METHOD OF CASTING USING A MOLD HAVING A REFRACTORY COATING THEREON


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ABSTRACT
A metal ingot mold having a thin bonded coating on the mold surface of a finely divided refractory material.

8 Claims, 3 Drawing Figures
METHOD OF CASTING USING A MOLD HAVING A REFRACTORY COATING THEREON

This invention relates to the pouring of ingots or pigs in steel molds and more particularly to the preparation of the mold and composition for use in the preparation of same for minimizing contamination, providing easier release and to produce an ingot having improved surface characteristics.

The concepts of this invention are addressed to the pre-treatment of molds from which remeltable ingots are produced of molten metal of the type generally referred to as high alloy steels or super-alloys of high cobalt and/or high nickel steels but it has application also to the pouring of ingots or pigs of high, medium or low carbon steels.

To the present, the use of steel molds in the production of ingots or pigs of such metals or alloy have been faced by a number of problems including contamination by the steel mold, sticking of the pig or ingot in the mold to prevent easy release, or to interfere with continuous casting and the production of a pig or ingot having undesirable surface characteristics.

It is an object of this invention to provide a method and composition which can be used in the treatment of the mold whereby contamination of the ingot or pig is materially reduced, removal of the ingot or pig from the mold is greatly enhanced, and a pig or ingot of improved appearance and surface characteristics is produced.

These and other objects of this invention will hereinafter appear and for purposes of illustration, but not of limitation, an embodiment of the invention is shown in the accompanying drawing in which

FIG. 1 is a sectional view of a steel mold for producing tubular products prior to treatment of the mold;
FIG. 2 is a sectional view similar to that of FIG. 1 taken after treatment of the mold but prior to casting of the ingot; and
FIG. 3 is similar to that of FIGS. 1 and 2 but taken after the metal has been cast and solidified in the mold.

It has been found, in accordance with the practice of this invention, that there is less contamination from the steel mold, less sticking in the steel mold and that an ingot or pig is produced having improved surface characteristics when the steel mold is provided with a thin layer of a refractory material which can be applied in a simple, efficient and inexpensive manner to the mold surface prior to pouring of the molten metal into the mold.

The thin refractory layer is believed to function as a barrier between the molten metal and the mold wall whereby the molten metal is prevented from coming into direct contact with the steel of the mold wall to cause contamination. The refractory layer also operates to cover over imperfections in the wall portions of the mold which otherwise come into contact with the molten metal whereby any such imperfections are immobilized from the standpoint of their ability to interfere with the easy release of the ingot. By reason of the low thermal conductivity of the intervening layer of refractory material, chill spots and excessive chill rates are reduced to the end that laps and cold shots in the ingot are materially reduced.

The desired refractory layer can be provided on the mold surface by a fluid composition containing the refractory material in finely divided form in combination with a binder system which will set in the layer that is formed on the mold wall to hold the layer of refractory material on the wall of the steel mold in the green stage, as well as in the dry or cured stage, and even during contact by the molten metal.

For this purpose, use can be made of various finely divided refractory materials, such as silica, zircon, alumina, titania, fused quartz, thoria, mullite, chromite and the like, but it is preferred to make use of finely divided zircon as the refractory material because of its relative inactivity with the molten metal and the steel wall of the mold.

As the binder system, it is desirable to make use of an inorganic binder component which becomes effective to hold the coating onto the mold surface at the elevated temperature existing during metal pouring. For this purpose, use can be made of a colloidal silica, such as the product “Nalcoag,” marketed by Nalco Chemical Company of Chicago, Illinois, and which can be gelled or set by a chemical or other agent or by evaporation of the moisture. The coating should also be formulated to contain an emulsifying agent as well as a suitable wetting agent to enable complete wetting of the metal walls of the mold for uniform coating.

The following example is representative of a refractory composition embodying the features of this invention for use in providing a suitable refractory coating onto the steel walls of the mold to be contacted by the molten metal:

**EXAMPLE 1**

<table>
<thead>
<tr>
<th>Zircon</th>
<th>125-200 Parts by wt.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colloidal silica solution (approx. 30% SiO₂)</td>
<td>7900 Parts by wt.</td>
</tr>
<tr>
<td>Gelling agent</td>
<td>0-150 Parts by wt.</td>
</tr>
<tr>
<td>Suspending agent</td>
<td>0-2%</td>
</tr>
<tr>
<td>Aqueous synthetic elastomer latex</td>
<td>up to 5%</td>
</tr>
<tr>
<td>Wetting agent</td>
<td>0-5%</td>
</tr>
<tr>
<td>Defoaming agent</td>
<td>0-5%</td>
</tr>
<tr>
<td>Water</td>
<td>0-15,000 ml.</td>
</tr>
</tbody>
</table>

The coating composition is applied by dipping or filling the mold 10, when in the form of a tubular mold, or by wetting the mold surface and pouring off the excess to leave a mold surface wet with a relatively uniform layer of the refractory coating composition. When applied by a dip process or by filling the tubular mold and pouring out the excess, the mold is allowed to drain for a while, such as for 5 minutes, and then dried as by means of a drying oven or cabinet heated to elevated temperature, such as a temperature of 175°-350°F, for about 2-12 hours. This is sufficient to achieve the desired drying of the refractory coating 12 whereby a thin adherent refractory coating is present on the mold surface.

