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Review

The need for waste management in the glass industries: A review

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Glass Industries produce a lot of waste ranging from the by products of the used raw materials to the damaged glass products. The fuel used during glass production is also in large quantity. Proper utilization of such wastes from glass cullets (container, flat, electronics and other glass containing products) can minimize the energy requirements and reduce production cost. This paper evaluates the economic potentials in cutting these expenses by recycling wastes to produce glass or other useful objects, which may also clean the environment and enhance efficient production.

Key words: Need, waste management, glass, industries.

INTRODUCTION

Glass has been in use for centuries; the Egyptians were the first to use glass containers in the fifteenth century BC. Modern use really started at the twentieth century when in 1903 the first fully automated bottle-making machine was developed in Ohio, USA. Glass is still widely used despite the introduction of substitute products, particularly plastics. Glass has wide range of applications and uses depending on its source of raw materials. The container glasses, tableware and flat glass are termed as soda lime glasses. The crystal tableware, TV screens and display screen equipment are lead glasses. The borosilicate glasses are for making glass-fibers, wool insulation, and ovenware and thermo flasks. The alumino-silicates (technical glasses) are for scientific and optical apparatus. Certain percentages of electronic and electrical equipment are made of glass. Glass constitutes about 2.9% of the materials in automobiles (by weight) usually inform of flat glass (British Glass, 2001). In 1992 over 40 billion glass were produced in US alone and UK used approximately 2.2 million tonnes of glass each year.. Recently Glass industries in UK produce over 3 million tonnes of glass per year (WRAP, 2001). Glass containers are widely used to package the huge arrays of foods and drinks. Majority of these glasses are being recycled. For example in Australia over 1 million tonnes of glass are produced per year and almost 20 thousand tonnes of which are recycled.

Various steps are involved in glass production and at each step there is possibility of waste generation. This is depicted as in the process flow chart below (Figure 1). Production process involves series of steps; each step has its own input out put and waste. Each step adds value to the products and also adds a cost from the labour, materials and utilities used in the process steps. Considering the huge amount of glass being produced annually, the possibilities, of waste generation from the unset of production of the glass to the product life-span, a lot of waste will be generated (David, 2004). Glass industries in the West and Asian countries have long been utilizing the waste generated from the industries ranging from the cullets and the scrap glasses to produce new ones through recycling process. In glass manufacturing industry a lot of waste glass or cullets are produced. Currently about 67% of all the cullets is land filled or stock pilled; only 30% of the cullets are mixed with raw materials to produce new glass. The cullets are not only recycled by glass industries, it can also be exported to other countries instead of throwing it into landfills (ACI, 1997).

Waste minimization aims to reduce the amount of waste being produced and therefore results in savings in both raw materials and disposal costs as well as to reduce the potential environmental impact of waste. Waste minimization can also play an important role in reducing growth rates in the production of house hold waste. However measures are difficult to implement within households and success cannot be guaranteed (EU, 1998).

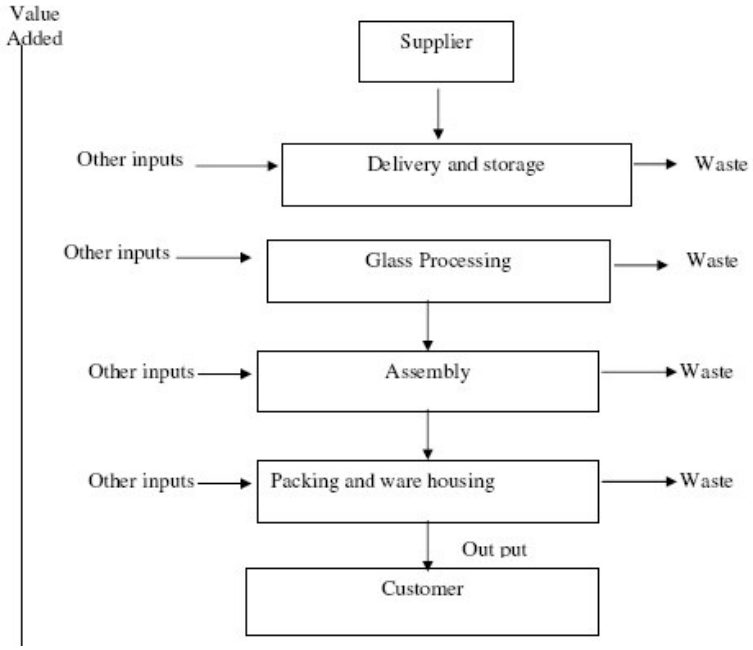

Figure 1. A process flow chart showing some typical inputs and out puts during glass processing (Waste management options, 2000).

