aa} + \frac{P_{af}}{13.6}}{(T_{ai} + 460)} = V_{ab} =$$ 88.8

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Laboratory Data

Particulate - probe and cyclone (W_{aj}), mg = 21.0

Particulate - probe, cyclone and filter (W_{ak}), mg = 25.7

Particulate - total (includes impinger washings) (W_{al}), mg = 33.0

Particulate Concentration Calculations

In grains/scf

(3) A. Particulate - probe and cyclone, grains/scf

$$C_{am} = 0.0154 \times \frac{W_{aj}}{V_{ab}} =$$ 0.0036

(4) B. Particulate - probe, cyclone and filter, grains/scf

$$C_{an} = \frac{0.0154 \times W_{ak}}{V_{ab}} =$$ 0.0045

(5) C. Particulate - total , grains/scf

$$C_{ao} = \frac{0.0154 \times W_{al}}{V_{ab}} =$$ 0.0057

In grains/cf at stack conditions

(20) G. Particulate - probe and cyclone, grains/cf at stack conditions

$$C_{as} = \frac{17.7 \times C_{am} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0029$$

(21) H. Particulate - probe, cyclone and filter, grains/cf at stack conditions

$$C_{at} = \frac{17.7 \times C_{an} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0036$$

(22) I. Particulate - total, grains/cf at stack conditions

$$C_{au} = \frac{17.7 \times C_{ao} \times P_{di} \times Mch}{(T_{df} + 460)} = \quad 0.0046$$

In lb/hr

(23) J. Particulate - probe and cyclone, lb/hr

$$C_{av} = 0.00857 \times C_{am} \times V_{db} = \quad 0.2276$$

(24) K. Particulate - probe, cyclone and filter, lb/hr

$$C_{aw} = 0.00857 \times C_{an} \times V_{db} = \quad 0.2845$$

(25) L. Particulate - total, lb/hr

$$C_{ax} = 0.00857 \times C_{ao} \times V_{db} = \quad 0.3604$$

(26) M. % isokinetic $= \frac{1032 \times (T_{df} + 460) \times V_{ab} = I_{ax}}{V_{dh} \times T_{aw} \times P_{di} \times M_{ch} \times (D_{av})^2} = \quad 96.70$

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VELOCITY DATA AND CALCULATION SHEET FOR TEST

Date October 26, 1972 Time 1:35 PM

Sampling Point Location Perlite Stack Run No. 2

Stack area (S_{dd}), in.^{2} 254

Note: Calculations for S-Type pitot tube, C = 0.85

Point No.	Distance from ref. point, in.	Stack press. (P_{dj}) in. Hg (gage)	Stack Temperature (T_{df}), °F	Stack Temperature (T_{df} + 460), °R	Velocity head (V_b), in. H_2O	$V_b \times (T_{df} + 460)$	$\sqrt{V_b \times (T_{df} + 460)}$
1B	1.21	0.0	184	644	1.45	933.8	30.56
2B	4.50	0.0	183	643	1.75	1125.3	33.55
3B	13.50	0.0	185	645	2.20	1419.0	37.67
4B	16.79	0.0	183	643	2.25	1446.8	38.01
1A	1.21	0.0	189	649	1.30	843.7	29.05
2A	4.50	0.0	187	647	1.90	1229.3	35.06
3A	13.50	0.0	184	644	2.20	1416.8	37.64
4A	16.79	0.0	185	645	2.20	1419.0	37.67
		Avg. = 0.0	Avg. = 185				Avg. (S_{de}) = 34.00

in. Hg abs) =

(P_{di}) = P_{dj} + P_{aa} = 30.06

P_{aa} from particulate sampling train sheet

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(13) A. Stack velocity at P_{di} and T_{df} (stack conditions), fpm

$$= 4350 \times S_{de} \times \left[\frac{1}{P_{di} \times M_{ca}}\right]^{1/2} = V_{dh} \qquad 5175$$

(14) B. Stack volume at standard conditions, scfm

$$= 0.123 \times \frac{V_{dh} \times S_{dd} \times M_{ch} \times P_{di}}{(T_{df} + 460)} = V_{db} = \qquad 7377$$

Crsat Analysis for Test

Date Oct. 26, 1972 Time 1:35 PM Run No. 2

Sampling Point Location Perlite Stack

	Analysis 1	Analysis 2	Analysis 3	Avg.	mole wt. × =	wt/mol (dry)
CO_2 (V_{bf}) % vol (dry)	1.5	NM	NM	1.5	44/100	0.66
CO (V_{bg}) % vol (dry)	1.0	NM	NM	1.0	28/100	+ 0.28
O_2 (V_{bh}), % vol (dry)	15.6	NM	NM	15.6	32/100	+ 4.99
N_2 (V_{bi}), % vol (dry)	81.9	NM	NM	81.9	28/100	+ 22.93
					M_{bj} = Avg. molecular wt of dry stack gas =	28.86

