A waste glass remelting system

The collection, processing and remelting of waste glass filaments can be economical and no additional thermal energy is required. Charlie Coggin* discusses how to manage waste glass fibres on site, rather than sending them to landfill.

Waste glass cullet always results from the glass manufacturing process, and costly methods have been adopted to either dispose of the waste product in landfill dumps or process the cullet and return it to the melting process as a ground raw material.

Always complicating the reuse of waste glass cullet is the fact that organic contamination is usually present, and if not removed can affect glass redox and quality.

Disposal of this bulky scrap material (which can average 15% of glass melted) constitutes a major environmental problem, and by recycling it is possible to save money by replacing raw batch materials.

Furthermore, melting energy will be reduced because it is easier to melt waste glass cullet than batch materials, and environmental problems, costs and government fines will be reduced.

Cullet burner

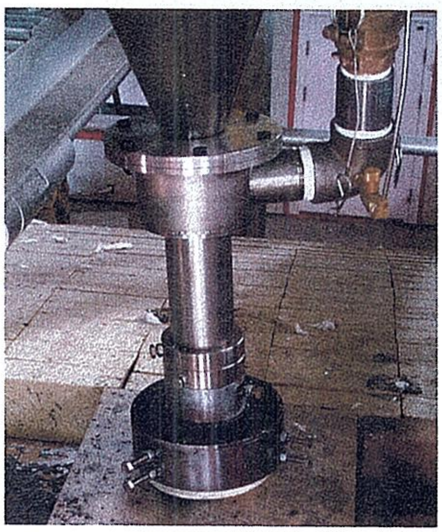
Glass Strand Inc (GSI) uses an oxygen/gas crown mounted Cullet-Burner (C-burner) to pass waste glass fibre cullet into a furnace used for producing quality glass from glass-forming raw batch materials (***Fig 1***). The burner flame rapidly incinerates all organics coating the waste glass surface in a high temperature, oxygen rich atmosphere before reaching the batch or glass melt. The small particles of glass (cullet) absorb energy rapidly and melt prior to reaching the surface of the glass bath.

The input of thermal energy from crown mounted burners has been practiced for a number of years and has proved to be the most energy efficient method of melting raw materials floating on the glass surface and imparting thermal energy into the glass from the atmosphere.

The C-burner is similar to oxygen-fuel burners, but with the means to insert smaller than 8mm particles of glass cullet from waste glass sources through the hottest portion of the flame and deposit the melted cullet on to the glass surface.

The burner invention also utilises the higher flame temperature and lower mass flow rate achievable with oxygen-fuel combustion to increase the heat transfer into glass, while maintaining refractory temperatures within operating limits.

The release of thermal energy directly into the glass cullet while passing through the flame is the most efficient method for melting glass. The milled particles of waste glass cullet pass through the hottest portion of the flame where the attached organic carbon rapidly oxidises away and the melted glass cullet spreads onto the batch or glass surface below. Thus, all traces of carbon are removed prior to reaching the glass bath.



▲ Fig 1. A C-Burner machine, used to melt waste glass fibre cullet before passing it into a batch melting furnace.

The continuous filament glass fibre industry collects and processes waste glass by grinding and heating it to above 650°C in a separate furnace and then adding it back into the batch as a raw material.

The most expensive portion of the process is the removal of organic materials to prevent redox problems with the glass in the furnace, resulting from carbon reactions with other batch ingredients.

The insulation fibre 'centrifugal' process produces relatively large amounts of edge-trim waste from the mats and this selvedge is an expensive waste by-product, which can be passed through this burner. Container glass cullet with labels can be ground and passed through the burner.

Oxygen atmosphere

The Cullet-Burner and associated waste-glass processing system provides a novel and economical method of incinerating all surface organic compounds in an oxygen atmosphere near 2,800°C it efficiently melts the waste glass cullet and other contaminants, without the cullet being first mixed and combined with the fresh batch feed, thus eliminating carbon reactions with raw materials.

The transfer of energy from the flame to the small particles of glass cullet is almost 100% efficient. The release of thermal energy by this burner directly into the glass cullet while passing

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through the flame is the most efficient method for melting glass.

Accordingly, the luminosity and high temperature portion of the flame is in direct contact with the glass cullet, thus increasing heat transfer via close radiation and strong convection. Consequently, the increased rate of heat transfer to the glass and batch results in a substantial increase in the rate of melting and fining of the glass.

The heating and melting of the glass cullet is much more rapid than if the particles were mixed with the loose powder batch raw materials in piles floating on the molten glass surface. A single small to mid-size crown mounted burner passing 240kg/hour or almost seven tons of waste glass per day allows the cullet to absorb energy for the glass cullet to reach 1500°C (***Table 1***).

