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SHELL MOLD

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This invention relates to shell molding and more particularly to the elimination of characteristic surface defects in low carbon, low alloy steel castings produced in conventional shell molds. As is well known in the art, such shell molds are generally formed of a mixture of silica sand and a thermo-setting phenolic resin either in powder form or in a solvent to achieve uniform coating of the grains of sand. Other types of sand may be used such as zircon, olivine, forsterite, etc. If desired, dust suppressants may be used and in some instances a release agent is incorporated in the mixture to prevent the shell from adhering to the pattern.

Although such shell molds ordinarily produce commercially acceptable iron castings and stainless steel castings, it is well known in the art that low carbon, low alloy steel castings such as those formed, for example, of grade "B" steel are subject to characteristic surface defects, such as porosity, blow holes and pock marking, when formed in such molds. Various approaches have been made in an attempt to solve the problem, but in almost all instances have proved to be entirely inadequate or prohibitively expensive for practical application.

It has been discovered that the characteristic surface defects of such low carbon, low alloy steel castings result from a reaction between the molten steel and the mold and between components of the mold. It is believed that this reaction is at least partially caused by the formation of undesirable gases at the time of pouring the molten metal int othe mold.

Accordingly, the primary object of the present invention is to eliminate the characteristic surface defects of low carbon, low alloy steel castings formed in shell molds.

A more specific object of the invention is to provide a shell mold having casting contacting surfaces which inhibit the formation of undesirable gases during pouring without destroying the dimensional accuracy of the mold.

Another object of the invention is to wash the casting contacting surfaces of a shell mold with a material which penetrates the surfaces and which preferably is inert with respect to the molten steel and with respect to the phenolic resin and the sand in the presence of molten steel, to prevent thereby the formation of gases or other phenomena causing the characteristic surface defects of low carbon, low alloy steel castings produced in conventional shell molds.

Still another object of the invention is to provide shell molds and cores for producing low carbon, low alloy steel castings, wherein certain of the particles forming the mold inhibit the formation of undesirable gases during pouring operations.

According to the present invention it has been discovered that the earthy residue resulting from the digestion of bauxite has the characteristic, when present at the casting contacting surfaces of a shell mold, of effectively eliminating the typical shell mold defects from low carbon, low alloy steel castings poured in these molds. It has been discovered further that the same desirable results are attained whether the material is utilized as a mold wash or as an additive to the sand resin mix, the important consideration, apparently, being that the material is present, in the proper quantity, at the casting contacting surfaces of the mold.

This earthy residue material, commercially available

from the Aluminum Company of America, East St. Louis, Illinois, and designated Alcoa R–20, is an extremely fine, yellowish-brown powder obtained, by elutriation, from the insoluble residue resulting from the digestion of bauxite in the operation of the Bayer process. It posesses good insulating and refractory properties and is a complex chemical composition of six metallic oxides in approximately the following percentages:

	Percent
Al_2O_3	26
Fe_2O_3	17
SiO_2	14
TiO_2	11
CaO	10
Na_2O	10
Ignition loss	Balance

Describing the use of the material first as a mold wash, after a conventional shell mold has been produced in the usual manner, as described heretofore, the casting contacting surfaces of the mold in which the casting is to be formed are washed, as for example, by brushing, spraying, or flushing, with a slurry containing the earthy residue material.

The shell mold is then filled in the usual manner with molten low carbon, low alloy steel. It has been found that steel castings produced in this manner are substantially free from the surface defects characteristic of low carbon, low alloy steel castings formed in shell molds according to conventional practices.

A shell mold wash which has been particularly effective for the purpose above described has been devised in accordance with the following formulation:

150 parts by weight of water.
100 parts by weight of earthy material resulting from the digestion of bauxite.
7.5 parts by weight of a one-stage thermo-setting resin.
0.75 part by weight of cellulose gum.

The use of a water soluble or water dispersible thermo-setting resin is desirable to cause the adhesion of the earthy residue to the sand grains. Wetting agents may be used to aid the penetration of the wash into the surface of the shell mold. Cellulose gum or similar material is used to adjust the viscosity of the wash. The use of cellulose gum does not affect the primary function of the wash.

The advantages of this earthy residue material may also be attained by utilization as an additive in sand-resin mixes containing conventional two-stage resins, and also in sand-resin mixes containing both a thermo-plastic, permanently fusible, resin and a one-stage thermo-setting resin.

For example, shells may be prepared using silica sand, 6% by weight powdered thermo-setting, two-stage resin containing hexamethylenetetramine, 5% by weight of the earthy residue and, if desired, 0.3% to 1% liquid phenolic resin as a dust suppressant and to strengthen the mold. These shells present a sufficient amount of the earthy residue at the casting contacting surfaces so that the castings poured therein are completely free of the characteristic shell mold defects. If the liquid phenolic resin addition is omitted, as may at times be desirable, the quantity of two-stage resin may be increased from 6% to 8% in order to retain adequate shell strength.

