METHOD OF INDIRECTLY HEATING MOLTEN METALS


No Drawing. Filed Apr. 21, 1951, Ser. No. 104,538

5 Claims. (Cl. 75—86)

This invention relates to the indirect heating of molten metal by a radiant surface disposed above the surface of the molten metal. More particularly, the invention improves the rate of heat transfer from a radiant structure to an underlying pool of molten metal.

In metallurgical operations, there is often the need to introduce heat into a pool of molten metal either to maintain it at an elevated temperature or to bring it to a boiling state. The refining of zinc by distillation to eliminate contaminants like lead and cadmium is a notable example of a metallurgical operation in which molten metal is indirectly heated to effect vaporization. A vaporizing furnace of the type used in refining zinc is illustrated by U.S. Patent 2,552,430 which shows a fuel-burning chamber positioned over and separated from a lower metal vaporizing chamber. A refractory arched roof separates the heating and vaporizing chambers and serves to transmit heat by radiation from the burning zone to the molten metal.

It is known that molten metals are generally poor absorbers of radiant energy because of their reflectivity. In short, the metallurgical industry has been long handicapped in attaining desirable rates of heat transfer from radiant bodies to underlying pools of molten metal. Worse yet, there is a tendency in many cases for a coating of metal oxide to accumulate on the surface of the molten metal and this oxide coating or film further decreases the rate of heat absorption by the molten metal because metal oxides are generally poor heat conductors. In other words, the problem of transmitting radiant energy to a pool of molten metal is aggravated by the presence of a superficial insulating layer of metal oxides.

An important object of this invention is to improve the rate of heat transmission from a radiant body to an underlying pool of molten metal.

A further object is to prevent the accumulation of metal oxides on the surface of molten metal receiving radiant energy from a radiant heating structure disposed thereabove.

In accordance with this invention, carbon is floated on the surface of a pool of molten metal being indirectly heated by a radiant structure disposed over the pool. The carbon may be in any of its usual forms such as soot, channel black, charcoal or graphite. The selection of the carbon to be used should take into account whether or not a small quantity of an impurity such as sulfur can be tolerated in the particular molten metal on which the selected carbon is to be floated. High-purity graphite is frequently preferred.

While powdered or granular carbon is suitable for forming a thin layer or film on the surface of the molten metal, larger bodies of carbon may also be used advantageously. Such larger bodies may take the form of spheres, discs or cylinders and may have holes or perforations extending therethrough to increase the heat transfer area of contact between the molten metal and the carbon body and to facilitate the escape of metallic vapor where the molten pool is being heated to effect vaporization of the metal.

The carbon on the molten metal should be disposed substantially as a single layer of particles or preformed bodies for optimum heat transfer to the supporting molten metal. For the same reason, when preformed carbon bodies are floated on the molten metal, the depth of the bodies should preferably not be more than about 1 inch. Illustrative carbon bodies are graphite balls having a diameter of 1¼ inches, discs with a diameter of 3¼ inches and a thickness of 1 inch, and cylinders having a 2-inch length and ¾-inch diameter. Holes of about ¼-inch diameter may extend through such carbon bodies to promote the transfer of absorbed heat from the carbon bodies to the molten metal in contact with the carbon bodies.

A specific operation conducted in accordance with this invention will exemplify the benefit accruing from the carbon layer.

Molten zinc was heated in a vaporizing furnace having a radiant silicon carbide roof. Graphite balls (1¼-inch diameter) were spread as a continuous single layer on the surface of the pool of molten metal. Increased boiling of the zinc was the evident result of the presence of the graphite balls. A systematic comparison of the boiling rates of the furnace with and without the graphite balls developed these data.

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<th>Radiant roof temperature in °C.</th>
<th>Zinc boiling rate increase with graphite balls in percent</th>
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<tr>
<td>1120</td>
<td>30</td>
</tr>
<tr>
<td>1166</td>
<td>37</td>
</tr>
<tr>
<td>1237</td>
<td>39</td>
</tr>
<tr>
<td>1309</td>
<td>51</td>
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Accordingly, the presence of the graphite balls on the molten zinc materially increased the rate of heat absorption by the zinc from the radiant roof of the vaporizing furnace to the extent that the boiling rate of zinc increased 30% at a radiant roof temperature of 1120°C and reached a 51% increase at 1309°C. It is therefore evident that a carbon layer on a pool of molten metal makes it possible to increase the rate of heat transfer from a radiant surface above the pool without increasing the temperature of the radiant surface.

As previously mentioned, metal oxide may accumulate on the surface of a pool of molten metal and worsen the rate of heat absorption by the pool from a radiant body thereabove. Such oxide may come from the oxidation of the metal by air leaking into the furnace or the oxide may be originally dissolved in the metal and float to the surface of the molten pool as metal is vaporized away and the non-volatile oxide concentration builds up in the pool. In such case, the carbon layer on the molten metal has the further advantageous effect of eliminating the oxide. Carbon reacts with the metal oxide thereby removing oxygen as carbon oxide and destroying the insulating coating of oxide on the molten metal.

This important function of the carbon layer placed on a pool of molten metal pursuant to this invention is dramatically demonstrated by operating a vaporizing furnace in which the pool of molten zinc has a superficial film of zinc oxide. After the furnace is operating steadily at a given boiling rate, granular carbon may be spread on the pool and in a very short time the boiling rate will increase appreciably without any increase in the temperature of the radiant roof over the pool.

While the invention has been discussed in terms of the zinc refining art, it is applicable to other metals which are heated indirectly in a furnace having a radiant roof. For instance, copper may be economically melted in such a furnace while maintaining an inert atmosphere over the molten pool which is coated with a carbon layer. Similarly, crude cadmium may be vaporized in the manner already described for zinc. The indirect heating of alloys like brass and bronze may likewise be improved by
spreading a layer of carbon on the molten pool so that radiant energy from a source thereabove will be absorbed at a higher rate by the molten alloy.

Modifications and variations of the invention will be visualized by those skilled in the art upon consideration of the foregoing disclosure without departing from its scope or spirit. Accordingly, only such limitations should be imposed as are set forth in the appended claims.

What is claimed is:

1. In the method for vaporizing metal in a vaporizing furnace having a refractory roof separating the heating and vaporizing chambers whereby heat from the heating chamber is transmitted through said roof to a pool of molten metal in said vaporizing chamber predominantly by radiation, the improvement in combination therewith comprising floating a single layer of small preformed carbon bodies on the surface of said molten metal to increase the rate of metal vaporization at a given roof temperature over the metal vaporization rate attained at the same roof temperature in the absence of said carbon bodies, said preformed carbon bodies being shaped to provide when in abutting relation to each other sufficient free space to permit ready passage of the metal vapors therebetween.

2. The method of claim 1 wherein the pool of metal consists of molten zinc containing impurities normally associated with impure zinc.

3. The method of claim 1 wherein the preformed carbon bodies are graphite spheres.

4. The method of claim 1 wherein the preformed carbon bodies are graphite discs.

5. The method of claim 1 wherein the preformed carbon bodies are perforated to promote the transfer of absorbed heat from said carbon bodies to the molten metal in contact therewith.

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