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Air

EPA

Calciners and Dryers in Mineral Industries—Background Information for Proposed Standards

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NSPS

The titanium hydrate is then calcined to drive off water and residual sulfuric acid from the hydrate. The product from the calciners (raw TiO_2) is then finished by pulverizing, milling, screening, coating with hydrous oxides, filtering, and drying. Sometimes, organic reagents are added (to aid dispersion of pigments for customer's use) before the TiO_2 is dried. Drying is performed in a pigment dryer followed by final grinding by attrition in the fluid-energy mills.

3.2.16.2.3 Dryers/calciners in the chloride process. Dryers are used in the chloride process for ore drying and for pigment drying. Calciners are only used in the chloride-ilmenite process. Rotary dryers are used in the chloride process for drying of rutile ore. Operating temperatures range from 150° to 650°C (300° to 1200°F). Natural gas is the most common fuel used. The most commonly used pigment dryers are spray dryers, although flash dryers are also used. Operating temperatures for spray dryers range from 130° to 700°C (275° to 1300°F).

3.2.16.2.4 Dryers/calciners in the sulfate process. Dryers and calciners are used in the sulfate process for ore drying, ore calcining, and pigment drying. The most commonly used ore dryers are rotary indirect dryers, though rotary direct dryers are also used. Operating temperatures range from 120° to 130°C (250° to 275°F). Natural gas is the most commonly used fuel, although fuel oil is also used.

The TiO_2 hydrate (~65 percent water and some H_2SO_4) from the digester is calcined in direct-fired rotary calciners. As material passes through the calciner, it is first dried, then combined water and sulfate are driven off. The calciner temperature is carefully controlled according to the grade of pigment being made, that is, either anatase or rutile. An increase in temperature favors the formation of rutile. The calcining operation converts TiO_2 from an amorphous to a crystalline state thereby raising the refractive index.[113] Calcined material is approximately 99 percent TiO_2 and contains no moisture.[115]

3.2.17 Vermiculite

3.2.17.1 Background. Vermiculite is the geological name given to a group of hydrated laminar minerals that are aluminum-iron-magnesium silicates and that resemble mica in appearance. When subjected to heat,

vermiculite has the unusual property of exfoliating, or expanding, due to the interlaminar generation of steam.[119]

The world's largest deposit of vermiculite is mined near Libby, Montana, with other major deposits located near Enoree, South Carolina, and in the Republic of South Africa. Vermiculite is also mined and beneficiated at a mine in Louisa County, Virginia. Deposits of economic significance contain 25 to 95 percent vermiculite.[120]

Estimated world production of crude vermiculite in 1981 was 522,000 Mg (576,000 tons), more than 80 percent of which came from five mines.[121] The United States and Republic of South Africa accounted for 92 percent of world production. Estimated U.S. production of crude vermiculite sold or used by producers in 1982 was 281,000 Mg (310,000 tons).[122]

Vermiculite ore is mined using open-pit methods. Beneficiation includes screening, flotation, drying in rotary or fluid bed dryers, and expansion by exposure to high heat. All mined vermiculite is dried and sized at the mine site prior to exfoliation. Approximately 84 percent of U.S. mined vermiculite is expanded. Uses of unexpanded vermiculite are minor and include muds for oil-well drilling and fillers in fire-resistant wallboard.[123]

Exfoliated vermiculite was produced at 48 plants in 31 States in 1981. The principal producing States were, in order of decreasing exfoliated vermiculite output, Ohio, California, Texas, Florida, South Carolina, New Jersey, and Illinois.[124] The main uses of exfoliated vermiculite in 1981 were: concrete aggregate (22 percent); premixes (20 percent); fertilizer carriers (14 percent); block insulation (13 percent); and loose fill insulation (12 percent). Other uses included plaster aggregates (2 percent), horticultural uses (8 percent), and soil conditioners (6 percent).[125]

Commercial exfoliation of vermiculite is achieved by heating the pre-sized crude vermiculite in a furnace chamber. The bulk volume of commercial grades increases 8- to 12-fold, but individual vermiculite particles may expand as much as 30-fold compared to the raw ore.[126]