Preferably, however, shells are prepared of a sand-resin mixture which is entirely free from hexamethylenetetramine. A typical sand-resin mix of this type, for example, comprises silica sand, 4% by weight of a thermo-plastic permanently fusible resin, and 1% by weight of a one-stage thermo-setting resin. While this shell mold mixture of itself results in the production of castings which are

substantially free from the characteristic shell mold defects, the defects sometime appear in pockets or recessed portions of intricate shaped castings. According to the present invention, all such defects are completely eliminated by the addition to the sand-resin mix of the earthy residue material in the range of about 2% to 3%.

Another typical shell mix which may be utilized for molds, but which is especially suitable for the making of cores, comprises 95% silica sand, 3% two-stage permanently fusible thermo-plastic phenolic resin, and 2% one-stage thermo-setting phenolic resin. The ratio of two-stage to one-stage resin may be varied from 1:4 to 4:1, depending on the specific application for which the mix is prepared. Suitable release agents such as calcium stearate, etc., in the amount of about 0.12% may be included as a release agent and about 1% alcohol may be added in order to dissolve the resin and coat the sand grains with the resin and earthy residue, after which the mixture is mulled to dryness in a conventional manner. The latter additions are percentages based on the combined weight of the sand and resin. The addition to the sand-resin mix of about 2% of the earthy residue completely eliminates the characteristic shell mold defects from the surfaces of low carbon, low alloy steel castings poured in mold-core structures formed from this mixture.

It will be understood that the foregoing examples of mixtures are for purposes of illustration only and recite percentages of the earthy residue material which give optimum results. For example, smaller percentages of the material may be utilized and castings produced thereby will have less characteristic surface defects than when none of the material is employed though probably will not be completely free therefrom. Similarly, larger percentages of the earthy residue material may be included in the wash or in the sand-resin mix but, in both instances, the cost will be greater and in the case of the sand-resin mix there will be a sacrifice of shell strength.

We claim:

1. A shell mold for producing low carbon, low alloy steel castings, said mold comprising: molding-sand particles bonded together by a phenol formaldehyde resin and having a sufficient amount of the earthy residue resulting from the digestion of bauxite at the casting contacting mold surfaces to effectively eliminate characteristic shell molding defects of castings poured therein, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

2. A shell mold for producing low carbon, low alloy steel castings, said mold comprising: molding-sand particles, and, in the range of about 2% to about 3% based on the weight of the sand, the earthy residue resulting from the digestion of bauxite, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

3. A shell mold comprising sand particles bonded together for producing low carbon, low alloy steel castings, said mold having a sufficient amount of the earthy residue resulting from the digestion of bauxite at the casting contacting mold surfaces to effectively eliminate characteristic shell molding defects of castings poured therein, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

4. A material for coating the casting surfaces of a shell mold comprising molding-sand particles bonded together with a thermo-setting phenol formaldehyde resin and to be utilized for producing low carbon, low alloy steel castings, said material comprising: approximately 7½ parts of a phenol formaldehyde thermo-setting resin, and approximately 100 parts of the earthy residue resulting from the digestion of bauxite, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

5. A material for coating the casting surfaces of a shell mold comprising molding-sand particles bonded together with a thermo-setting phenol formaldehyde resin and to be utilized for producing low carbon, low alloy steel castings, said material comprising: a thermo-setting phenol formaldehyde resin and the earthy residue resulting from the digestion of bauxite in a ratio of about 3 to 40, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

6. A material for coating the casting surfaces of a shell mold comprising molding-sand particles bonded together with a thermo-setting resin and to be utilized for producing low carbon, low alloy steel castings, said material comprising: a solution of thermo-setting phenol formaldehyde resin, the earthy residue resulting from the digestion of bauxite, and water in a ratio of about 3 to 40 to 60, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

7. A material for producing shell molds and cores to be utilized in the production of low carbon, low alloy steel castings, said material comprising: silica sand particles bonded together by a thermo-setting phenol formaldehyde resin and the earthy residue resulting from the digestion of bauxite, the latter being in a range of about 2% to about 5% by weight of the total material, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

8. A material for producing shell molds and cores to be utilized in the production of low carbon, low alloy steel castings, said material comprising: silica sand particles bonded together by a mixture which consists essentially of thermo-setting phenol formaldehyde resin and the earthy residue resulting from the digestion of bauxite present in the ratio of 12 to 25 parts by weight of phenolic resin and ten parts by weight of the earthy residue resulting from the digestion of bauxite, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

9. A material for producing shell molds and cores to be utilized in the production of low carbon, low alloy steel castings, said material comprising: silica sand particles bonded together by a thermo-setting phenol formaldehyde resin containing hexamethylenetetramine and the earthy residue resulting from the digestion of bauxite in a ratio of 5 parts of the earthy residue resulting from the digestion of bauxite and 6 to 8 parts resin, said residue comprising in chemical combination the following constituents in approximately the percentages indicated: Al_2O_3, 26%; Fe_2O_3, 17%; SiO_2, 14%; TiO_2, 11%; CaO, 10%; Na_2O, 10%; the balance ignition loss.

References Cited in the file of this patent

UNITED STATES PATENTS

2,763,626	Salzberg	Sept. 18, 1956
2,869,191	Cooper et al.	Jan. 20, 1959
2,869,196	Cooper et al.	Jan. 20, 1959

FOREIGN PATENTS

709,125	Great Britain	May 19, 1954
166,066	Australia	Nov. 21, 1955