

December 18, 1964

Mr. Andre A. Sicile  
The National Lead Company  
General Engineering Department  
111 Broadway  
New York, New York 10006

Dear Mr. Sicile:

Enclosed are three signed copies of the final report, describing the results of the survey conducted at the Mullite plant on October 21 and 22, 1964, in South Shore, Kentucky. In accordance with instructions received by Mr. Schafer, a copy has been forwarded to Mr. Hall in South Shore, Kentucky, and a copy forwarded to Mr. Neumann in Louisville, Kentucky.

We enjoyed doing this survey, and trust that the data collected will serve your needs.

A statement covering the cost of conducting the survey, analyzing the samples, and writing the report is also enclosed.

Sincerely yours,

J. Cholak  
Director, Division of  
Industrial Hygiene Technology

JC:egm

Enclosures

cc: Mr. C. Hall  
Mr. W. Neumann  
Dr. Robert A. Kohes  
Mr. L. J. Schafer

Client: Charles Taylor Company, South Shore, Kentucky

Dates and Purpose of Visits: September 29, 1964, for initial inspection of plant, by Mr. J. Chelak and Mr. L. J. Schafer.

October 21 and 22, 1964, by Messrs. L. J. Schafer and D. Yeager, to collect samples from the stack in order to determine the amount of particulate matter being emitted to the atmosphere.

Contacts: Mr. Andre A. Sicile, General Engineering Department, National Lead Company, New York, New York; Mr. C. Hall, Plant Superintendent, Charles Taylor Company, South Shore, Kentucky

### The Plant and Process

The plant produces mullite ( $3\text{Al}_2\text{O}_3 \cdot 2\text{SiO}_2$ ), a refractory material, from Alabama bauxite.

Bauxite, after treatment in "rollers" to produce flakes, passes, on a moving grate, through three preheating sections and then, through a large kiln, maintained at temperatures between  $2800^\circ\text{F}$  and  $3000^\circ\text{F}$ , in which the mullite is produced. The finished product drops upon a conveyor, whereby it is moved to a storage shed. Dust, gases and steam are produced in the kiln and are discharged to the outside through a stack 55 feet in height. The effluent from the preheater section passes through a tubular dust collector before being discharged to the outside through the same 55-foot high stack. The production, rated at 60 to 75 tons of mullite per day, is affected in a new installation, which has been in continuous operation since August 10, 1964.

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## Sampling and Analysis

Samples of dust were collected from the stack at a point approximately two feet below its top. The procedures followed the recommendations of the A.C.M.E., as published in Transactions of the A.S.M.E., page 327, October, 1934. A metered quantity of the effluent mixture was drawn through a series of Greenburg-Smith impingers, using water as the collecting medium, and then through a paper thimble. The samples were returned to the Kettering Laboratory, where the total quantity of particulate matter emitted to the atmosphere was determined by calculation from the amounts of particulate matter retained in the impingers and the paper thimble. Samples of particulate matter were also removed from the effluent in the short duct between the third "preheat" section and the "dust collector." These samples were collected in an attempt to determine the efficiency of the collector.

## Results

Tables 1 and 2 give the total quantities of particulate matter and of water emitted to the atmosphere during the period in which the plant was operating "normally," and when it was operating under "unbalanced" conditions. Table 3 gives the concentrations of particulate matter and water in the gas at the inlet to the dust collector. In all of the tables, the quantities of particulate matter emitted are expressed as tons per 24 hours, pounds per hour, pounds per 1000 pounds of gas, and grains per standard cubic foot of flue gas.

## Discussion

The quantitative data obtained during this survey are difficult to relate to existing codes, which have been promulgated mainly for the control of fly-ash or smoke from combustion processes. Maximum permissible levels of the concentration of particulate matter in these codes are generally corrected to a standard concentration of carbon dioxide, usually 12 per cent, when the volume of the incoming air is considered increased 50 per cent above that required for complete combustion. Permissible levels of concentration of dust in stack effluents, established in relation to combustion or for other purposes, have been expressed in various ways. The most widely used limits and expressions are:

1. 0.4 grain per cubic foot of gas under standard conditions;
2. 0.85 pound of particulate matter per 1000 pounds of gas; or
3. in pounds per hour. In Los Angeles the permissible quantities follow a sliding scale related to production, the maximum permissible rate being 40 pounds per hour for each operation in which 60,000 pounds or more of material are processed per hour.