POUNDS PER HOUR EMISSION CALCULATION

Total particulate collected by train, grams $W_{1a} =$ 0.0330

Area of sampling nozzle, $in.^2$ $W_{1b} =$ 0.0491

Area of stack, $in.^2$ $W_{1c} =$ 254

Time of particulate test, min. $W_{1d} =$ 64

Emissions, lbs/hr

$$= \frac{0.132 \times W_{1a} \times W_{1c}}{W_{1b} \times W_{1d}} = \qquad C_{ay} = 0.352$$

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STACK MOISTURE CONTENT DATA AND CALCULATIONS FOR TEST

Date October 26, 1972

Run No.	2
H_2O condensed in impingers (V_{cb}), ml	16.0
H_2O absorbed by silica gel (V_{cd}), ml	23.8
Total H_2O collected = $V_{ce} = (V_{cb} + V_{cd})$, ml	39.8
Vol. of H_2O vapor at 70 °F and 29.92 in. Hg = 0.0474 x V_{ce} = (V_{cf}), cf	1.89
Moisture in stack gas = (V_{cg}), % (from formula below)	2.1
Mole fraction dry gas, = (M_{ch}) (from formula below)	0.979
Molecular weight of stack gas (M_{ca}) (from formula below)	28.63

(6) A. Moisture in stack gas (V_{cg}), %

$$= \frac{100 \times V_{cf}}{V_{ab} + V_{cf}}$$

(7) B. Mole fraction dry gas (M_{ch})

$$= \frac{100 - V_{cg}}{100}$$

(8) C. Molecular wt. of stack gas

$$M_{ca} = M_{bj} \times M_{ch} + 18\ (1 - M_{ch})$$

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LABORATORY WORK SHEET

NATIONAL GYPSUM

RUN: #2

OCTOBER 26, 1972

Container No. 1

0.4146
0.4099
0.0047 g

Container No. 2

95.4029
95.3819
0.0210 g

Container No. 3

95.4681
95.4656
0.0025 g

Container No. 4

235.1
211.3
23.8 g

Container No. 5

93.9336
93.9288
0.0048

Total

Particulate - probe, cyclone	21.0 mg
Particulate - probe, cyclone, filter	25.7 mg
Total Particulate - (includes impinger catch)	33.0 mg

Ambient Temp. °F 46

Barometric Press. " Hg. 30.06

Moisture, % 2.1

Probe Heater Setting 250

Sampling Probe Dia. In. 0.25

Probe Length, Ft. 3

Box Heater Setting 250

PARTICULATE FIELD DATA

Date October 26, 1972

Run No. 2

Location Perlite Stack

Operator Arthur V. Allen
Joseph P. Turski

Equip. Train E.P.A.

Silica Gel - Gross 235.1
Tare 211.3
Net 23.8

H_2O - Impingers

No.1 260 -250 = 10

No.2 156 -150 = 6

No.3 0 - 0 = 0

Total 39.8

Point	Clock Time	Dry Gas Meter CF	Pitot in.H_2O ΔP	Orifice ΔH in. H_2O		Dry Gas Temp. °F		Pump Vacuum in. Hg. Gauge	Box Temp. °F	Impinger Temp. °F	Stack Press. in. Hg.	Sta Tem °F
				desired	actual	T_1 inlet	T_2 outlet					
1B	1:35	307.8	1.45	5.20	5.20	64	63	5.0	250	54	0	184
2B	1:43	317.5	1.75	6.30	6.30	89	65	7.0	250	55	0	183
3B	1:51	328.2	2.20	7.90	7.90	103	70	8.5	250	58	0	185
4B	1:59	340.1	2.25	8.10	8.10	111	75	9.0	250	62	0	183
stop	2:07	352.2										
1A	2:19	352.2	1.30	4.70	4.70	90	77	5.0	250	50	0	189
2A	2:27	362.4	1.90	6.90	6.90	106	80	7.0	250	60	0	187
3A	2:35	373.6	2.20	7.90	7.90	114	82	8.0	250	60	0	184
4A	2:43	385.7	2.20	7.90	7.90	119	87	8.5	250	60	0	185
stop	2:51	397.8										

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PROCESS RATES

The theoretical capacity of the Perlite Process is listed as 90 bags per hour. In actual operation, production does not exceed 80 bags per hour. The process weight is calculated as follows:

80 bags/hr. x 4 cuft/bag x 8.1 lbs./cuft = 2600 PPH

On the days of the test the production rate was 2592 PPH.