NATIONAL GLASS ASSOCIATION with GANA

Glass Technical Paper **FB40-14 (2021)**

Recyclability of Architectural Glass Products

Objectives

The interest in recycling architectural glass products is growing; however, information on companies offering recycling services is fragmented and difficult to find. A recent survey conducted by NGA showed that the architectural glass industry is interested in more recyclability of post fabrication products. Respondents indicated that roadblocks such as labor, cost, space and the lack of local resources prevent them from recycling glass waste. The purpose of this bulletin is to identify the different products that can be recycled and those that cannot be recycled. It also serves to clarify misconceptions about glass recycling and identify sources for recycling architectural glass. Finally, it provides examples of a variety of products that can be created or improved using recycled glass.

Introduction

Over one million tons of architectural glass is recycled annually throughout North America. Due to the weight of glass, the proximity between the glass fabricator, the recycler, and the end user is important. As shown in Figure 1, the supply chain begins with a glass fabricator shipping its glass scrap to a recycler. From there, the recycler mechanically cleans, crushes, and screens the glass to create a uniform material. This material (shown in Figure 2) is generally sold in bulk to an end user or manufacturer where it is melted for use in a derivative product. Occasionally, a glass recycler grinds the material to a fine powder to sell for use as a filler or an abrasive.

The desire for additional recycled glass is high and scrap glass generators have an opportunity to find a better economic alternative to discarding glass in a landfill.

Figure 1. Glass Recycling Supply Chain

Figure 2: Examples of Crushed Glass in recycling facilities

Recycled Glass in Float Glass Manufacturing

The float glass process recycles virtually all the glass waste (called cullet) from the in-plant production melting and cutting processes. Cullet generated within the same plant and reintroduced to the original process does not qualify as pre-consumer recycled content for green building initiatives such as LEED *Building Product Disclosure and Optimization-Sourcing of Raw Materials* credit. However, there is still opportunity to gain LEED credit by participating in a LEED EPR recycling program. Refer to Glass Technical Paper FM03-10 (2017) *LEED® Recycled Content for Glass* for more information[i].

Float glass manufacturers typically do not recycle post-consumer or pre-consumer recycled cullet from glass fabricators or other sources primarily due to glass composition differences and possible contamination. Cullet that is generated from glass of different compositions, whether it is from other glass suppliers or different substrates, could potentially result in extensive defects during the manufacturing process. However, the biggest issue or concern is possible contamination, namely from aluminum metal and stainless steel. Neither of these materials are ferromagnetic so they would not be picked up by a magnet that is used to prevent tramp metal from entering a float furnace. Both metals are major concerns for float glass manufacturers that could result in significant furnace upsets resulting in days or weeks of lost production.

Glass Recyclability

A wide variety of architectural soda-lime glass products can be recycled. Annealed, tempered, and low-emissivity (low-e) glass can be recycled with virtually no restrictions; however, other types of glass, such as laminated, mirror, ceramic frit, and insulating glass units (IGUs) require additional processing and may not be accepted by all recycling locations.

Contaminants

The amount and type of contamination is important for all streams of glass. Glass recyclers are able to process most contaminants, such as but not limited to small amounts of cutting stones, metal, aluminum or plastic frames, plastic films, temporary protective film (TPF), refractory or rocks, caulk, rubber gaskets, etc. Contamination that will hinder recycling opportunities are mixed chemical compositions like some types of borosilicate and glass ceramic. Other unacceptable contaminants that will result in rejected loads are lead-based paints, desiccants, hazardous or heavy metal material, and high levels of normal contamination. Typically, larger recyclers can process glass, metal, and other components, while smaller recyclers have limited capabilities. It is important to communicate with the glass recycler to understand what types of glass and what levels of contamination are acceptable.

Clarifying the Current Situation

Glass fabricators should establish a working relationship with the nearest glass recycling company. This will lower freight costs and drive the highest value. Recyclers typically accept glass from a spectrum of suppliers and industries beyond just glass fabricators. They work with automotive, solar, glazing, and others, and therefore are knowledgeable of how to leverage value across many different end markets. A recycler with a broad network of facilities can easily move material between markets in case of a disruption.

