Cullet Specifications for Fiberglass Insulation Manufacturing

Material: Recycled Glass

Issue: *Fiberglass insulation manufacturing has grown to be one of the largest uses for recycled glass. Because fiberglass does not have glass's clarity, there is an assumption among some that fiberglass raw materials can tolerate higher levels of contaminants than container manufacturing. In fact, metal, organic, and ceramic contaminants can be costly to fiberglass quality and production equipment.*

Best Practice: During fiberglass production, raw batch materials and glass cullet are continuously added to the furnace. After melting and "fining," the molten glass is spun into fibers by a process called fiberizing. To ensure production of consistent fibers, cullet must meet specifications for major and minor oxide chemical composition, color consistency, and contaminant levels.

Major and Minor Oxide Chemical Composition. The chemical composition of cullet as raw batch material for fiberglass should fall within the ranges listed in the table.

Material	Minimum	Maximum
	(% by weight)	(% by weight)
SiO_2	70.0	none
Fe_2O_3	none	0.5
CaO & MgO	11.0	none
Na_2O	13.0	none
PbO	none	0.2
H_2O	none	2.0
Carbon	none	0.1
FeO	none	0.1
Ag_2O	none	0.05
Cr_2O_3	none	0.1
CoO	none	0.05

Variations in major oxide concentration can affect both the viscosity and emissivity of the glass melt. Viscosity is a measure of flow resistance, while emissivity is the ability of a material to emit heat through radiation. Both of these properties affect the attenuation ability of the molten glass during fiber formation. In addition, a shift in a major oxide concentration can cause fluctuations in the electrical resistivity of the melt. This requires an adjustment of transformer settings controlling the power input to the furnace, as well as creating changes in heat flow patterns, current paths, and temperature distribution, all of which are undesirable during stable furnace operations. Minor and trace oxide composition of the batch cullet is also very important. Oxides such as CoO, Cr_2O, and FeO can influence infrared heat transmission, heat transfer during melting, and rate of fiber cooling. These factors will affect fiber attenuation, leading to variability in the fiber diameters and lengths.

Color Consistency. Each of the color groups of container glass - flint (clear), green, and amber - is characterized by a different oxidation state. Flint is highly oxidized, green varies from slightly oxidized to slightly reduced, and amber is highly reduced. Therefore, color changes in the cullet supply can shift the bulk glass melt oxidation state in the furnace. The melting process can operate within a wide range of oxidation states, but stability within that range is absolutely necessary. A sudden shift in the oxidation state will result in mild to serious furnace upset because the solubility of SO_2 gas in the glass melt varies with the oxidation state. In general, SO_2 is highly soluble in an well-oxidized or well-reduced melt. When the oxidation state shifts and SO_2 is released, a glassy foam forms on the surface of the melt, insulating the reaction zone of the batch material from the heat of the molten glass beneath. More power must then be applied to the furnace to melt the incoming batch material, which will otherwise form a crust on the surface of the melt. Increasing the temperature of the melt changes the viscosity of the glass, and the rate of fiberization must be adjusted.

Metal Contamination. Metal contaminants found in cullet feedstock are not oxidized in the fiberglass furnace, and thus will not dissolve. These contaminants instead sink and form pools of molten metal on the furnace floor, causing corrosion and subsequent glass leaks, shortening the life of the furnace. Or, the metals can work their way through the furnace refractory, contact support steel, and cause a ground, shutting off the furnace power and threatening worker safety.

Organics. Cullet feedstock used for fiberglass raw batch material should also be free of organics including paper labels, plastic caps, or even wood chips. The presence of organic material can affect the oxidation state of the melt much like a change in the color-mix.

Ceramics. Cullet feedstock must be free of coarse ceramic contaminants, or should be fine-sized prior to melting. Ceramic contaminants in cullet feedstock include fragments of dishware (saucers, cups) cookware (Visionware, Pyrex), as well as bricks, rock, and concrete. Ceramic particles larger than No. 12 mesh (1.7mm) do not melt in the fiberglass furnace, and clog the furnace spinners. Spinners are rotating, flat-bottomed bowls with perforated sidewalls that are used to produce the glass fibers during fiberization.

Implementation: Cullet feedstock processing should include color sorting, removal of metals and organics, and removal or fine-sizing of coarse ceramics. For information on processing steps, refer to the Best Practices *Identifying Typical Contaminants in Recycled Glass, Automated Color-Sorting of Recycled Glass, Using Magnetic Separation Technologies, Non-Ferrous Separation Technologies, Removal of Ceramics From Recycled Glass,* and *Fine-Sizing of Recycled Glass.* To maintain chemical consistency in the cullet feedstock and glass melt, the fiberglass manufacturer or MRF should periodically complete a comprehensive chemical analysis for representative cullet samples. Acceptance standards of individual fiberglass manufacturers for chemical consistency, color distribution, and contaminant levels should be considered prior to cullet preparation and delivery.

Benefits: Ensuring the chemical and color-mix consistency of the batch material optimizes the glass melting and fiberizing stages of fiberglass production. In addition, eliminating cullet contaminants will help minimize damage to the furnace and fiberizing equipment.

Application Sites: Fiberglass manufacturing facilities, material recovery facilities.

Contact: For more information about this Best Practice, contact CWC, (206) 443-7746, e-mail info@cwc.org.

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