Table 1. Problem associated with cullet usage.

S/N	Potential problem areas	Risk to float quality if not controlled
1.	Cullet from glass of different compositions (different chemical make-up) e.g. bottle glass and glass from table ware or oven ware	Optically different regions appear within the glass product, which have a composition different from the average.
2.	Mix of clear and tinted glass	Glass colour and solar control properties are upset.
3.	Contamination issue (metal attachments e.g. hinges, door handles insulating glass unit spacers), window framer, adhesives, glass printing, plastic from laminated glass.	Problems occur such as inclusions, bubbles, ream knots, colour variation
4.	Particles such as porcelain, china stones, bricks, dirts, concrete.	Problems occur such as inclusions; bubbles ream knots, colour variation.

(Waste management options, 2000).

CULLETS

Cullet is the main source of waste glass used as a feedstock in glass recycling. Potentially, there are certain problems that are usually encountered within the glass product procured of new glass. Some of the potential problem areas are: - summarized in the Table 1. Glass cullet is associated with contaminants, which beyond certain limit may interfere with the final product. Example of effect of contamination is presented in the Table 2. Contaminants greatly lowers the quality of the glass, the contaminated glass might not be able to be recycled which results in the generation of waste product, as such purification of the cullet is very important. Using cullets saves resources, saves energy, and glass melt at lower temperature than virgin raw materials thus less energy is required during manufacturing process (European Commission, 2001).

Ways of purifying crushed glass (cullets)

Depending on the impurities identified, batch and continuous experiment using thermal and chemical treatment method can be used to remove the identified impurities. The thermal treatment experiment is conducted in a batch, high temperature electric oven and then in continuous infra-heated thermal reactant. Flat glass could be recycled to other useful product via the routes below (Figure 2; Industry and Environment, 1994).

Table 2. Examples of the effect of contamination.

S/N	Potential problem areas	Effect
1.	Aluminum	Silicon inclusion and major bubble out break
2.	Refractory particles examples include: Chromite > 0.2 mm Carborundum > 0.5 mm	Bubbles, ream knots, colour variations.
3.	Silicon carbide	Major bubble out break
4.	Carbon	Affects melting and forming causing inclusions and bubbles. Also colour.
5.	Special steel particles	Inclusion, bubbles, colour variation.

(Waste management options, 2000).

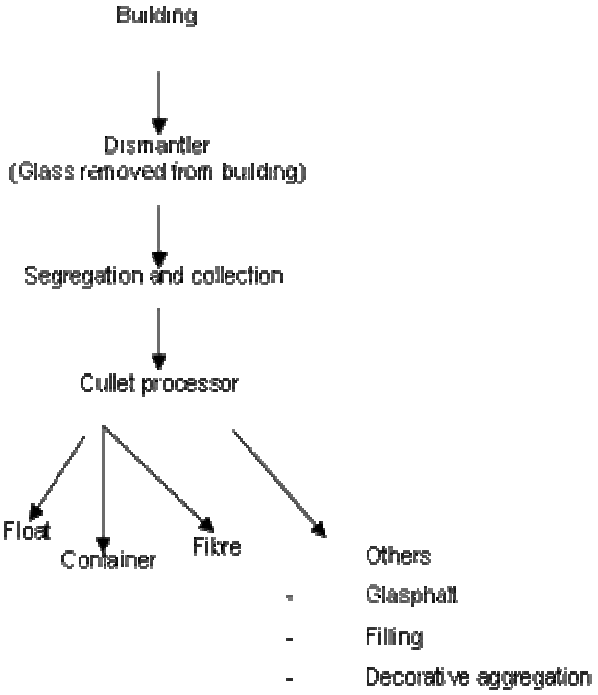

Figure 2. Waste from flat glass and its recycling (Glass in Building, 2005).

