11.14 Frit Manufacturing

11.14.1 Process Description[1-6]

Frit is a homogeneous melted mixture of inorganic materials that is used in enameling iron and steel and in glazing porcelain and pottery. Frit renders soluble and hazardous compounds inert by combining them with silica and other oxides. Frit also is used in bonding grinding wheels, to lower vitrification temperatures, and as a lubricant in steel casting and metal extrusion. The six digit Source Classification Code (SCC) for frit manufacturing is 3-05-013.

Frit is prepared by fusing a variety of minerals in a furnace and then rapidly quenching the molten material. The constituents of the feed material depend on whether the frit is to be used as a ground coat or as a cover coat. For cover coats, the primary constituents of the raw material charge include silica, fluorspar, soda ash, borax, feldspar, zircon, aluminum oxide, lithium carbonate, magnesium carbonate, and titanium oxide. The constituents of the charge for a ground coat include the same compounds plus smaller amounts of metal oxides such as cobalt oxide, nickel oxide, copper oxide, and manganese oxide.

To begin the process, raw materials are shipped to the manufacturing facility by truck or rail and are stored in bins. Next, the raw materials are carefully weighed in the correct proportions. The raw batch then is dry mixed and transferred to a hopper prior to being fed into the smelting furnace. Although pot furnaces, hearth furnaces, and rotary furnaces have been used to produce frit in batch operations, most frit is now produced in continuous smelting furnaces. Depending on the application, frit smelting furnaces operate at temperatures of 930° to 1480°C (1700° to 2700°F). If a continuous furnace is used, the mixed charge is fed by screw conveyor directly into the furnace. Continuous furnaces operate at temperatures of 1090° to 1430°C (2000° to 2600°F). When smelting is complete, the molten material is passed between water-cooled metal rollers that limit the thickness of the material, and then it is quenched with a water spray that shatters the material into small glass particles called frit.

After quenching, the frit is milled by either wet or dry grinding. If the latter, the frit is dried before grinding. Frit produced in continuous furnaces generally can be ground without drying, and it is sometimes packaged for shipping without further processing. Wet milling of frit is no longer common. However, if the frit is wet-milled, it can be charged directly to the grinding mill without drying. Rotary dryers are the devices most commonly used for drying frit. Drying tables and stationary dryers also have been used. After drying, magnetic separation may be used to remove iron-bearing material. The frit is finely ground in a ball mill, into which clays and other electrolytes may be added, and then the product is screened and stored. The frit product then is transported to on-site ceramic manufacturing processes or is prepared for shipping. In recent years, the electrostatic deposition spray method has become the preferred method of applying frit glaze to surfaces. Frit that is to be applied in that manner is mixed during the grinding step with an organic silicon encapsulating agent, rather than with clay and electrolytes. Figure 11.14-1 presents a process flow diagram for frit manufacturing.

11.14.2 Emissions And Controls[1,7-10]

Significant emissions of particulate matter (PM) and PM less than 10 micrometers (PM-10) are created by the frit smelting operation in the form of dust and fumes. These emissions consist primarily of condensed metallic oxide fumes that have volatilized from the molten charge. The emissions also contain mineral dust and sometimes hydrogen fluoride. Emissions from furnaces also include products of combustion, such as carbon monoxide (CO), carbon dioxide (CO_2), and nitrogen oxides (NO_x). Sulfur oxides (SO_x) also may be emitted, but they generally are absorbed by the molten material to form an