The rates of emission described in this report relate only to the conditions of production which existed during this survey, and do not portray the effects of other conditions or different rates of production. The average quantity of water exhausted through the stack during normal, or "balanced," operating conditions, assuming that the relative

humidity of the inlet air was 50 per cent, was found to amount to 72 tons per day. The average decreased to 21.8 tons per day, when the plant was being operated under "unbalanced" conditions, i.e., when the doors of the "preheat" section were left open.

An average quantity of 0.96 ton of particulate matter per day was found to be flowing from the stack when the plant was operating under "balanced" conditions. Under "unbalanced" conditions, 0.63 ton of dust was being emitted per day into the atmosphere. The total amount of particulate matter, as calculated from the quantities in the samples collected at the inlet of the collector, appeared to be less than the amount emitted from the stack. This is probably due to turbulence in the very short inlet duct to the collector, which made it practically impossible to obtain the large number of samples required to portray the average rate of flow of the mixture of gas and particulate matter across the area of the 32-inch by 72-inch inlet duct. The velocities of the air in the stack, at the level of 2 feet from the top, were uniform over the entire cross section of the stack. Samples collected isokinetically from the stack, at this point, when averaged, yielded a total quantity of particulate matter which can be considered to be representative of the amounts emitted to the atmosphere when the plant was operated either in "balance" or "unbalance."

The quantities of particulate matter emitted on the days of this survey exceeded those permitted in most

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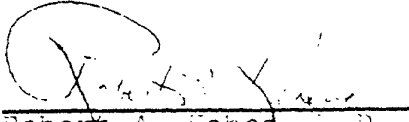
codes, regardless of the manner of their expression. When expressed as pounds per 1000 pounds of gases, the emission was 15 per cent greater than the permissible value, and when expressed as grains per standard cubic foot, the emission was 38 per cent in excess of the suggested limit. The amount of dust emitted per hour was twice the amount permitted in Los Angeles in dealing with ten times the production involved in this instance.

Apparently, the dust collector is inefficient, since our data show only slight differences between the quantity of dust which enters the collector and that which passes through the stack.

From the Kettering Laboratory in the Department of Preventive Medicine and Industrial Health, College of Medicine, University of Cincinnati, Cincinnati, Ohio

Work and Report by:

J. Cholak, Ch.E.  
L. J. Schafer, B.S.E.(Ch.E.)  
D. Yeager, B.S.

Approved: 

Robert A. Kehoe, M.D.,  
Director

Date: December 17, 1944

VE 02013

Table 1

The quantities of particulate matter and of water emitted to the atmosphere from the stack of the sulfate plant, when the plant was being operated under "normal" or "abnormal" conditions

| Location of Sample                | Date and Time of Sampling    | Volume of the Stack Gases cfm | Temperature of the Gases °F | Tons of Water Emitted Per Day | Particulate Matter Emitted |                 |                               |                  |
|-----------------------------------|------------------------------|-------------------------------|-----------------------------|-------------------------------|----------------------------|-----------------|-------------------------------|------------------|
|                                   |                              |                               |                             |                               | Tons Per Day               | Pounds Per Hour | Pounds per 1000 Pounds of Gas | Specific Gravity |
| 24" from opening in wall of stack | 10-21-64<br>11:30-11:50 a.m. | 24,000                        | 225                         | 20.0                          | 1.05                       | 87.0            | 1.04                          | 0.56             |
| 12" west of center of stack       | 4:00-4:15 p.m.               | 24,000                        | 225                         | 78.0                          | 1.06                       | 88.2            | 1.05                          | 0.59             |
| 12" east of center of stack       | 4:20-4:35 p.m.               | 24,000                        | 225                         | 144.0                         | 0.96                       | 80.5            | 0.96                          | 0.54             |
| 41" from opening in wall of stack | 10-22-64<br>11:05-11:35 a.m. | 24,000                        | 225                         | 54.5                          | 0.86                       | 72.0            | 0.91                          | 0.51             |
| 14" from opening in wall of stack | 11:50 a.m.-12:20 p.m.        | 24,000                        | 225                         | 63.5                          | 0.88                       | 74.0            | 0.93                          | 0.52             |
| Average                           |                              | 24,000                        | 225                         | 72.0                          | 0.96                       | 80.3            | 0.96                          | 0.55             |

Temperatures measured while still in the plant before release in stack.