In use, it is preferred to preheat the mold before casting the molten metal into the mold to insure complete removal of moisture from the coating to produce the best surface condition on the ingot. In one test, a tubular mold of low alloy steel having a diameter of 2½ inches and a length of 43 inches was heated for 8 hours at 425°F. and then for 30 minutes at 1,000°F., followed by casting the molten metal to form an ingot of the Inco 713 alloy. In another test, the mold of Example 1 was preheated as in the previous test but only for 8 hours at 425°F. before the molten alloy was cast therein.
In each instance, the surface of the ingot 14 was better by comparison with the same alloy cast at the same temperature in the same mold without the refractory coating. An ingot of exceptionally good surface characteristics was secured with a refractory coated mold which had been preheated for one-half hour at 1,000°F. before casting.

The ingot 14 produced from the mold of the first test, having the refractory coating heated to 1,000°F. before casting of the alloy, could be remelted to produce a clean remelt which is relatively free of dross, that is with less than 1 percent dross on the melt surface. In each instance, casting characteristics, measured visually and by fluorescent penetrant inspection, were not adversely affected. It appears, however, that gassing of the ingot is noticeably reduced by preheating the mold to a temperature above 400°F. and preferably to a temperature of 1,000°F. before casting the molten metal therein.

The amount of finely divided inorganic refractory material can be varied within the range of 80–95 percent by weight of the coating composition when calculated on the dry solids basis with the amount of inorganic binder, such as the colloidal silica, being varied within the range of 3–10 percent by weight or the solids basis.

The suspension agent of Example 1 serves as an emulsifying agent to produce a stable coating suspension, and as a means for providing a coating suspension having the desired viscosity and flow characteristics. For this purpose use can be made of a wide variety of suspension agents known to those skilled in the art including hydrophilic or natural gums (e.g., gums tragacanth), water-soluble resins, methyl cellulose, glue, gelatin, etc.

Desirable viscosity characteristics will also contribute to the described composition by the latex component which functions primarily as an interim binder for holding the coating onto the walls of the metal mold, at least until the inorganic binder component is activated. While not essential, the latex component can be formed of a natural rubber or a synthetic elastomer dispersed in aqueous medium and though not essential, it is desirable to make use of such organic interim binder component in an amount within the range of 0.5–5 percent by weight of the coating composition.

As indicated, the composition can be gelled or set by evaporation of moisture or by formation of the composition to include a chemical gelling agent. A wide variety of such gelling agents may be used when a chemical gelling agent is employed, and include mineral acids, such as hydrochloric acid, sulfuric acid, phosphoric acid, etc.; aliphatic organic acids, such as formic acid, acetic acid, propionic acid, butyric acid, succinic acid, malonic acid, oxalic acid, citric acid, as well as various electrolytes (e.g., alkali metal fluorides). As the wetting agent, use can be made of a number of well known wetting agents, such as the Aerosol, sulfate type wetting agents, etc.

The applied coating is removed from the mold wall with the ingot or after the ingot has been removed to prepare for reprocessing by coating with the refractory composition and preheating prior to casting of the next metal ingot therein. Removal of the spent coating can be achieved mechanically by brushing, blasting or abrading and/or by washing the coating from the mold surface.

It will be understood that changes may be made in the details of formulation and operation without departing from the spirit of the invention, especially as defined in the following claims.

I claim:

1. In the method of casting molten metal in metal molds comprising coating the surface of the metal mold against which the molten metal is received with a thin bonded layer of a finely divided refractory material and binder prior to pouring of the molten metal in which the binder comprises an inorganic binder component present in an amount within the range of 3–10 percent by weight and an organic binder in the form of a rubber latex present in an amount within the range of 0.5–5 percent by weight calculated on a solids basis, drying the coating and then pouring the molten metal in the refractory coated metal mold.

2. The method as claimed in claim 1 in which the refractory coating is preheated immediately prior to metal pouring to a temperature of at least 400°F.

3. The method as claimed in claim 1 in which the refractory coating is preheated immediately prior to metal pouring to a temperature of at least 1,000°F.

4. The method as claimed in claim 1 in which the metal mold is coated with a coating composition containing the finely divided refractory material in an amount within the range of 80–95% by weight on the solids basis.

5. The method as claimed in claim 1 in which the finely divided refractory material is selected from the group consisting of silica, zircon, alumina, titania, fused quartz, thoria, mullite, chromite and mixtures thereof.

6. The method as claimed in claim 1 in which the binder is colloidal silica.

7. The method as claimed in claim 1 in which the coating composition contains a hydrophilic emulsifying agent present in an amount within the range of 0.2–2 percent by weight.

8. The method as claimed in claim 7 in which the hydrophilic emulsifying agent is a natural gum.