

## 11.28 Vermiculite Processing

### 11.28.1 Process Description<sup>1-9</sup>

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. The chemical formula for vermiculite is  $(\text{Mg,Ca,K,Fe}^{+2})_3(\text{Si,Al,Fe}^{+3})_4\text{O}_{10}(\text{OH})_2 \cdot 4\text{H}_2\text{O}$ . When subjected to heat, vermiculite has the unusual property of exfoliating, or expanding, due to the interlaminar generation of steam. Uses of unexpanded vermiculite include muds for oil-well drilling and fillers in fire-resistant wallboard. The six-digit source classification code (SCC) for vermiculite processing is 3-05-033.

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.

#### Crude Ore Processing -

Figure 11.28-1 is a process flow diagram for vermiculite processing. Crude ore from open-pit mines is brought to the mill by truck and is loaded onto outdoor stockpiles. Primary processing consists of screening the raw material to remove the waste rock greater than 1.6 centimeters (cm) (5/8 inch [in.]) 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 then concentrated by gravity. All concentrates are collected, dewatered, and dried in either a fluidized bed or rotary dryer. Drying reduces the moisture content of the vermiculite concentrate from approximately 15 to 20 percent to approximately 2 to 6 percent. At least one facility uses a hammermill to crush the material exiting the dryer. However, at most facilities, the dryer products are transported by bucket elevators to vibrating screens, where the material is classified. The dryer exhaust generally is ducted to a cyclone for recovering the finer grades of vermiculite concentrate. The classified concentrate then is stored in bins or silos for later shipment or exfoliation.

The rotary dryer is the more common dryer type used in the industry, although fluidized bed dryers also are used. Drying temperatures are 120° to 480°C (250° to 900°F), and fuel oil is the most commonly used fuel. Natural gas and propane also are used to fuel dryers.

#### Exfoliation -

After being transported to the exfoliation plant, the vermiculite concentrate is stored. The ore concentrate then is conveyed by bucket elevator or other means and 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 both a high rate of heat transfer and a rapid generation of steam within the vermiculite particles. The expanded product falls through the furnace and is air conveyed to a classifier system, which collects the vermiculite product and removes excessive fines. The furnace exhaust generally is ducted through a product recovery cyclone, followed by an emission control device. At some facilities, the exfoliated material is ground in a pulverizer prior to being classified. Finally, the material is packaged and stored for shipment.

