Small Melting Furnace Simulates Industrial Conditions

by B. M. Larsen

Fig. 1—Side view showing tilting and counterweight arrangement.

Design Reproduces Conditions of Basic Open Hearth And Electric Furnaces

THE purpose of this furnace design is to produce conditions in which flame radiation comes from above the bath. An electric arc is put in place of the flame as a small radiation source, thereby avoiding the requirement of preheated air. The reducing effect of the carbon arc is not very different from that of the flame zone. Movable brackets and a tilting arrangement for the electrode holders allow the arc to be projected directly on the bath surface or to move it up 8 to 10 in. when desired to minimize arc reducing effect on the bath surface.

Electrodes of 2½-in. diam make it possible to overpower up to around 60 to 65 kw at moderate arc voltages, overcoming inherent handicaps of intermittent operation under laboratory conditions. For drying or preheating the furnace, a long carborundum Globar unit can be substituted for the graphite electrodes. The power supply is a 75 kva air-cooled transformer with variable taps and an air-cooled variable inductance. By using 110 or 220 v primary input, delivered voltage can vary from 40 to 140 v to meet a variety of furnace applications.

The furnace is arranged to be tilted about an axis through the point at which the tap stream leaves the edge of the spout, Fig. 1. This was very helpful in handling the ladle, for it may rest on supports beneath the spout, as the stream shifts little during the tapping period. It proved desirable to ease the load on the electric hoist by providing a counterweight shown in Fig. 1. Manual adjustment of the electrodes by a handwheel has proved quite satisfactory. The roof rests in place on top of the side-wall brickwork, sealed by a layer of chrome ore. It is fitted with four hooks and easily lifted off by the 1-ton electric hoist.

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Fig. 2—Detail view of furnace lining and brickwork.

Main Considerations are Simplicity and Provision for Insulation

The furnace shell is made with ⅛-in. steel plate, appropriately braced. Lining detail is indicated in the cross-sections of Fig. 2. Such a furnace is not normally used for continuous operation; so the brick lining is not subject to heavy wear by erosion. Lining should be thin, since at best its heat capacity is somewhat larger than is really desirable. Shape of the hearth and banks look out of proportion, but this is essential in a small furnace. Bath depth should not be less than 8 to 10 in. so that exposed surface area is not out of proportion with larger operations. Otherwise, at temperatures of 2800° to 3000°F, interaction with gas will be too rapid for close control of composition; therefore, the banks must be steep, necessitating a rammed hearth lining. With high-magnesia ramming mix, slag tends to build up to around 15 pct MgO, which is objectionable even though bank erosion may not be excessive. To reproduce the conditions of commercial refining, a special mix containing a large proportion of dolomite has been used, yielding slags close to the normal hearth range in MgO.

Applicability

This unit has been used on small-scale research problems for melts of steel or liquid blast furnace iron. For example, basic iron melts have been blown with oxygen to determine limits on silicon removal with maximum retention of manganese under a basic slag. Limits on steel refining relative to retention of residual manganese and phosphorus content have also been explored. Carbon boil conditions approaching those in an open hearth are obtained, and it has been possible to control carbon content quite successfully. Useful information has been collected on behavior of hearth and brick refractory materials.

Experience on this furnace indicates that any of the operations conducted in large scale steel refining, either electric arc or open hearth, can be approximately reproduced.