FURNACE FOR HEATING FEEDER SHEARS

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To cut molten glass having a temperature of 1200-1250° on glass-melting furnaces it is usual to install knives, the shear faces of which are prepared from alloy steel grades R9 and R18M. In preparing the cutting edges, the following technical steps are carried out: heating with stamping, stamping, heating by thermo-processing, hardening in oil, and annealing. Because of the high temperatures of the molten glass, the life of the shears is not great, and as a result the factory needs to improve the quality of the shears.

At the Gostomel'sk Glass Factory shears 1.5 mm thick are heated in a chamber furnace with roof burners. The furnace is brought to the required temperature schedule after 10-12 h. The shears are loaded into the furnace in packets and heated for 5-6 min, and then subjected to hardening in oil. The hardness of the shears was 30-35 units on the Rockwell scale, and the loss due to buckling amounted to 35-40%. Scale formation developed on the surface of the metal.

![Fig. 1](image1)

**Fig. 1.** Heat-treatment furnace with a fluidized bed. 1) Mixing chamber; 2) device for feeding gas and air; 3) gas-distribution baffle; 4) thermocouple; 5) shear blades; 6) heating chamber; 7) hose; 8) connecting pipe; 9) slab.

![Fig. 2](image2)

**Fig. 2.** Change in the temperature of the fluidized bed over the height.
1) Coefficient of air consumption, $\alpha = 1$; 2) $\alpha = 1.1$; 3) $\alpha = 1.2$; 4) $\alpha = 1.3$.

Diameter of particles 0.25-1 mm.


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<table>
<thead>
<tr>
<th>Factor</th>
<th>Chamber heat-treatment furnace</th>
<th>Fluidized bed furnace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output area, m²</td>
<td>2.5</td>
<td>0.6</td>
</tr>
<tr>
<td>Gas consumption, m³/h</td>
<td>30</td>
<td>6-8</td>
</tr>
<tr>
<td>Loss due to buckling, %</td>
<td>35-40</td>
<td>-</td>
</tr>
<tr>
<td>Rockwell hardness of the shears</td>
<td>30-35</td>
<td>62-75</td>
</tr>
</tbody>
</table>

To eliminate these drawbacks the factory has constructed a furnace with a fluidized bed of inert heat carrier for heating the shears during thermal processing. The furnace (Fig. 1) consists of a heating chamber lined with firebrick, a mixing chamber, and a gas-distribution baffle. Connecting pipes are specified for discharging the heat carrier.

The gas-distribution porous baffle is made according to the method specified for unfired ceramics [1]. To bond the grains measuring 2-3 mm we use a bond containing 1% MgO, 75% calcined aluminum, and 24% fireclay. The batch in amounts of 10% of the weight of the crumbs is mixed with an aqueous solution of orthophosphoric acid in the ratio of 0.8 liter of solution per kg of dry body. The shaped slab 20 mm thick was then placed on a perforated ceramic lattice with a cross section of 30%. The porous slab was densified and subjected to heat processing at 400-450°. The inert carrier consisted of a high-alumina powder, fractions 1.0-1.5 mm. The firing agent consisted of a gas-air mixture burnt directly in the bed. The consumption of gas and air in the furnace was respectively 6-8 and 70-95 m³/h (STP).

In firing the furnace we charged 5-10 kg of crumbs and burnt the gas-air mixture in the combustion chamber. When the mixture in the furnace was ignited it made characteristic explosions until the temperature of the fluidized bed reached 850-900°, after which the explosions ceased, and the crumbs were added to the furnace up to the level corresponding to a fluidized bed layer of 250-300 mm.

The combustion zone for the natural gas with a coefficient of air consumption of $\alpha = 1-1.3$ terminates at a height of up to 20 mm from the grid level [2] (Fig. 2), depending on the temperature of the bed. Beyond the limits of the combustion zone of the fluidized bed we assume that the temperature is constant over the entire volume, and differs from the maximum by 100-300°. Therefore, the blades are arranged in the furnace at a height of 40-50 mm from the gas-distribution baffle.

The temperature in the fluidized bed was checked with a thermocouple at a height of 120 mm from the baffle. The warming-up time was 10-15 min. The actual velocity of the combustion products, calculated over the complete cross section of the furnace, was 1.7-2.3 m/sec, which provided stable fluidization and excellent blending of the inert heat carrier.

The blades were loaded into the fluidized bed on a hosepipe. When they were being loaded into the furnace the temperature of the bed hardly altered. The dwell time of the particles (or aggregates of them) about the surface, as shown by measurements with a Kiev-16U camera with a speed up to 64 shots a second, changed from 0.05 to 0.15 sec. Then the particles were removed from the surface by the gas stream, and at the site of the bubble new portions of particles were allowed to enter, heated to the temperature of the middle of the bed (Fig. 3).

Owing to the uniform heating, loss due to buckling was eliminated. The hardness of the shears after heat processing depends on the dwell time in the fluidized bed, and is characterized by the following data: