Cord dispersal system reduces cat scratches on glass

In this article, Les Gaskell* introduces a cord dispersal system designed to eliminate cat scratches on glass by slow, continuous stirring.

Parkinson-Spencer Refractories (PSR) is a refractory manufacturer supplying refractories exclusively to the glass industry, together with glass conditioning systems.

Cord dispersal

PSR's cord dispersal system provides a solution to the cat scratch cord defect, which consists of a visible line or a series of lines on the outer surface of glass articles; particularly containers and thin blown tableware, which have the appearance of scratches made down the side of the article by a cat's claws.

It is considered a visual defect, not significantly affecting the strength of the article, although the lines can often be felt with the fingernail as ridges and can cause problems with the subsequent labelling or other surface decoration of the article.

The lines are due to a surface cord which is a vitreous defect having a different composition and hence different physical and chemical properties from the base glass being manufactured. This surface cord is a glass enriched in alumina and/or zirconia by typically 2 to 6% compared to the base glass and originates from the dissolution of refractories into the glass being manufactured. It is more viscous than the base glass and its presence on the surface of the container derives from its presence on the surface of the gob, which in turn is due to it being concentrated in the bottom glass of the feeder spout and forehearth channel.

The most probable source of this viscous cat scratch cord material is the vitreous (glassy) phase of the fusion cast alumina-zirconia-silica (AZS) refractories extensively used in the furnace melting-end tank and superstructure. This glassy phase exudes from the fusion cast AZS refractory surface during the initial heat-up of the furnace and dissolves into the glass during the subsequent corrosion of these refractories during the furnace campaign. Under normal circumstances, these exudation and corrosion products are incorporated into the glass melt and mainly remain dispersed, only registering as minor changes in the final glass analysis.

However, if the exudation is excessive during initial heating, the corrosion rate is excessive at any time during the furnace campaign due to a particular operating problem. Alternatively, the resultant viscous glassy phase accumulates in an area of the furnace, distributor or forehearth and subsequently becomes mobile. This can result in the material being concentrated rather than dispersed in the base glass and thus manifest as the cat scratch cord defect.

▲ Hot replacement of equalising section roof.

Eliminating cat scratch

Other than temporary short-term methods to eliminate cat scratches, such as changing the direction and speed of the feeder tube rotation, replacing the feeder orifice ring, replacing the feeder spout or draining the forehearth of glass; the two main methods adopted are continuous draining and stirring.

Draining relies on collecting and removing all the viscous cord material that has settled out before it reaches the feeder spout. Although many companies

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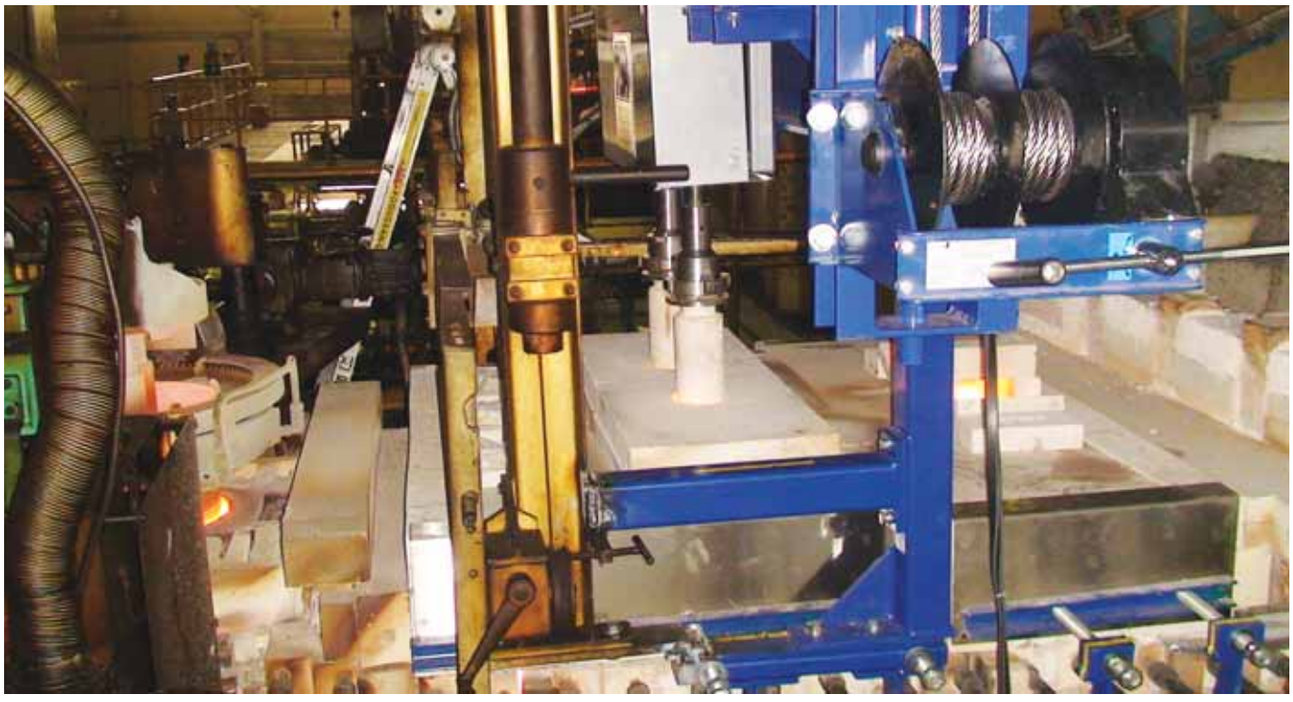

