When thermal glass-shaping lines were introduced in the USSR, no special glass composition for them was devised, but instead a composition was adopted close to that used in continuous rolling on the basis of foreign experience.

The following glass composition is now recommended for such lines (in mass %, subsequently): 71.5-73.0 SiO₂, 1.0-2.0 Al₂O₃, 0.1 ≤ Fe₂O₃, 8.2-8.7 CaO, 3.4-3.8 MgO, 13.1-13.6 Na₂O, 0.5 ≤ SO₃, which virtually covers the entire range of glass compositions handled by that method.

It is desirable to optimize the glass composition for the purpose in order to improve the technology.

There are the following reasons for this:

1) the throughput on a line is usually limited by that in the furnace source;
2) increasing processing speeds requires either lengthening the liquid bath of accelerating the heat transfer in it; and
3) the chemical stability of the glass needs to be improved.

There are the following ways of optimizing the glass composition for the purpose:

1) reducing the melting and processing temperatures and reducing the viscosity of the glass in the working temperature range, which enables one either to raise the throughput or to reduce the energy consumption in melting, while improving the heat-transfer conditions in the bath;
2) increasing the setting rate to raise the processing speed; and
3) improving the chemical stability.

It is thus necessary to alter the composition in such a way as to reduce the viscosity, increase the setting rate, and improve the stability without increasing the consumption of alkali raw materials.

Experience with designing glass compositions shows that one should increase the contents of alkaline earth oxides RO and of Al₂O₃, and it may also be possible to increase the contents of the alkali oxides R₂O somewhat, since they partially enter the glass with the raw material containing aluminum, so there is no increased demand for soda.

The composition has been optimized in several stages. This institute researched improved stability in thermally polished glass based on increasing the Al₂O₃ [1]; a glass containing 1.8% Al₂O₃ has been produced since 1981 at the Saratov technical glass plant. However, the modified composition did not merely improve the chemical stability but also raised the refractoriness, which hindered melting and homogenization.

To modify the melting, the content of alkaline earth oxides was increased from 12.3 to 13.6% [2], and tests showed improved throughput, with reduced specific fuel consumption and with simultaneous improvement in the glass quality and strength. However, raising the chemical stability for constant R₂O content was not attained.

These researches were extended to other properties, which involved more radical composition change.

Compound Al₂O₃ has a favorable effect on the working properties and chemical stability; it has proved possible to raise the pulling rate in this type of system by increasing the Al₂O₃ content. Also, for given contents of the other components, Al₂O₃ reduces the tendency to crystallization. It was therefore necessary first to determine the scope for increasing
the \( \text{Al}_2\text{O}_3 \) in glasses to be processed on these lines. It was borne in mind that the glass becomes more refractory when \( \text{Al}_2\text{O}_3 \) is raised.

It appeared promising to raise the alkaline earth oxides; those components, particularly \( \text{CaO} \), are fluxes at the melting and working temperatures but raise the viscosity in the low-temperature range and make the working range shorter. They are available as cheap and plentiful raw materials: dolomite and limestone, whose addition to the charge reduces the cost.

The main disadvantage is that the glass has an elevated tendency to crystallize when the \( \text{RO} \) content increases, where the crystalline phases are usually wollastonite and devitrite, which have high crystal growth rates. This sets a limit to the \( \text{RO} \) for glasses to be handled by normal and fast processing lines. In thermal forming, the initial processing temperature corresponds to a low viscosity (log \( \eta = 3.5 \)), and the difference between the forming temperature and the upper crystallization limit \( t_{uc} \), the so-called safe working interval, is more than 100°C, so it is possible to raise \( t_{uc} \) by increasing the \( \text{RO} \) content without the danger of crystallization during processing.

Compound \( \text{P}_2\text{O}_5 \) also reduces the crystallization tendency; the scope for adding it to these processing line glasses remain to be elucidated.

We examined commercial glasses whose % contents were up to 5 \( \text{Al}_2\text{O}_3 \), up to 16 \( \text{RO} \), and 12-15 \( \text{R}_2\text{O} \); some of them additionally contained 0.5-3% \( \text{K}_2\text{O} \). The glasses were melted in platinum crucibles in a crucible furnace at the experimental furnace run by this institute.

We determined the crystallization behavior, viscosity, and resistance to water and alkalies, and calculated the working characteristics.

We found that:

1) increasing the alkaline earth oxide content increased the tendency to crystallization but reduced the viscosity, and with contents over 15%, the glass could crystallize during processing;

2) \( \text{P}_2\text{O}_5 \) improves the crystallization tendency;

3) adding \( \text{K}_2\text{O} \) while maintaining an equivalent sum of the \( \text{R}_2\text{O} \) did not raise the resistance appreciably; and

4) the water resistance was improved by increasing the \( \text{Al}_2\text{O}_3 \) content even though \( \text{R}_2\text{O} \) increased simultaneously.

These glasses included ones having much lower melting and working temperatures, higher setting rates, and better chemical stability.

For example, there was a glass containing elevated amounts of \( \text{Al}_2\text{O}_3 \) and \( \text{RO} \) with 14% \( \text{R}_2\text{O} \), which had the following advantages over the glass processed on these lines at the Bor glass plant: melting temperature reduced by 38°C, forming temperature by 22°C, increase in relative solidification rate by 2.6%, an improved chemical resistance, and soda consumption reduced by 5.5 kg/t.

One can thus recommend a glass for these lines with reduced melting and working temperatures and showing elevated chemical resistance and setting rate (Table 1).

This composition enables one either to reduce the energy consumption in producing glass for these lines or to increase the throughput for a fixed heating load by improving the melting behavior and raising the pulling rate for the strip, as well as improving the working characteristics.