Only a small amount of the burner's energy is required to raise the waste glass cullet to the temperature of the glass melt. All of the combustion energy remains in the melter, since the melted cullet and the absorbed energy become part of the glass contained in the furnace. Multiple cullet burners can be used to melt larger quantities.

The oxygen-fuel burner of this invention performs as a superior burner whether waste glass cullet is being charged or not. Therefore, stoppage or variation of material feeding has no adverse effect on the thermal condition of the furnace.

The glass cullet is inserted into a conduit separated from the fuel and oxidant gasses so that the presence or absence of glass cullet feeding has no effect on normal operation of the burner as a thermal source for the furnace.

The flow of glass cullet is in the form of a porous and surrounding curtain wall separating the oxidant from the fuel. The separation of oxidant and fuel by the energy absorbing cullet curtain creates a form of staged combustion, which lowers the flame temperature and reduces the formation of oxides of nitrogen.

The oxygen-fuel burner has an inner central cylindrical fuel conduit, a middle conduit concentric with the central fuel conduit, and an outer cylindrical conduit concentric with the middle conduit for providing oxygen. Pulverised glass cullet is dropped through the middle conduit without the aid of compressed gas.

The glass cullet falls down the nearly vertical burner tube under the influence of gravity, but is strongly aided by the resultant suction imposed on the middle conduit by the pressurised flows of gaseous fuel and oxygen gas exiting their concentric conduits.

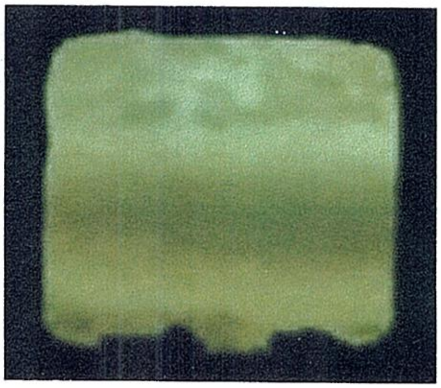
The burner is designed so as to control the velocity of the gaseous fuel and oxygen from the oxygen-fuel burner of this invention. This provides a generally laminar gaseous flow to combust above and impinge on the surface in the area of the glass-forming raw material floating on the glass surface.

Some small ports are open between the pressurised oxygen conduit and the middle cullet conduit to provide a gaseous force.

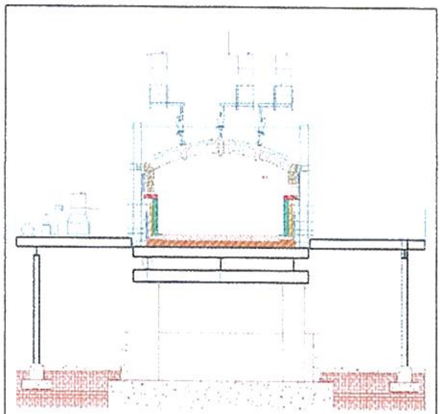
These accelerate the falling cullet particles and create a spiraling pattern of cullet particles to spread the particles more evenly in the form of a porous curtain wall and create a spiraling flow leaving the burner.

Burner energy release (Kcal / hour)	Energy to melt cullet (Kcal / hour)	% to melt cullet
Low Fire = 500,000	144,000	28.8 %
Hi-Fire = 1,250,000	144,000	11.6 %

▲ Table 1. Sharing the amount of energy needed to melt cullet.



▲ Fig 2. A 'view-port' showing the impact of melted cullet on the glass surface.



▲ Fig 3. Glass Strand's cullet transport and distribution system.

The spiraling flow of gases maintains a tighter column of flame and helps to prevent molten particles of glass from spreading away from the flame.

Cullet 'footprint'

The darker area seen in ***Fig 2*** is the impact 'footprint' of the melted cullet on the glass surface where piles of batch can be seen floating nearby. The small impact area demonstrates the fight spiraling flame, which prevents the particles from spreading.

The cullet transport and distribution system supplied by Glass Strand along with the cullet burner is shown in ***Fig 3***.

Small cullet supply hoppers with variable speed screw conveyors are associated with each crown-mounted burner and can be supplied from a cullet storage vessel at ground or furnace level.

Hot air collected from the furnace environment is used for conveying and removing moisture.

The waste glass cullet burner does not require the waste glass feed to the burner transport system to be ground to a powder or even be completely dry.

This is important with fibrous waste glass collected below winding equipment. The damp waste glass can be shredded by hammer mills while damp, transferred pneumatically to collection hoppers and then re-transferred by pneumatic or vacuum means to small feed hoppers located above the cullet burners.

It has been found that the low bulk density shredded filaments dry quickly in the hot environment above the furnace crown. The fact that only first stage shredding is required and further drying and size reduction is not required reduces the processing cost for the waste glass cullet to be fed through the burner.

The C-burner allows for a more economical method for reusing waste glass, will lower overall operating costs and is ecologically friendly. ■

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