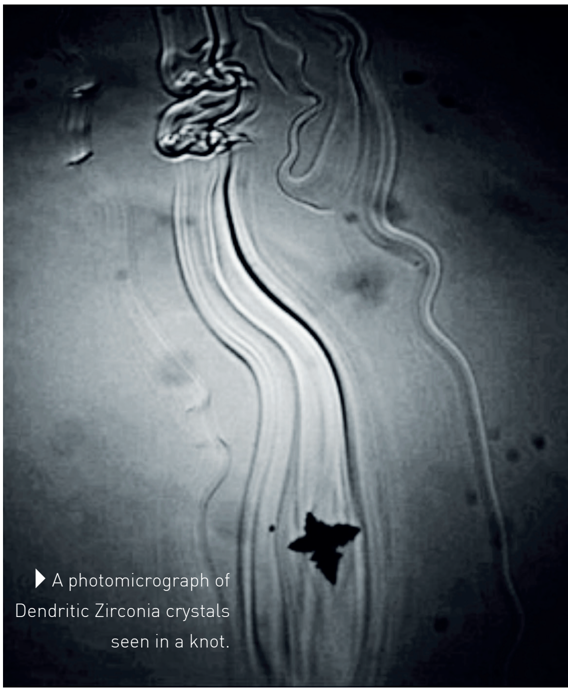
Unusual behaviour of knots in a float glass furnace

Bala Mookoni* discusses the problem and possible causes of knots in a float glass furnace.



A photomicrograph of Dendritic Zirconia crystals seen in a knot.

Identifying the source in an outbreak of defects in a glass melting furnace is always tricky. When the defects are knots containing alumina and zirconia, the problem is often one of determining whether the source is glass-contact or superstructure AZS refractory.

If the source is the superstructure then the alumina in the in-situ defect is higher than in the glassy phase of the refractory. This is because the in-diffusion of the alkalis causes the dissolution of the alumina crystals into the glass matrix in the refractory. If it is glass-contact then the alumina in the original defect is lower, as the alumina in the refractory gets dissolved into the glass melt.

Further, the dissolution of zirconia increases when the alumina content in the defect is lower. It has been seen that when the ratio of alumina to zirconia in the defect is high, the source is likely to be the superstructure, and when it is closer to unity, it is glass-contact AZS.

In the case of a float furnace, the defect (a knot) exhibited a ratio of 14 in the beginning that tapered down to 1 in the span of a year. It was safe to believe that the source of the knots was the same because there was a pattern: the knots were invariably linear in incidence.

Knot composition

It was interesting to observe that in the composition of the knot, the percentages of silica, MgO and CaO fell to accommodate the presence of alumina and zirconia, and Na2O showed a slight rise. The ratio of silica to sodium oxide decreased from 5.25 in the glass to 5 and below in the knot.

This, and the high ratios of alumina to zirconia at the early stages of this defect phenomenon, pointed to a superstructure source.

Further, the defects formed a linear chain in the glass in spells that often lasted over an hour. A chain of defects indicates a source that is located in the zones of the furnace that have unhindered laminar flow, which is more likely in the refiner than in the melter.

Since in the refiner the superstructure is a more potent source of AZS knots than the glass-contact refractory, it is logical to infer that the likeliest source of the defect was the superstructure in the refiner.

What was again interesting to note is that the defects managed to remain as a chain even during their passage through the stirrers and coolers in the waist. An inference of this is that the glass retains its laminar nature even in the apparently turbulent zone of the stirrers.

Some float lines have stirrers in the canal, something that is anathema for many designers who believe that such stirring creates the antithesis of the layer-stratification that is needed for the high optical quality of float glass in the canal.

Yet, the fact that glass with such stirrers is capable of producing excellent optical quality is yet another indicator that the action of the stirrers does not create turbulence—the new flow patterns that arise are still in the laminar range.

Puzzle

The outbreak of the defect created another puzzle: the defects were high in number in thin glass and quite negligible in thick glass. This almost created the illusion that the outbreak was linked to a change of thickness. A close study revealed the cause of this conundrum.

In thin glass, the defect was located on the bottom side of the glass while in thick glass the defect rose up away from the bottom surface, due to the forming action in the tin bath.

When the defect lay at the bottom side, it created a surface aberration that got accentuated in the journey of the glass ribbon over the lehr rollers, creating a distortion that got rejected by the defect scanner. In thick glass, the embedded vitreous defect that had no distortion often went undetected by the defect scanner.

The defects persisted for more than two years, begging the question as to how such prolonged corrosion had left no apparent tell-tale signs in the refractory.

A simple calculation showed that not even 2kg of refractory was corroded in a year, even though the havoc wreaked on the yields was colossal. ■

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www.hilllakes.com/index.html