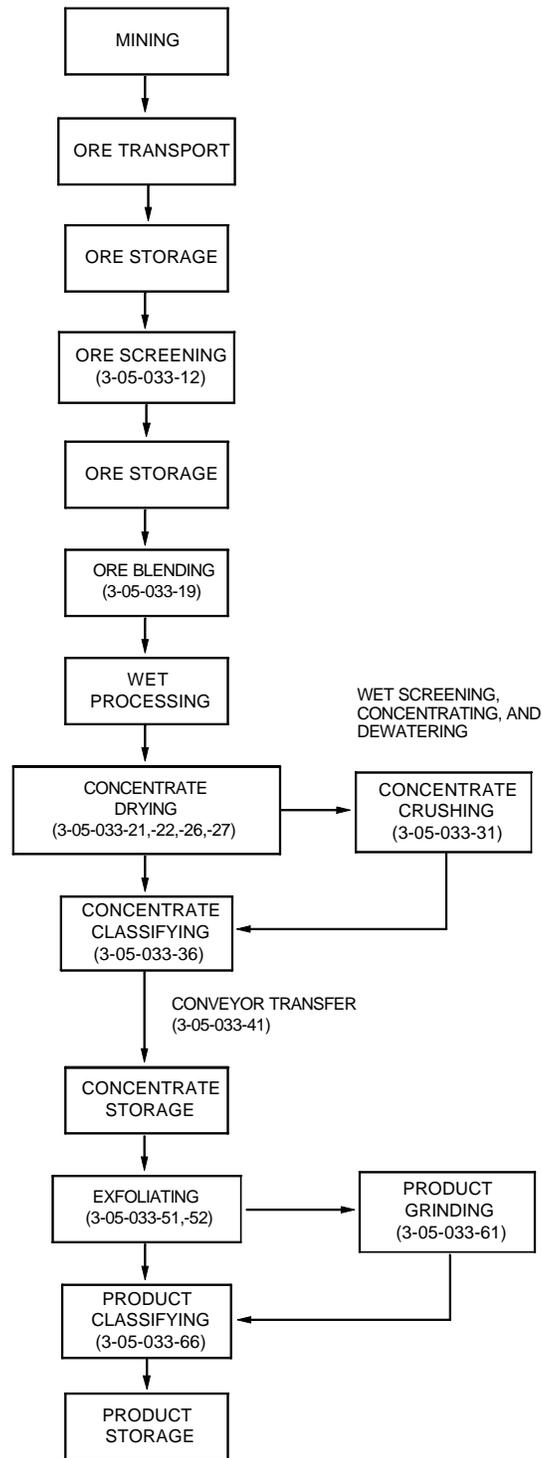


Figure 11.28-1. Process flow diagram for vermiculite processing.  
(Source Classification Codes in parentheses.)

## 11.28.2 Emissions And Controls<sup>1,4-11</sup>

The primary pollutants of concern in vermiculite processing are particulate matter (PM) and PM less than 10 micrometers (PM-10). Particulate matter is emitted from screening, drying, exfoliating, and materials handling and transfer operations. Emissions from dryers and exfoliating furnaces, in addition to filterable and condensible PM and PM-10, 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>).

Wet scrubbers are typically used to control dryer emissions. The majority of expansion furnaces are ducted to fabric filters for emission control. However, wet scrubbers also are used to control the furnace emissions. Cyclones and fabric filters also are used to control emissions from screening, milling, and materials handling and transfer operations.

Table 11.28-1 summarizes the emission factors for vermiculite processing.

Table 11.28-1 EMISSION FACTORS FOR VERMICULITE PROCESSING<sup>a</sup>

EMISSION FACTOR RATING: D

Process	Filterable PM <sup>b</sup>	Condensible organic PM <sup>c</sup>	Total PM <sup>d</sup>	CO <sub>2</sub>
	kg/Mg	kg/Mg	kg/Mg	kg/Mg
Rotary dryer, with wet collector (SCC 3-05-033-21,-22)	0.29 <sup>e</sup>	ND	ND	50 <sup>f</sup>
Concentrate screening, with cyclone (SCC 3-05-033-36)	0.30 <sup>g</sup>	NA	0.30 <sup>g</sup>	NA
Concentrate conveyor transfer, with cyclone (SCC 3-05-033-41)	0.013 <sup>g</sup>	NA	0.013 <sup>g</sup>	NA
Exfoliation - gas-fired vertical furnace, with fabric filter (SCC 3-05-033-51)	0.32 <sup>h</sup>	0.18 <sup>i</sup>	0.50 <sup>k</sup>	ND
Product grinding, with fabric filter (SCC 3-05-033-61)	0.18 <sup>m</sup>	NA	0.18 <sup>m</sup>	NA

<sup>a</sup> Factors represent uncontrolled emissions unless noted. Emission factor units for drying are kg/Mg of material feed; emission factor units for other processes are kg/Mg of product. 1 kg/Mg is equivalent to 1 lb/1,000 lb. SCC = Source Classification Code. ND = no data. NA = not applicable.

<sup>b</sup> Filterable PM is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train.

<sup>c</sup> Condensible PM is that PM collected in the impinger portion of a PM sampling train. Condensible organic PM is the organic fraction of the condensible PM.

<sup>d</sup> Total PM equals the sum of the filterable PM, condensible organic PM, and condensible inorganic PM.

<sup>e</sup> Reference 8. EMISSION FACTOR RATING: E.

<sup>f</sup> References 8,11. Factor represents uncontrolled emissions of CO<sub>2</sub>.

<sup>g</sup> Reference 11. For dried ore concentrate.

<sup>h</sup> Reference 10.

<sup>j</sup> Reference 10. Emissions may be largely from volatilization of oil used in ore beneficiation.

<sup>k</sup> Sum of factors for filterable PM and condensible organic PM; does not include condensible inorganic PM.

<sup>m</sup> Reference 9.

## References For Section 11.28

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