

Date: April 6, 1993

Subject: Background Information for Proposed AP-42 Section 11.22 (Formerly 8.29), Diatomite Processing Review and Update Remaining Sections of Chapter 8 (Mineral Products Industry) of AP-42 EPA Contract 68-D2-0159, Work Assignment 012 MRI Project 3612

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## I. INTRODUCTION

This memorandum presents the background information that was used to develop the proposed AP-42 Section 8.29 on diatomite processing. A description of the industry is presented first. A process description followed by a discussion of emissions and controls are then presented. Finally, the reference list is provided. The draft AP-42 section is provided as the attachment.

## II. INDUSTRY DESCRIPTION<sup>1-3</sup>

Diatomite is a chalky, sedimentary rock consisting mainly of an accumulation of skeletons formed by diatoms, which are single-celled microscopic aquatic plants. The skeletons are essentially amorphous hydrated or opaline silica but occasionally include some alumina. The Standard Industrial Classification (SIC) code for diatomite mining is 1499 (miscellaneous nonmetallic minerals, except fuels), and the SIC code for diatomite processing is 3295 (minerals and earths, ground or otherwise treated). The six-digit Source Classification Code (SCC) for diatomite processing is 3-05-026.

The unique physical properties of diatomite derive from the size, shape, and structure of individual diatom skeletons and the packing characteristics of a mass of the particles. Diatoms range in diameter from about 10 micrometers ( $\mu\text{m}$ ) ( $4 \times 10^{-4}$  inch [in.]) to over 500  $\mu\text{m}$  (0.02 in.) and generally have a spiny structure with intricately pitted surfaces. Contact between particles is chiefly at the outer points of the irregular surfaces. Ground diatomite is a microscopically porous material with an apparent density of 80 to 255 kilograms per cubic meter ( $\text{kg}/\text{m}^3$ ) (5 to 16 pounds per cubic foot [ $\text{lb}/\text{ft}^3$ ]), giving this material exceptional filtering and thermal characteristics.

Diatomite products are separated into various grades based on different performance characteristics determined by empirical tests. Processed diatomite powders are classified into three general types based on production methods. These types are (1) natural, which is produced by simple milling, drying, and air classification, (2) calcined, or pink, which results from further heat treatment of the natural, and (3) flux-calcined, or white, which is from a similar heat treatment of the natural

with the addition of a fusible alkali salt. These process designations do not translate directly into the market classifications. The major processed diatomite products are powders and aggregates of various sizes and grades. Diatomite products are used primarily as filter aids and filters.

Because calcined diatomite has a number of unique physical properties, it has diversified uses. The widest domestic use for diatomite (72 percent in 1991) is as a filter aid for separating suspended solids from fluids. The greatest growth potential for diatomite use is in this area of application because of increased emphasis on water purification and the removal of objectionable impurities in manufactured products and reusable process fluids. Diatomite is processed into filter aids for all types of food and nonfood processing applications. The more commonly known applications are in the filtration of dry cleaning solvents; pharmaceuticals; beer, whisky, and wine; raw sugar liquors; antibiotics; industrial, municipal, and swimming pool waters; fruit and vegetable juices; lube, rolling mill, and cutting oils; jet fuels; organic and inorganic chemicals; and varnishes and lacquers.

The second largest use of diatomite is as a filler or extender for paint, paper, asphalt products, and plastic. Fillers accounted for 14 percent of diatomite production in 1991. Other uses of diatomite include abrasives, absorbents, catalysts, fertilizer coatings, insulation, and lightweight aggregates, which collectively consumed 14 percent of U.S. production in 1991.

All domestic diatomite production comes from California, Nevada, Oregon, and Washington, with California accounting for more than half of the total national production. Total domestic production of diatomite in 1991 was 610,000 megagrams (Mg) (671,000 tons).

### III. PROCESS DESCRIPTION<sup>1,3</sup>

Most diatomite deposits are found at or near the surface and can be mined by open pit methods or quarrying. Diatomite mining in the United States is all open pit, normally using some combination of bulldozers, scraper-carriers, power shovels, and trucks to remove overburden and the crude material. In most cases, fragmentation by drilling and blasting is not necessary. The crude diatomite is loaded on trucks and transported to the mill or to stockpiles. Figure 1 shows a typical process flow diagram for diatomite processing.