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Table 2

The Quantities of Particulate Matter and of Water Emitted to the Atmosphere from the Stack of the Pulverizing Mill when the Plant Was Kept Operated Under "unbalanced" Conditions

| Location of Sample                | Date and Time of Sampling      | Volume of the Stack Gases cfm | Temperature of the Gases °F | Tons of Water Emitted Per Day | Particulate Matter Emitted |                               |                     |
|-----------------------------------|--------------------------------|-------------------------------|-----------------------------|-------------------------------|----------------------------|-------------------------------|---------------------|
|                                   |                                |                               |                             |                               | Tons Per Day               | Pounds Per 1000 Pounds of Gas | Pounds per 1000 cfm |
| 46" from opening in wall of stack | 10-21-64<br>1:15-<br>1:30 p.m. | 24,000                        | 225                         | 9.1                           | 0.55                       | 45.5                          | 0.54                |
| 41" from opening in wall of stack | 1:40-<br>2:15 p.m.             | 24,000                        | 225                         | 13.8                          | 0.55                       | 45.8                          | 0.53                |
| 34" from opening in wall of stack | 2:20-<br>2:40 p.m.             | 24,000                        | 225                         | 44.3                          | 0.81                       | 66.0                          | 0.76                |
| 14" from opening in wall of stack | 2:45-<br>3:10 p.m.             | 24,000                        | 225                         | 36.8                          | 0.60                       | 49.5                          | 0.59                |
| 7" from opening in wall of stack  | 2:20-<br>3:35 p.m.             | 24,000                        | 225                         | 15.5                          | 0.65                       | 54.0                          | 0.67                |
| 2" from opening in wall of stack  | 3:40-<br>3:55 p.m.             | 24,000                        | 225                         | 17.5                          | 0.64                       | 53.5                          | 0.71                |
| Average                           |                                | 24,000                        | 225                         | 21.6                          | 0.63                       | 52.4                          | 0.63                |

\* Temperatures measured while the plant was operating in stack.

Table 2

The Quantities of Particulate Matter and of Water Entering the  
"Collector" of the Illite Kiln

| Location of Sample         | Date and Time of Sampling | Volume of the Stack Gases cfm | Temperature of the Gases °F | Tons of Water Emitted Per Day | Particulate Matter Emitted |                 |                               |                     |
|----------------------------|---------------------------|-------------------------------|-----------------------------|-------------------------------|----------------------------|-----------------|-------------------------------|---------------------|
|                            |                           |                               |                             |                               | Tons Per Day               | Pounds per Hour | Pounds Per 1000 Pounds of Gas | Grains per Std. Cu. |
| Center of duct             | 10-22-64                  |                               |                             |                               |                            |                 |                               |                     |
|                            | 9:32-9:52 a.m.            | 41,000                        | 250                         | 62                            | 1.08                       | 90.0            | 0.65                          | 0.37                |
| 26" west of center of duct | 10:02-                    |                               |                             |                               |                            |                 |                               |                     |
|                            | 10:17 a.m.                | 21,500                        | 220                         | 53                            | 0.65                       | 54.0            | 0.72                          | 0.40                |
| 26" east of center of duct | 10:25-                    |                               |                             |                               |                            |                 |                               |                     |
|                            | 10:40 a.m.                | 21,500                        | 210                         | 59                            | 0.78                       | 65.0            | 0.87                          | 0.49                |
| Average                    |                           | 28,000                        | 227                         | 58                            | 0.84                       | 69.7            | 0.75                          | 0.42                |

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