OVERHEAD FUELLING AND BATCH-LOADING
SYSTEM FOR ORE-MELTING TANK FURNACES

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In order to intensify the melting process for basic rocks of magmatic origin (amphibolite, diabase, basalt, etc.), we have developed a series of small tank furnaces of a new type; the special feature of these is the combined supply of batch and gas fuel through the furnace crown, perpendicular to the surface of the melt, by means of numerous gas and batch nozzles distributed over the melting end of the tank [1]. Such furnaces are significantly better in relation to specific yield of glass and unit fuel consumption than the usual stone-melting furnaces. At the present time they have been installed in several enterprises. The practical experience which has been gained makes it possible to plan some larger furnaces based on the same principle.

This article considers the equipment and operational principle of the fuel and batch-loading system which are both important and are also the most distinctive features in relation to the usual furnaces of a particular melting assembly.

In normal glass-melting tank furnaces the flame is spread out in a horizontal direction and of the total amount of heat supplied from the flame to the tank,

\[ Q = Q_r + Q_c \]

only 5-15% belongs to the convective component \( Q_c \) and the remainder is the radiant heat \( Q_r \) [2]. In furnaces where the direction of the flame is vertical to the direction of the clear surface of the melt, the convective component of the heat exchange is increased and the addition of batch to a large number of flames distributed over the tank intensifies the melting process by supplying batch to the zone where the flame strikes the melt (i.e., in the zone of maximum temperature and convective heat currents) and also by making use of the maximum distribution of the charge in relation both to the furnace area and also to time. Because of the necessity of obtaining short, high-temperature flames, the overhead fuelling is done by a gas-air mixture.

Figure 1 shows the layout of the fuel and batch-loading system of the tank furnace at the Irpensk Progress Combine of Structural Materials. The furnace has a tank area of \( 0.4 \times 2 = 0.8 \) m\(^2\) and a productivity when the melt is bubbled of 5000 kg/day [1].

The air for the combustion mixture is fed into the system from a high-pressure fan (1) through a metal recuperator (2) consisting of two sections: radiative (slot) and convective (piping). The air is heated in the recuperator by heat from the exhaust gas to a temperature of 300-400°C and reaches the mixer (3) where it is mixed with natural gas supplied from the gas mains. The gas-air mixture thus obtained reaches the burners (4) of the furnace. The centralized preparation of the gas-air mixture is one of the special features of this system since in normal direct-heating furnaces the gas and air arrive at the burners separately and this makes it difficult to regulate the components of the mixture. A common batch charger (5) is installed over the burners arranged in a single row along the crown. The fuelling systems of the two feeders (not shown in diagram) are supplied with air from the fan (1) through the recuperator (2) but have individual mixers.

The burner (Fig. 2) has the following construction. Inside the hollow body (1) there is a circular open-ended vertical charging channel (2) of diameter 25 mm finished above with a calibrating sleeve (3) and a charging funnel (4). The batch passes through the funnel into the charging channel; the batch consists of ore milled to a particle size of 10 mm or less. The calibration sleeve has an opening whose diameter is 3 mm less than the diameter of the charging channel and prevents the latter from becoming choked by large lumps. The walls of the charging channel and the body enclosing it form the circular channel (5) along which the gas-air mixture arrives from the mixer. In the lower part of the body there is a constricted region forming a round nozzle (6) with the lower end of the charging channel; the outlet hole is 4 mm. All the elements of the burner except for the nozzle are made from carbon steel (tubes and 3 mm sheet); the nozzle is made from heat-resistant steel grade Kh18N10T.

Fig. 1. Layout of fuel and charging system of the tank furnace: 1) high-pressure fan; 2) convective-radiant recuperator; 3) mixer; 4) burner; 5) charger; 6) tank furnace; 7) safety-valve; 8) cut-off valve (gate); 9) reverse valve; 10) faucet.

Fig. 2. Layout of burners.

Below we give the characteristics of the burners:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>Consumption:</td>
<td></td>
</tr>
<tr>
<td>gas</td>
<td>5 m³/h</td>
</tr>
<tr>
<td>batch</td>
<td>40 kg/h</td>
</tr>
<tr>
<td>Cross section of nozzle</td>
<td>5 cm²</td>
</tr>
<tr>
<td>Pressure of gas-air mixture</td>
<td>0.006 MPa</td>
</tr>
<tr>
<td>Rate of flow of mixture from nozzle</td>
<td>55 m/sec</td>
</tr>
</tbody>
</table>

Since the batch charging is reduced to the free fall of batch particles down the vertical channel of the burner, the design of the charging unit (7) is extremely simple. The main working part is a 60 mm diameter spindle with two journal bearings at its end; this is brought into motion by a gear drive consisting of a one-kilowatt electric motor and a worm reducing gear. The rotational frequency of the spindle is 2-3 rev/min. The length of the spindle corresponds to the total length of the funnel of the entire assembly installed in the furnace port. The spindle is in contact with the batch bunker above. Opposite each funnel, there are slots for the batch to pass through the walls of the bunker facing the side of the rotation of the spindle. When the spindle rotates, particles of batch are drawn out and are scattered on to a sloping chute along which they roll into the funnels.

The productivity of the charging unit depends on the rotational frequency of the spindle and the area of the cross section of the outlet holes in the bunker. By changing the size of these holes by means of a choke with regulating screws it is possible to control the consumption of batch.

The charging unit of this design is reliable in use and ensures the necessary stable supply of batch to the furnace. The specified level of melt in the furnace is maintained automatically by means of a needle-type level gauge mounted on the feeder which is interlocked with the starter of the batch-charging unit.

The nozzles of the burners are mounted in the port apertures (9) of the refractory crown burner block (9). Particular attention has been paid to the correct installation of the burners. Too great a depth of insertion of the nozzle into the opening of the burner block leads to the overheating of the nozzle and to its gradual burn-up and, as a result, the outlet aperture is reduced in size. Moreover, when the nozzle is overheated,