

Materials Characterization Paper
In Support of the
Advanced Notice of Proposed Rulemaking –
Identification of Nonhazardous Materials That Are Solid Waste

Secondary Glass Material - Used as ingredient in glass manufacture

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1. *Definition of Secondary Glass Material*

Secondary glass material consists of both post-consumer (MSW) glass as well as post-industrial glass (i.e., glass scrap generated in the process of glass material manufacture. Glass in the MSW stream includes glass containers and packaging as well as glass used in durable goods, such as furniture, appliances, and consumer electronics. Post industrial glass includes fiber scrap from fiber glass and fiberoptics manufacturing processes as well as internal container glass scrap.

2. *Annual Quantities Generated and Used*

(1) Sectors that generate secondary glass material:

- Secondary glass material is generated by NAICS sector 3272, Glass and Glass Product Manufacturing. Secondary glass material can also be collected as part of municipal solid waste streams (MSW), but the focus on this paper is on the industrial product.

(2) Quantities and prices of secondary glass material generated:

- EPA estimates that 13.6 million tons of glass packaging and other glass scrap material was generated in 2007 (EPA 2007).
- In addition, one report addressing the glass industry estimates that more than 60,000 tons of “glass-manufacturing scrap” are generated annually (Argonne National Laboratory). It is unclear if other process steps in glass manufacturing generated additional quantities of scrap, and it is also unclear whether this scrap includes or excludes scrap that is internally reused in manufacturing. This estimate does, however, exclude scrap from fiberglass manufacturing, and appears to exclude secondary glass from post-consumer sources.
- The report further estimates that an additional 200,000 tons of fiberglass scrap is annually generated during the manufacturing of fiberglass products (Argonne National Laboratory).
- Glass pricing information is available in some cases for post-consumer MSW glass, but is not available specifically for industrial scrap. It is possible that industrial glass scrap has a different pricing structure, due to differences in composition, quality, product consistency, and contamination.

(3) Trends in generation of secondary glass material:

- Differences in trends between different types of glass could not be identified at this time.

3. Uses of Material/Commodity

(1) Ingredient uses of secondary glass material in combustion processes:

- Glass-to-glass processing is generally the most environmentally beneficial recycling option, other things being equal. Ninety percent of recycled MSW glass is used to make new glass containers. Today, most glass manufacturers rely on a steady supply of recycled crushed glass, known as "cullet," to supplement raw materials. To make glass, manufacturers mix sand, soda ash, limestone, and cullet; heat the mixture to a temperature of 2,600 to 2,800 degrees F; and mold it into the desired shape. Sand is the only material used in greater volumes than cullet to manufacture glass.
- Attempts by the glass manufacturing industry to recycle secondary glass fiber material back into fiber glass and fiberoptics production processes have failed in the past because they have resulted in an unacceptably high rate of filament breakage in the subsequent glass-manufacturing processes. This breakage rate is due to the presence of impurities in the secondary glass fiber material. It is not clear, however, whether these problems prevent the use of this material in other types of products

(2) Other uses of secondary glass material:

- Other uses of high-quality cullet include use as abrasives, aggregate substitute, bead manufacturing, kitchen tiles, counter tops, wall insulation, frictionators (match tips), fluxes in metal foundry work, and roadbed aggregate.

(3) Quantities of secondary glass material landfilled:

- The recycling rate of glass in the MSW stream in 2007 was 23.7 percent. Of the 13.6 million tons of MSW glass and packaging generated in 2007, 10.36 million tons were landfilled and 3.22 million tons were recycled (EPA 2007).
- At this time, we have not determined landfill quantities of other glass types, such as fiberoptic material and glass manufacturing scrap that never enters the MSW stream. At most, according to the report by Argonne National Laboratory, these quantities would be roughly 260,000 tons for fiberglass and other glass manufacturing scrap.

(4) Quantities of secondary glass material stockpiled/stored:

- Estimates of the quantity of secondary glass material being stockpiled could not be identified at this time, but because disposal of these products is not restricted and the market for secondary materials has generally been strong, little incentive exists to create stockpiles.