The processing of uncalcined or natural-grade diatomite consists of crushing and drying. Crude diatomite commonly contains as much as 40 percent moisture, and in many cases contains over 60 percent. Primary crushing to aggregate size (normally done by a hammermill) is followed by simultaneous milling-drying, with suspended particles of diatomites being carried in a stream of hot gases. Flash and rotary dryers are used to dry the material to approximately 15 percent moisture. Typical flash dryer operating temperatures range from 70° to 430°C (150° to 800°F). The suspended particles exiting the dryer pass through a series of fans, cyclones, and separators to a baghouse. These sequential operations separate the powder into various sizes, remove waste impurities, and expel the absorbed water. These natural milled diatomite products are then bagged or handled in bulk without additional processing and are used principally for fillers and uses other than filter aids.

For filtration uses, natural grade diatomite is calcined by heat treatment in gas- or fuel oil-fired rotary calciners, with or without a fluxing agent. Typical calciner operating temperatures range from 650° to 1200°C (1200° to 2200°F). For straight-calcined grades, the powder is heated to the point of incipient fusion in large rotary calciners, and thus, in the strict technical sense, the process is one of sintering rather than calcining. The material exiting the kiln then is further milled and classified. Straight calcining is used for adjusting the particle size distribution for filter aid applications in which

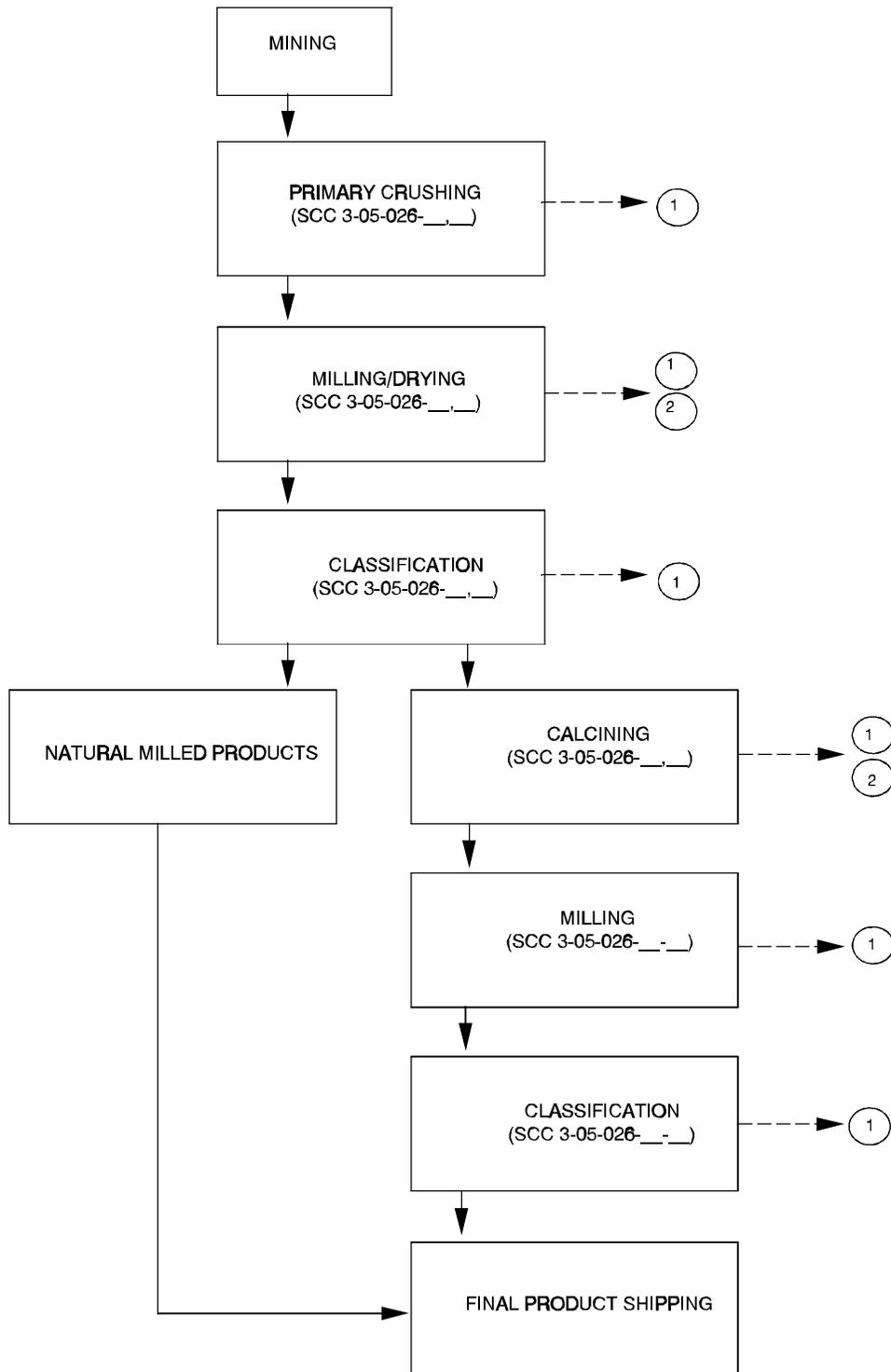


Figure 1. Typical process flow diagram for diatomite processing.

medium flow rates are required. The product of straight calcining has a pink color, which is caused by the oxidation of iron in the raw material and becomes more intense with increasing iron oxide content.