Most glass scrap generated by an architectural glass fabricator can be recycled if normal care is given to avoiding cross contamination. Laminated glass is potentially a valuable part of the value stream of recycled glass when the PVB is separated from the laminate. Prior to shipment, fabricators should work with their recycler to define the best way to segregate their scrap to ensure positive value and acceptability.

Below are suggested topics to discuss with the glass recycler:

- Type of glass to be recycled (e.g., factory cuttings, IGUs, laminated, low-iron, clear and tinted glass, or something else; pictures help).
- The chemistry of the glass (e.g., soda-lime, glass ceramic, borosilicate, or mixed).
    - Note: if a fabricator cuts glass made up of multiple chemistries in the same plant, discuss the different types of chemistries and how to best keep them separate for the recycler.
- Single tint or mixed tints of glass, and its ability to be separated to maximize value.
- Silver or gray backed mirror glass is accepted by some recyclers. Mirror in 1/8-inch thickness is most desired, but any thickness may also be accepted. All mirror glass is typically sampled before it is accepted.
- Contaminants that may be included and applicable pictures. See potential contaminants provided above.
- Expected volume and frequency of recycled glass to be generated:
    - Is this a one-time shipment, or will it require a permanent roll-off box serviced on a schedule or on an on-call basis?
- Storage method for transportation:
    - Will it be kept in crates, bins, hoppers, roll-off boxes, or bulk? Roll-off boxes are typical for small to mid-sized facilities and bulk slab storage for larger plants.
    - Freight costs are typically lower for bulk shipments but require access to a front-end loader to allow for the bulk glass to be loaded into a truck.
- Space limitations:
    - Is there room outside for one or more roll-off boxes, or a bulk slab storage system? What are the height limitations; is the space free from overhead electrical wires? Recyclers can often provide multiple roll-off boxes so clear glass, mixed glass, and IGUs can be separated into individual containers.
- Freight handling: delivery or pick-up by the recycler.

Some end markets have expressed concern over the proliferation of tints and coatings. If a supplier has a variety of tinted glass, it would be helpful to provide their chemistries to the recycler, if known. The value of the recycled glass is contingent upon the distance to the recycler, the amount of contamination and the uniformity of the type of glass included (e.g., clear glass only; mixed glass). While most glass scrap has a positive value to the fabricator, the distance to the recycler, the distance from the recycler to the end market, or the glass contamination levels may result in a negative value. However, it could result in cost savings for the glass manufacturer when compared to landfill disposal costs.

Finding and communicating with a local, knowledgeable glass recycler helps ensure a successful recycling program.

Possible Sources for Recycling Architectural Glass

Architectural glass recyclers set their own requirements on the types of glass they will accept. The proximity between a supplier and its recycler is important due to the high cost of transportation. Search local listings for recycling facilities.

Below are recyclers who contributed to the development of this document and are good resources for additional information on recycling of glass and glazing products.

- Infinite Recycled Technologies (www.infiniterecycledtech.com) has locations in North America and is an NGA member[ii].
- Strategic Materials (www.strategicmaterials.com) has locations in North America and is an NGA member[iii].

Products Originating from Recycled Glass

Many products originate from recycled architectural glass. The primary end users are fiberglass insulation and highway glass bead, which use crushed glass as part of their raw materials. Other end user industries include abrasives, terrazzo countertops and flooring, filtration and filler materials. The use of cullet (furnace-ready, recycled glass) in manufacturing fiberglass insulation reduces consumption of raw materials, saves on energy costs, extends furnace life, and improves air emissions. End user customers want higher levels of recycled content and are limited only by cullet availability.

Fiberglass

High levels of recycled glass are in fiberglass insulation products. Recycled glass accounts for 40 percent of the raw materials in residential fiberglass insulation[iv]. Energy savings is a primary benefit of using recycled glass because it reduces the costs associated with manufacturing. According to the North American Insulation Manufacturers Association (NAIMA)[v], the industry uses over 2.2 billion pounds of crushed glass annually[vi].