▲ Cord dispersal stirrer system.

believe that it is better to remove this material from the glass, this is very difficult to achieve in practice. It requires a special drain block or sump to be provided where the cord material can be collected and then drained out of the glass flow. The drain sump area is electrically heated to control the drain outlet temperature and thereby the glass flow.

Drains were initially installed in the bottom of the furnace throat, but this was only partially successful because the viscous corrosion products do not all settle out at this point and are more likely to settle out in the forehearths and distributor, due to the much lower temperatures and throughput. They are now installed near the end of each forehearth to ensure the material is collected wherever it may settle out during the conditioning process.

The major disadvantages of draining are the loss of glass, which could otherwise be used for production and the fact that a special drain block needs to be installed to collect the cat scratch cord material. Although theoretically the contaminated glass should be discarded, in practice it is often returned to the furnace with the other cullet.

The special drain block cannot be installed without shutting down the forehearth. Many companies install these drain blocks in the forehearth during a furnace rebuild in case they should encounter a future cat scratch cord problem. However, as the purpose of the drain blocks is to collect the cat scratch cord material, this action can actually precipitate a cat scratch problem during the campaign, making it then necessary to use the drain.

The installation of a drain cannot guarantee the elimination of the cat scratch cord because the drain blocks have a limited capacity to contain the cat scratch cord material. They also have a limited maximum flow capacity of approximately 1·5 tonnes per day, as at higher flows, hotter surface glass can be preferentially pulled down through the drain instead of the cord material. These factors can result in the excess cord material flowing past rather than being collected and drained.

Stirring relies on re-dispersing the cat scratch cord material into the glass before it reaches the feeder spout. The stirrers lift the viscous glass off the bottom of the forehearth channel and mix it into the body of the glass so that it is no longer concentrated on the gob surface, but is instead distributed throughout the base and sidewalls of the article during the forming process and is no longer visible in the finished product.

Many in the glass industry still regard the use of stirrers as 'old technology' and consider it unsuitable for the elimination of the cat scratch cord defect. This is generally due to their experience with the use of traditional blenders in the equalising section, which are helical stirrers positioned towards the channel side walls designed to improve glass thermal homogeneity. Traditional equalising section blenders are not suitable for the dispersal of cat scratch cord because the viscous glass will pass between the stirrers, particularly in wider equalising sections.

Others consider that more efficient stirring can be achieved with the hotter and less viscous glass at the forehearth entrance and install one or more banks of helical stirrers across the forehearth channel in this location, as used in colourant forehearths. This stirrer configuration is also unsuitable for cat scratch cord dispersal because the viscous glass can settle out again downstream from the stirrers, or it may already only be settling out in the colder areas along the forehearth.