3.2.17.2 Process Description.

3.2.17.2.1 Crude ore processing. Figure 3-34 is a flow diagram of vermiculite ore processing. Crude ore from open-pit mines is brought to the mill by truck where it is stored in outdoor stockpiles. Primary processing consists of removing the plus 1.6 cm (5/8 in.) waste rock and returning the raw ore to stockpiles. Blending is accomplished as material is removed from stockpiles and conveyed to the mill feed bin. The blended ore is fed to the mill where it is separated into fractions by wet screening and concentrated by gravity. All concentrates are collected, dewatered, and dried in a fluid bed or rotary dryer. The dryer products are separated by standard screens and are stored in bins or silos for later shipment or exfoliation.[127]

The rotary dryer is the most common dryer type used in the industry, although one fluid bed dryer is used. Drying temperatures are 120° to 480°C (250° to 900°F), and fuel oil is the most common fuel. One plant has recently switched from No. 2 fuel oil to propane as the fuel for its rotary vermiculite dryer. Personnel at another plant indicated that the capacity for burning oil or wood may be added to their dryer or heat may be recovered from the dryer stack gases.

3.2.17.2.2 Exfoliation. Figure 3-35 depicts a typical vermiculite expanding process. Sized crude vermiculite is dropped continuously through a gas- or oil-fired vertical furnace. Exfoliation occurs after a residence time of less than 8 seconds in the furnace, and immediate removal of the expanded material from the furnace prevents damage to the structure of the vermiculite particle. Flame temperatures of more than 540°C (1000°F) are used for exfoliation. Proper exfoliation requires a high rate of heat transfer and rapid generation of steam within the vermiculite particles.[128] The expanded product falls through the furnace and is air conveyed to a classifier system, which collects the vermiculite product and removes excessive fines. Most units operate at production rates of approximately 0.9 Mg/h (1 ton/h).

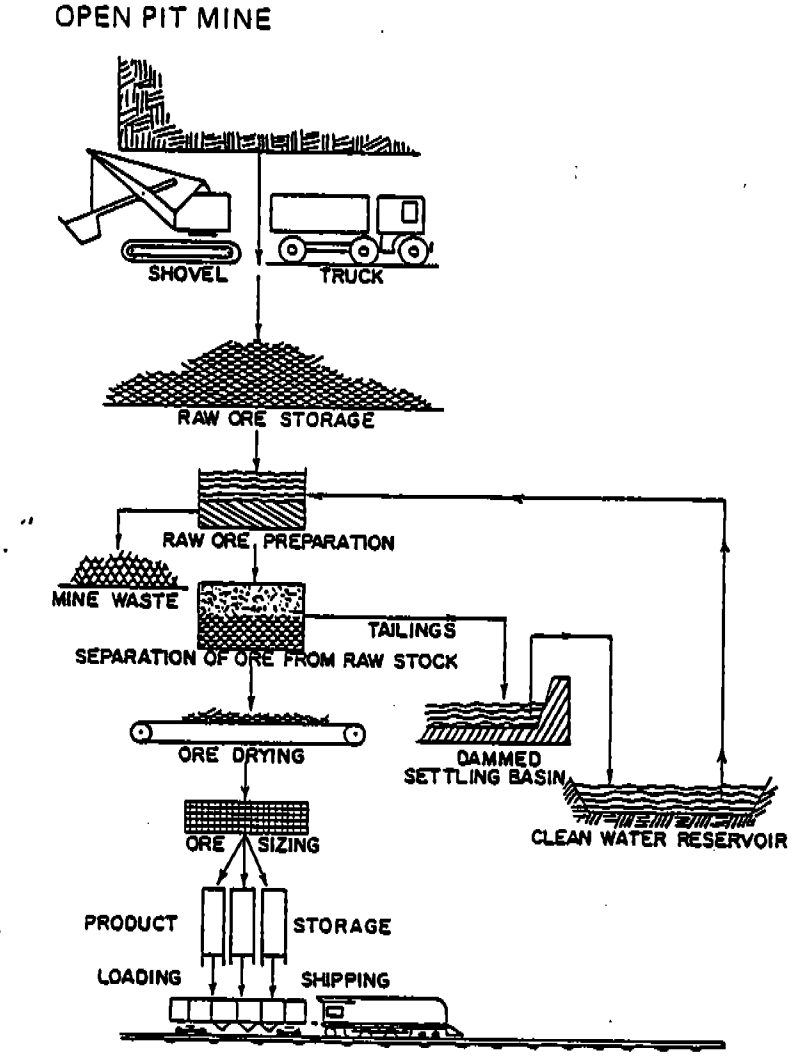

Figure 3-34. Flow diagram of vermiculite ore processing.[129]