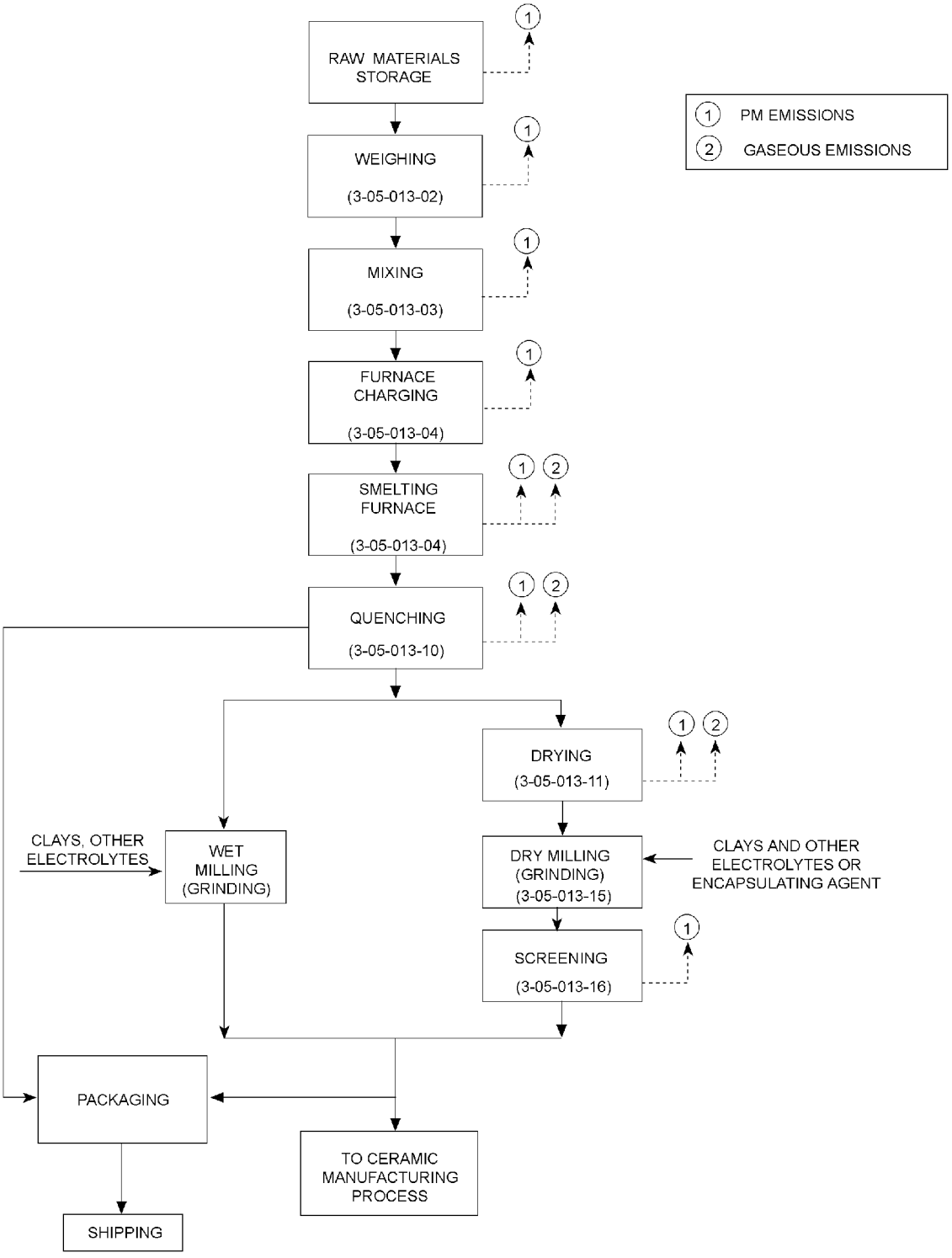

Figure 11.14-1 Process flow diagram for frit manufacturing.
(Source Classification Code in parentheses)

immiscible sulphate that is eliminated in the quenching operation. Particulate matter also is emitted from drying, grinding, and materials handling and transfer operations

Emissions from the furnace can be minimized by careful control of the rate and duration of raw material heating, to prevent volatilization of the more fusible charge materials. Emissions from rotary furnaces also can be reduced with careful control of the rotation speed, to prevent excessive dust carryover. Venturi scrubbers and fabric filters are the devices most commonly used to control emissions from frit smelting furnaces, and fabric filters are commonly used to control emissions from grinding operations. No information is available on the type of emission controls used on quenching, drying, and materials handling and transfer operations.

Table 11.14-1 presents emission factors for filterable PM, CO, NO_x, and CO_2, emissions from frit manufacturing. Table 11.14-2 presents emission factors for other pollutant emissions from frit manufacturing.

11.14.3 Updates Since the Fifth Edition

The Fifth Edition was released in January 1995. A complete revision of this section was completed on 11/95. The emission factor for NOx for Smelting Furnace was revised on 6/97 based upon a review of the production information that was provided by the manufacturing facility.

Table 11.14-1. EMISSION FACTORS FOR FRIT MANUFACTURING[a]

EMISSION FACTOR RATING: E

Source	Filterable PM[b]	CO	NO_x	CO_2
Smelting furnace (SCC 3-05-013-05,06)	16[c]	4.8[c]	16[d]	1,300[e]
Smelting furnace with venturi scrubber (SCC 3-05-013-05,06)	1.8[f]	[g]	[g]	[g]
Smelting furnace with fabric filter (SCC 3-05-013-05,-06)	0.020[d]	[g]	[g]	[g]

[a] Factors represent uncontrolled emissions unless otherwise noted. Emission factor units are lb/ton of feed material. ND = no data. SCC = Source Classification Code. To convert from lb/ton to kg/Mg, multiply by 0.5.
[b] Filterable PM is that PM collected on or prior to the filter of an EPA Method 5 (or equivalent) sampling train.
[c] Reference 1.
[d] Reference 10.
[e] Reference 7-10.
[f] References 7-9. EMISSION FACTOR RATING: D
[g] See factor for uncontrolled emissions.

Table 11.14-2. EMISSION FACTORS FOR FRIT MANUFACTURING--
FLUORIDES AND METALS[a]

EMISSION FACTOR RATING: E

	Pollutant	Emission factor, lb/ton
Smelting furnace with fabric filter (SCC 3-05-013-05,-06)	fluorides	0.88
	barium	2.8×10^{-5}
	chromium	1.4×10^{-5}
	cobalt	4.3×10^{-6}
	copper	1.9×10^{-5}
	lead	9.6×10^{-6}
	manganese	1.4×10^{-5}
	nickel	1.6×10^{-5}
	zinc	1.2×10^{-4}

[a] Reference 10. Factor units are lb/ton of material feed.
SCC = Source Classification Code. To convert from lb/ton to kg/Mg, multiply by 0.5.

References For Section 11.14

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