Further particle size adjustment is brought about by the addition of a flux, usually soda ash, before the calcining step. The addition of fluxing agent sinters the diatomite particles and increases the particle size, thereby allowing increased flow rate during liquid filtration. The resulting products are called "flux-calcined." Flux-calcining produces a white product that is believed to be formed by the conversion of iron to complex sodium-aluminum-iron silicates rather than to the oxide. Further milling and classifying follow calcining.

#### IV. EMISSIONS AND CONTROLS<sup>1,3</sup>

Although no data on emissions from diatomite processing were available for the preparation of this memorandum, assumptions concerning diatomite emissions can be made based on the raw material and types of processes used in the industry. The primary pollutant of concern in diatomite processing is particulate matter (PM) and PM less than 10  $\mu\text{m}$  (PM-10). Particulate matter is emitted from crushing, drying, calcining, classifying, and materials handling and transfer operations. Emissions from dryers and calciners include products of combustion, such as carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and sulfur oxides (SO<sub>x</sub>), in addition to filterable and condensable PM. Table 1 summarizes the results of a trace element analysis for one type of finished diatomite. These elements may constitute a portion of the PM emitted by the sources listed above.

Wet scrubbers and fabric filters are the most commonly used devices to control emissions from diatomite dryers and calciners. No information is available on the type of emission controls used on crushing, classifying, and materials handling and transfer operations.

TABLE 1. TRACE ELEMENT CONTENT OF FINISHED DIATOMITE<sup>3</sup>

| Element <sup>a</sup> | ppm <sup>b</sup> | Element      | ppm  |
|----------------------|------------------|--------------|------|
| Antimony*            | 2                | Mercury*     | 0.3  |
| Arsenic*             | 5                | Molybdenum   | 5    |
| Barium               | 30               | Neodymium    | 20   |
| Beryllium*           | 1                | Nickel*      | 120  |
| Bismuth              | <0.5             | Niobium      | 5    |
| Boron                | 100              | Osmium       | <0.5 |
| Bromine              | 20               | Palladium    | <1   |
| Cadmium*             | 2                | Platinum     | <2   |
| Cerium               | 10               | Praseodymium | 2    |
| Cesium               | 5                | Rhenium      | <0.5 |
| Chlorine             | 400              | Rhodium      | <0.5 |
| Chromium*            | 100              | Rubidium     | 10   |
| Cobalt*              | 5                | Ruthenium    | <1   |
| Copper               | 40               | Samarium     | 2    |
| Dysprosium           | <1               | Scandium     | 20   |
| Erbium               | <0.5             | Selenium*    | 10   |
| Europium             | 1                | Silver       | <0.5 |
| Fluorine             | 50               | Strontium    | 20   |
| Gadolinium           | <1               | Tantalum     | 20   |
| Gallium              | 5                | Tellurium    | <2   |
| Germanium            | <10              | Terbium      | <0.2 |
| Gold                 | <0.5             | Thallium     | <0.5 |
| Hafnium              | <0.5             | Thorium      | 5    |
| Holmium              | <0.2             | Thulium      | 0.2  |
| Indium               | <0.5             | Tin          | <1   |
| Iodine               | 1                | Tungsten     | <0.5 |
| Iridium              | <0.5             | Uranium      | 5    |
| Lanthanum            | 10               | Vanadium     | 200  |
| Lead*                | 2                | Ytterbium    | <0.5 |
| Lithium              | 1                | Yttrium      | 100  |
| Lutetium             | <0.2             | Zinc         | <10  |
| Manganese*           | 60               | Zirconium    | 20   |

<sup>a</sup>Hazardous air pollutants are indicated by an asterisk (\*).

<sup>b</sup>< indicates below detection limit.

## REFERENCES

1. Calciners and Dryers in Mineral Industries--Background Information for Proposed Standards, EPA-450/3-025a, U.S. Environmental Protection Agency, Research Triangle Park, NC, October 1985.
2. L. L. Davis, Diatomite in 1991, Mineral Industry Surveys, Annual Report, Bureau of Mines, U.S. Department of the Interior, Washington, DC, April 7, 1992.
3. F. L. Kadey, "Diatomite", Industrial Rocks and Minerals, Volume I, Society of Mining Engineers, New York, 1983.