Glass to be recycled

Clear glass, (flint) green and brown bottle, soft drink mineral, water, wine, beer, all glass jars, spread and sauce battles can be recycled. Other possible wastes from glass industries are refractory scraps, from which glass facilities can also be recycled. Bricks manufacturers can use spent refractory bricks.

There is strong commitment by company management towards reducing waste refractory for successful recycling. It is cost intensive but steps towards reducing financial cost involves sorting of the materials by types communication and final separation refractory recycling from glass furnaces is an alternative to economical and environmental land filling (Glass in Building, 2005)

Effective utilization of cullets

Glass industries should be able to play an effective role in the development of practicable and economical solutions; this can be achieved by using good quality cullets from various sources. For effective cullets utilization:

A good way to estimate the limit of profitability is to consider the material value of the cullets that replaces batch raw materials.

Highest quality level is produced for flat glass because it gives an impression of sensitivity during melting processes.

Well-mixed cullets with constant chemical analysis ensure a stable melting process and avoid quality problems that may considerable diminish yield and cost.

Despite the advantages of the utilization of waste, shortcomings include capital outlay to redesign processes by industry and the difficulty for small companies and non-manufacturing companies to implement.

Survey

- In Australia over 300,000 tonnes of glass is being recycled annually.
- Glass can be recycled again and again indefinitely.
- For every tonne of glass produced in Australia one-third is recycled.
- In Switzerland 91% of manufactured glass is recovered from recycling. This termed as the best world recycling practice.
- Making glass from recycled materials required only 40% of energy needed to produce glass from the sand (Carew et al., 1994).

CONCLUSION

A lot of benefits are derived by management of industrial waste, some of which are conservation of raw materials in term of cost and environmental preservation. It also helps to reduce demand of land filling of waste. One great advantage of waste management particularly to glass industries is energy conservation; that it is by using

cullets to produce glass. Low energy input is required compared to using virgin raw materials (Klein and Huribut, 1997). A report from a glass fiber producing industry shows that for an every tonne of fiberglass produced from a recycle glass, an average of $3 – $8 per tonne is saved in terms of energy compared to using virgin raw materials. An estimate of $2 million in terms of energy conservation is saved and over $3 million is saved in case of disposal cost annually.

In the case of using cullets in glass producing, for every one tonne of cullet used 1.1 tonne of raw material is saved. Another advantage of environmental importance is reduction in emission from glass manufacturing process because the used glass has already been processed and it is close to its final form as such low energy is required during the process. There is an extensive benefit, in terms of cost and long term in recycling in that it is only effective or a form of waste reduction (Klein and Huribut, 1997). Generally principal sources of glass waste from glass industries can be from receiving and delivery areas; therefore improving clean up and maintenance in receiving areas can minimize waste because clean environment can make spills be collected and added to the raw materials.

Industrial wastes for long have constituted problems of land filling and environmental pollution. Utilizations of these wastes will invariably reduce problems. On the economic aspect particularly to the glass industries waste and their products, if properly utilized that is recycled, a lot of benefits will be realized by the companies in term of low energy input to produce high quality glass by using the cullets. It is known fact that recycled glass melt at lower temperature compared to the one produced using virgin raw materials of the same quality. It is also a way of reducing the exploitation of the raw material used to produce new glass. In this way land will be conserved for farming and the risk of erosion greatly reduced. In using virgin raw material for glass production a lot of gases are emitted which pollute the environment and endangered the living organisms, through emission of carbon dioxide that interferes with ozone layer which protect the atmosphere from the deadly ultraviolet light radiation.

Statistical results from the literature clearly favor waste management for greater productivity particularly for glass industries. Many directives are in place for waste regulation in order to safeguard the environment. Therefore the need for waste management is becoming a must for glass companies.

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