Highway glass bead

Clear, low–iron, and tinted glass are used in the production of small glass beads, which are added to highway paint to create a reflective surface. The glass beads are sprayed on top of paint, as shown in Figure 3. The average amount of glass beads needed for one mile (1.6 kilometer) of a continuous strip of paint is more than 102 pounds (46 kg). This distance requires 20 gallons (76.8 liters) of paint. Potters Industries, for example, delivers one billion pounds annually of recycled glass for the highway paint industry throughout the world.[vii]

Figure 3: Example of recycled glass used in highway paint

Abrasives

The sand and coal slag industry faces increased government regulations due to hazardous health concerns for their products. Crushed glass has become accepted as a high performing safe alternative. Glass is crushed, separated by mesh size, and then sold to blasting distributors and contractors who use it to clean and prepare metal surfaces for painting.

Terrazzo Countertops and Flooring

Some terrazzo countertops and flooring are produced using 100 percent recycled decorative glass as one of the primary materials. Terrazzo countertop and flooring manufacturers often mix crushed mirror with their glass aggregate for these applications. These markets are regional, prefer clear glass, and tend to use smaller quantities.

Other Usage and Applications

Recycled glass products serve many other purposes. Recycled glass is used as abrasive material to place in grinding wheels or into matches, as flux in metal foundries, and as specialized fillers. Some companies use recycled glass as decorative glass aggregate for use in landscaping or fire pit glass. The glass aggregate may be further processed to form mosaic patterns.

The glass container industry uses recycled glass in its manufacturing process, routinely using over 25 percent of post-consumer bottle glass in North America. Several plants have reached a 90 percent recycled content level. The glass container manufacturing plants are getting their cullet from local glass recycling operations. The Glass Packaging Institute, the industry's trade group, advises that every 10 percent of recycled glass content contributes to approximately a 2 to 3 percent energy savings in manufacturing finished glass container products.[viii] The glass container industry's goal is to use 50 percent recycled content and generating new sources of recycled content is identified as the biggest hurdle.[ix] They can and do use architectural glass as part of their batch formulations although the practice is not widespread.

Laminated glass is frequently used in architectural applications that require lamination as a measure of security, by code, or simply for aesthetic reasons. It is now possible to recycle both laminated glass and PVB interlayer by separating them. After PVB is separated from glass, the glass portion becomes a clean cullet supply. The PVB is made into different sizes or forms, such as fleck, pallet, liquid, or new film. The main consumer of recycled PVB is the carpet industry, which uses recycled PVB as part of the carpet backing. See Figure 4 for an example of recycled PVB.

Figure 4: Example of recycled PVB

Conclusion

Glass is easily recyclable, and the need for recycling architectural glass will continue to grow. New facilities will open in different markets as demand for architectural glass recyclers increases. This growth will be spurred in part to reduce energy consumption and CO_2 emissions, and the continued demand for recycled products by consumers.

Clear and low-iron glass are the most widely accepted products by recyclers and thus the easiest to recycle. Technology has evolved so that historically harder to recycle items, such as laminated glass, back-painted glass, mixed tints, and mirror have become routinely recycled as industries have adapted to use these in their manufacturing processes. Technologies and the demand for products are changing rapidly.

References

[i] NGA Glass Technical Paper NGA Glass Technical Paper FM03-10 (2017) *LEED® Recycled Content for Glass* available at glass.org

[ii] Glass recycling company: Infinite Recycled Technologies (www.infiniterecycledtech.com)

[iii] Glass recycling company: Strategic Materials (www.strategicmaterials.com)

[iv] Insulation Institute https://insulationinstitute.org/wp-content/uploads/2018/05/N088-Fiberglass-Insulation-is-a-Smart-Choice-for-Your-Home.pdf

[v] North American Insulation Manufacturers Association (NAIMA)- https://insulationinstitute.org/about-naima/

[vi] Insulation Institute Blog, Nov. 2018: https://information.insulationinstitute.org/blog/3.2-billion-pounds-of-progress

[vii] Potters Industries: https://www.pottersindustries.com/

[viii] Glass Packaging Institute https://www.gpi.org/glass-recycling-facts

[viiii] https://assets.noviams.com/novi-file-uploads/gpi/pdfs-and-documents/Recycling/GPI_Recycled_Content_Report__September_2014.pdf

Visit www.glass.org/store for a complete list of Glass Technical Papers, as well as other glazing and glass building products industry reference materials. Most Glass Technical Papers are available free of charge to NGA members and for a small fee to nonmembers.

This Paper was developed by dedicated member volunteers and subject matter experts. The original version of this document was approved and published in 2014. This version of the paper was updated and published in June 2021.