THE EFFECT OF THE PREPARATION CONDITIONS
OF THE MELT ON THE OPTICAL DISTORTION
OF FLAT GLASS

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One of the fundamental criteria in evaluating the quality of flat glass is the degree of the optical
distortion in the glass. In this connection it has become necessary to find the conditions which will ensure the
production of a high quality flat glass.

Much statistical material showing the mutual connection between the melting processes and the quality
of the flat glass has been accumulated at the Bor Plant. The quality of the glass strip with respect to optical
distortion is monitored at the Plant by two methods: the "zebra" method (measurement of the angle be-
tween the planes of the glass sheet and of a screen at which no bending of the lines on the screen is ob-
served) and a shadow projection method. The methods are complementary and together make it possible
not only to evaluate the quality of the glass by optical distortion but also to classify the distortions accord-
ing to the way in which they have been generated.

At the same time the Plant has monitored the chemical uniformity of the glass using a centrifuge
which has made it possible to establish the part played by this parameter in the development of optical
distortions in the glass strip.

Under the Plant production conditions the greatest optical distortions were observed in the central
portion of the strip and were produced by threadlike inclusions of a striate type. It could therefore be

<table>
<thead>
<tr>
<th>Location of sample</th>
<th>Uniformity, °C</th>
<th>Amount of fraction, %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>first</td>
<td>second</td>
</tr>
<tr>
<td></td>
<td>determination</td>
<td>determination</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Throughout the thickness of the strip:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>left-hand side</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>center</td>
<td>1.9</td>
<td>1.7</td>
</tr>
<tr>
<td>right-hand side</td>
<td>1.2</td>
<td>Not determined</td>
</tr>
<tr>
<td>A 1 mm surface layer:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>left-hand side</td>
<td>4.5</td>
<td>2.5</td>
</tr>
<tr>
<td>center</td>
<td>3.8</td>
<td>2.7</td>
</tr>
<tr>
<td>right-hand side</td>
<td>3.5</td>
<td>2.4</td>
</tr>
</tbody>
</table>

State Scientific-Research Institute of Glass. Maxim Gor'kil Bor Glass Plant. Translated from Steklo
i Keramika, No. 4, pp. 6-7, April, 1973.
assumed that the deterioration in the quality of the glass was caused by the low chemical uniformity of the melt due to possible weakening of the filling cycle of currents and to the flowing of an SiO₂ enriched layer of melt through the hot spot into the working current, to low quality batch, to low melting temperatures, etc.

When a sample of glass from the glass strip, was centrifuged a light fraction of glass enriched by SiO₂ was found to be present in an amount of < 5% while in vertical-drawing system furnaces with a high yield of melt the content of SiO₂ can reach 20%.

A study of the change in chemical composition through the strip (Table 1) showed that no deterioration in the uniformity of the melt across the whole width could be observed in the central region of the strip where the threadlike striae most frequently appear under the Bor production conditions.

It is also clear from the table that the uniformity of the glass samples selected from the surface layers of the strip (ground off to a depth of ~1 mm) and containing coarse threadlike inclusions exhibited a lower chemical uniformity than in the samples taken from the whole thickness of the strip. Consequently the nonuniform glass which causes the distortions is in a layer of the strip.

Since such a degradation in the uniformity of the surface layer of the melt occurred periodically we may conclude that the optical distortions in the glass were caused by nonuniformities in small volumes of melt which vary with time.

These results show that the centrifuging method does not provide an opportunity to observe local deviations in the chemical uniformity of the glass.

While the Plant was starting up the new composition department, cristobalite inclusions appeared periodically in the glass strip simultaneously with the coarse optical distortions. A study over a long period of the statistical connection between these two defects showed that, with a probability of 95%, their occurrence in the strip was caused by a single factor (correlation coefficient 0.5%). This connection was used as the basis of a study of the effect of batch quality on the optical distortions. The quality of the strip was poorer and showed an increase in the deviations on the high side in the concentration of insoluble material in the composition of the batch. This dependence was followed up for several months during the initial period of operation in the new composition department.

For isolated periods the quality of the batch deteriorated with a rather low concentration of insolubles in the batch due to nonuniformity in mixing the batch components. An analogous connection was observed between the quality of the batch and the concentration of cristobalite inclusions in the glass strip.

![Fig. 1. The effect of the temperature level in the furnace on the quality of the glass with respect to optical distortions.](image-url)