Exhibit 1: Overview of Generation and Use of Secondary Glass Material

Commodity	Annual Quantity Generated	Annual Quantity Used as Ingredient		Annual Quantity Landfilled	Annual Quantity in Other Uses	Total Quantity Stockpiled
		Glass Furnaces	Other			
----- <i>Short Tons per Year</i> -----						
MSW Glass	13.6 million	2.90 million*	Undetermined	10.36 million	0.32 million	Undetermined
Glass manufacturing scrap	60,000	Undetermined	Undetermined	Undetermined	Undetermined	Undetermined
Fiberglass manufacturing scrap	200,000	Undetermined	Undetermined	Undetermined	Undetermined	Undetermined
<p>*Calculated using EPA data (EPA, 2007) and the EPA estimate that 90% of MSW glass is used to make new glass containers (EPA, 2008). All other ingredient uses are included in the “Other Uses” category.</p> <p>Sources: EPA 2007, 2008 Argonne National Laboratory</p>						

4. Management and Combustion processes

(1) Types of units using secondary glass material:

- Secondary glass material can be used in glass furnaces in place of virgin raw materials in glass manufacturing, though particular types of scrap (e.g., from fiberglass) appear to be difficult to use in certain applications.

(2) Sourcing of secondary glass material:

- In terms of industrial glass production, typically the same glass manufacturing facility that produces secondary glass material reuses it in their glass manufacturing processes; it is not clear to what extent this feedstock is considered scrap. Glass manufacturers can also buy recovered glass (cullet) on the commodity market; much of this glass is recovered from municipal solid waste streams and traded by municipal recycling facilities (MRFs) or by brokers.

(3) Processing of secondary glass material:

- Although all glass is made of silica and soda, the type and quantity vary slightly with different types of glass. These differences frequently cause manufacturing problems due to different melting points and chemical incompatibility. In addition, since neither brown nor amber glass is used to manufacture clear glass, it is important to sort glass by color. After color sorting, glass is typically crushed and travels by conveyor belt through a series of refinements. Magnets pull out metal, and air currents remove lightweight material such as paper (EPA 2008).
- Some cullet suppliers use sophisticated equipment such as lasers to sort colors of crushed glass and further remove small contaminants. Scientists continue to develop mechanisms to improve materials sorting, and, therefore, the quality of the cullet (EPA 2008).

- Argonne National Laboratory is developing a technology that will enable the glass fiber industry to recycle its glass-fiber-forming and fiberglass-manufacturing scrap into new glass products without either adversely impacting its operations, or the quality of its products due to the increasing glass-filament breakage rate (Argonne National Laboratory).

(4) State status of secondary glass material use as ingredient:

- At this stage we have not identified any states that have approved use of secondary glass material in glass manufacturing, but we have not performed an exhaustive investigation of state activities and regulations. The practice of glass-to-glass recycling is commonplace, although manufacturers of CRT glass are now generally located outside of the United States. Under federal regulations, processed CRT glass sent to a glass manufacturer is not a solid waste, and it is unlikely states consider this a process that falls within their solid waste jurisdiction.

5. Commodity Composition and Impacts

(1) Composition of secondary glass material:

- Common glass contains about 70 percent silicon dioxide. In addition, other compounds used in glass manufacturing are present in the final glass product. Soda ash (anhydrous sodium carbonate) acts as a fluxing agent in the melt. It lowers the melting point and the viscosity of the formed glass, releases carbon dioxide, and helps stir the melt. Either limestone or dolomite are sometimes used in lieu of soda ash. Alumina, lead, and cadmium are used to increase the strength of the glass and increase resistance to chemical attack. Various iron compounds, chromium compounds, carbon, and sulfur are used as coloring agents (Turner Fairbank Highway Research Center).
- The major contaminants present in glass-manufacturing material from the fiber-optics industry include: carbonaceous material, tiny noble metal particles, as well as trace amounts of Zr, Sr, Cr, Cu, Mg, Zn, Fe, Ba, V, and Mn (Argonne National Laboratory).

(2) Impacts of secondary glass material use:

- Using cullet saves money and helps the environment. Cullet costs less than raw materials, prolongs furnace life since it melts at a lower temperature than sand, and demands less energy. Avoided energy use results in reduced emissions of nitrogen oxide. Use of cullet also can reduce the unit consumption of virgin glass materials (primarily sand).
- The specific lifecycle impacts of cullet use as a raw material in glass manufacturing are not evaluated here because of uncertainties in lifecycle scenario development. For example, it is difficult to determine the replacement ratio between cullet and other raw materials in glass production. Thus, the correct quantity of material to be modeled is unclear.
- The ability to use recycled glass fibers in fiber optic applications lowers energy costs by an average of \$3-\$8 per ton of glass fibers, when compared to using

virgin raw materials. If these glass material streams are recycled, the glass industry will annually save over \$2 million in energy costs and over \$5 million in disposal costs. Associated with the energy savings is also a significant reduction in NOx emissions (Argonne National Laboratory).

References

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