The successful elimination of the cat scratch cord defect requires the correct stirrer design, location, configuration, installation and operation.

Cord dispersal stirring

The PSR cord dispersal system uses twin counter rotating and bladed, paddle type stirrers installed in the equalising section.

The paddle stirrers have left and right-hand blades and are rotated in opposite directions to lift glass off the channel base, as well as move glass from

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the channel sidewalls to the centre and towards the feeder spout. The left-hand bladed paddles are rotated anti-clockwise while the right-hand bladed stirrers are rotated clockwise to lift the glass. The stirrers are operated as close to the channel base as possible with the paddle blades at 90° to each other and configured to overlap and cover as much of the channel base as possible to provide efficient stirring across the channel base. The exact stirrer design and configuration for each installation depends on the channel width, profile and depth at the required stirrer location.

As a feeder expendable supplier, PSR supplies a wide range of stirrer designs suitable for different applications and can manufacture new stirrer designs if necessary for a particular application.

Equalising

Every new PSR forehearth is supplied already configured for the possible on-the-run installation of a cord dispersal stirrer system. A suitable access slot is provided in the equalising section superstructure refractories and the superstructure bracing steelwork is configured with the necessary support mountings for the stirrer mechanism. However, most installations have been carried out on other forehearth designs.

For existing forehearth designs, if a suitable access slot is not available, then the equalising section superstructure refractories must be replaced to provide the necessary stirrer access slot. This can be carried out while hot, during an extended job change or other machine stoppage such as a feeder spout change. The replacement equalising section superstructure refractories are designed to match the existing design as closely as possible, while incorporating the necessary access slot for the stirrers to minimise the refractories that need to be replaced hot and thereby minimise downtime.

The superstructure refractories are supplied in PSR 333 material, which is suitable for hot installation. Suitable roof block lifting frames and temporary, lightweight, high-grade ceramic fibre roof block covers are supplied to assist with the hot replacement operation. The superstructure bracing steelwork incorporating the necessary support mountings for the stirrer mechanism is installed at the same time. Typical production downtime would be four to eight hours, depending on the quantity of refractories that have to be replaced.

The stirrer mechanism and support frames can be installed on-the-run during normal operation of the forehearth once the superstructure refractories have been replaced.

Stirrer operation

The stirrers should be operated as slowly as possible to achieve the dispersal of the cat scratch cord with minimum stirrer and additional channel block refractory wear. Stirrer speeds are normally in the range of two to 15 revolutions per minute (rpm) with 5 rpm being typical.

Initially, any cord material already built up downstream from the stirrers on the equalising section channel blocks and spout must be washed out with the clean glass provided by the operation of the stirrers. The time required for this depends on the age and condition of the channel blocks and spout as the cord material tends to accumulate in cracks and badly worn areas. Carrying out the stirrer system installation during a feeder spout change helps to speed up this process, as the equalising section channel blocks are normally drained of glass and the feeder spout is new.

Following this initial period, adjusting the stirrer speed can closely and predictably control appearance. The stirrer speed can be reduced to the minimum required. The stirrers are normally continuously operated to guard against the build-up and appearance of cat scratch cord. However, they can be stopped and raised above the glass into the roof space or completely removed if considered necessary when no cord is present.

The stirrer operation does not interfere with thermocouple readings or gob weight control and can help to improve the glass thermal homogeneity at the feeder spout entrance. It can also help to minimise glass head loss at high forehearth loads.

Stirrers are supplied in PSR 333 material. Stirrer life depends on the glass composition, glass temperature and stirrer speed and ranges from three to 12 months, with nine months being typical. As the stirrers wear over time, stirrer speed needs to be increased to maintain the same effect.

Installations

PSR has designed, manufactured, supplied and supervised the installation of approximately 70 cord dispersal systems to date. These have been installed on forehearths ranging from 16 inches (406mm) to 48 inches (1220mm) wide, of different designs and producing different glass colours (white flint, amber and green). The company has installed cord dispersal systems on forehearths with electric boost electrodes installed in the equalising sections, as well as on forehearths with drains (the drains have subsequently been stopped allowing increased production). It has also installed systems on forehearths supplying gathering bays operating with robot ball gatherers. ■

▲ Stirrer control panel.

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