Glass recycling for waste reduction in built environments

Research Question/Issue

The amount of waste glass from building demolition is increasing worldwide which implies that from environmental, economic and social viewpoints, there is a need to prevent this trend by recycling. Generally, glass itself can be recycled endlessly, however factors like impurities/additives, contaminants, and processing method limit the recyclability of the corresponding glass. The different properties of the processed glass result in different melting point and strength which if mixed with the raw materials in glass production will cause defect in the final product. Thus, there is a necessity to modify and treat the waste glass into a product that can be used in further manufacturing.

Piles of glass cullet (Wonderopolis, n.d)

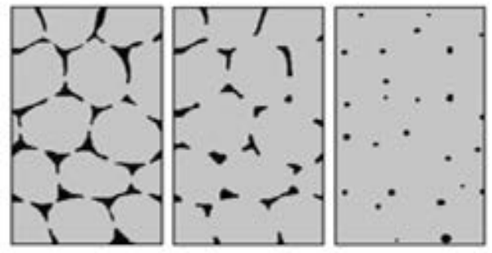
Objective

Three main approached will be pursued in my study: Impurities separation, glass modification/alloying and using end of life waste glass for building materials.

- From thermodynamics consideration, separation of impurities is possible by using reductant in which if combined with designated impurities gives negative Gibbs free energy. The glasses that are free from particular impurities can then be used again as a standard glass stock cullet for glass manufacture.
- Secondly, depending on the kind of impurities, different methods and addition of additives/ alloying element will be implied to modify the waste glass composition and properties. Such modification for instance altering the glass structure from dense to foam for light weight aggregate in civil engineering application or production of alloy by using silica source from the waste glass such as producing alumina silicate.
- Effort will also be made to reuse end of life waste glass as raw materials for building resources such as in ceramic and table slab production. This method is expected to be energy efficient, as it allows the use of waste glass without re-melting and it also expected that the waste glass used can be at least 35% of the total raw material used.

Methodology

- For impurities separation, suitable reductant will be chosen based on Ellingham diagram. The waste glass will be heated to its molten stage at which reduced viscosity of the glass melt might not impede the mass transport of the corresponding impurities. The impurities are expected to separate due to different density.
- For my second approach, before any modification of the glass structure or alloying, a comprehensive characterisation of waste glasses is required. It is then followed by adding small amount of additives in the range of 0-5 wt% individually to modify the structure. For instance, adding carbon foaming agent to create foam glass. Optimum percentage will be noted by checking which resulting product has the lowest density and homogenous pores. Combination of few superior additives will also be conducted to see any anomaly or improvement is achieved.
- To make the stone-glass composite, the end of life glass cutlet will be mixed with stone aggregate and polymer to make composite. The powder mixture is then compacted in a mould and pressed under compression. The sample is then heated to the polymer sintering temperature. At this processing temperature, the polymer powder causes neck to form through diffusion process and grow at a contact point with its neighbouring powder. In short, the polymer will act as an adhesive for the waste glass and stone aggregate. By changing the processing condition and addition of additives, it is expected to produce high quality table slab, or glassy ceramic with end of life waste glass.



Sintering process (Yong-Taeng, Fujino and Morinage, 2002)

Reference

O. Yong-Taeg, S. Fujino and K. Morinaga, “Fabrication of Transparent Silica Glass by Powder Sintering”, *Sci. and Tech. of Adv. Mater.*, **3** [3] 297 - 301 (2002)

Wonderopolis, n.d. photograph, viewed 28 October 2015 <http://wonderopolis.org/wp-content/uploads//2013/08/dreamstime_xxl_10492077-Custom.jpg>

Further information

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