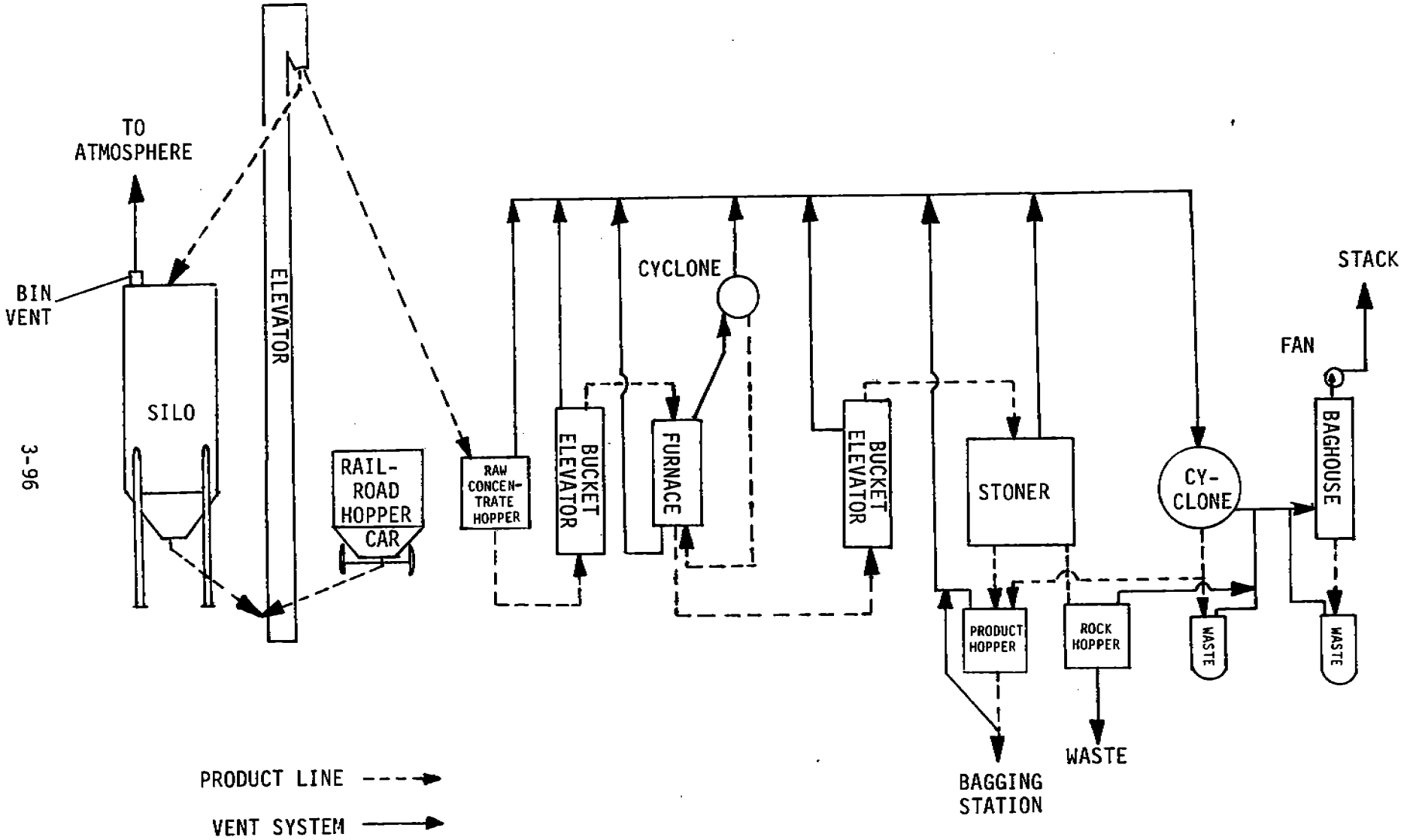

Figure 3-35. Vermiculite expansion system.[130]