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MOLD COATING

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This invention relates to a coating composition which, when applied to foundry sand mold and core surfaces, greatly increases the fluidity of molten casting metals, such as aluminum alloys, magnesium alloys and ferrous metals, poured into contact with the coated mold or core. More specifically, the invention pertains to a sand mold or core wash containing hexachlorobenzene.

In the past it was possible to successfully cast many thin sections of gray iron, aluminum alloys and magnesium alloys only if the casting metal was superheated appreciably above the temperature conventionally used, the mold was preheated and/or the metallostatic pressure was substantially increased. It obviously is desirable to eliminate these procedures. A principal object of the present invention, therefore, is to provide a coating for foundry sand molds and cores which materially increases the fluidity of molten casting metals contacting such molds and cores and which consequently eliminates the necessity of superheating these metals, preheating the molds or raising metallostatic pressures to an undesirable extent. The term "fluidity," as used herein, refers to the property of molten casting metal in contact with a mold which allows the metal to flow into the mold and fill it before solidification obstructs further flow of the metal.

The above and other objects of this invention are attained with a mold and core coating containing hexachlorobenzene. For most applications, it is desirable to add one or more filler materials to this coating composition, and asbestos fibers, mica powder and amorphous carbon have been found to be satisfactory for this purpose. A liquid carrier, such as alcohol, methylene chloride and/or water, also is normally included in the coating slurry. In many instances it is desirable to likewise add a small amount of wetting agent and/or binder to the coating material. The mold coating thus provided is relatively inexpensive and can be readily applied by conventional means, such as by spraying, dipping or brushing.

It will be understood that the term "mold," as generally used herein, is a casting form which includes both molds and cores, this invention not being limited to the former. Likewise, the word "sand" is used in its generic sense and is not restricted to silica particles.

The amount of hexachlorobenzene in the coating composition may be as small as about 2% by weight and still provide beneficial results. For some applications, the balance of the composition can be insulating or filler materials. In general, we prefer a coating containing approximately 2% to 20% by weight of hexachlorobenzene. Apart from mica, asbestos and carbon in finely divided form, powdered fillers which are suitable for use in the present invention include talc, fly ash, silica flour and, in some cases, certain comminuted metals. These filler media may be considered as chemically "inert" for the purposes of this invention, and the use of the term "inert filler" in the claims is intended to include any combination of the above types of particulate or fibrous materials. For reason of economy at least one of these insulating substances should be present in the coating composition, and occasionally it is advantageous to use two or more of these fillers when coating molds having certain configurations. The particulate filler material should be sufficiently fine to provide the resultant castings with reasonably smooth surfaces when desired. We have found

particle sizes of approximately —80 mesh and finer to be satisfactory.

If the molds are to be dipped or sprayed, it is usually advantageous to include a relatively large amount of liquid carrier in the coating composition. When this is done, the resultant slurry frequently may contain as much as 90% by weight of liquid carrier, and in general it is desirable to use a mold wash in which the carrier constitutes at least 50% of the total weight of the slurry. The hexachlorobenzene content of a liquid coating composition of this type may be reduced to approximately 1% by weight. In all instances, however, the hexachlorobenzene should constitute at least 2% by weight of the solids content of the coating.

It also has been found advantageous in many instances to include a relatively small amount of binder in the mold coating composition to increase the adhesion of the coating to the sand mold. Among the binding agents which are recommended are thermoplastic resins such as polyvinyl chloride, vinylidene chloride, polyvinyl alcohol and polyvinyl acetate, and thermosetting resins such as phenol-formaldehyde and melamine formaldehyde. Of course, various other binders besides the polymeric vinyl and phenolic resins can be employed. For example, methyl cellulose, linseed oil, corn cereal and certain clays, such as bentonite clay, are examples of substances which are useful as binder constituents.

When the coating is to be applied by spraying, a small amount of certain thermoplastic, lignin-type resinous materials derived from wood have proved to be desirable binders. The molecules of these resins contain both methoxyl and hydroxyl groups. Such materials may be obtained from a variety of wood products including sawdust, waste liquor from the paper industry, wood chips, etc., by physical and/or chemical treatment. Illustrative of one type of thermoplastic resinous material is a substantially gasoline-insoluble resinous material obtained by extracting a resinous wood with a coal tar hydrocarbon, removing said hydrocarbon by evaporation, leaving a residue comprising a mixture of wood rosin and thermoplastic resinous material, and extracting the rosin with a petroleum hydrocarbon, leaving a thermoplastic resinous material. Such a product is available commercially under the trade name "Vinsol."

Of course, more than one binder may be used in the coating composition, but the total binder content normally should not constitute more than about 15% of the weight of the solids in the coating material. Even 0.5% by weight of binder in the coating causes it to adhere more strongly to the mold.

If it is found desirable to use a wetting agent, a low-foaming, nonionic type is preferred. Examples of such a wetting agent are those available under the trades names "L–62 Pluronic" and "L–64 Pluronic."

The hexachlorobenzene and filler material are first blended together in dry form. This mixture then is preferably formed into a slurry with one or more of the above-mentioned liquid vehicles and wetting agent, if one is employed, and the resultant composition normally is applied to the cavity-defining surface of the mold at room temperature.

The following is a specific example of a coating of the above-described type which is designed to be sprayed onto the mold surfaces:

400 milliliters of isopropyl alcohol
45 grams of mica powder (—160 mesh)
45 grams of C_6Cl_6
10 grams of Vinsol resin

When green sand molds were coated with this slurry, the fluidity of both gray cast iron and aluminum alloys poured at normal casting temperatures into these molds

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was increased more than 100% as compared with similar molds which were uncoated. At somewhat lower pouring temperatures, the fluidity increase was as much as 390%. The fluidity of the molten metals in the molds was determined by means of a double spiral fluidity test mold in which one spiral is coated with the mold wash while the other remains uncoated, both being fed by the same pouring basin and down sprue. This test mold design and the procedure for using it are described in Transactions of the American Foundrymen's Society, volume 67, (1959), pages 496 to 507.

As indicated above, the coating of this invention also can be applied to baked sand cores by a dipping operation. The following is a mixture which is especially formulated for dipping such cores:

400 milliliters of water
90 grams of mica powder (—160 mesh)
10 grams of C_6Cl_6
0.5 gram of methyl cellulose
0.5 gram of L–62 Pluronic wetting agent

Each of the above coating compositions provided excellent casting surfaces, substantially reduced chill in thin sections, and materially aided in cleanup of the castings.

The hexachlorobenzene is a source of chlorine which reduces oxides forming on the surfaces of molten aluminum and magnesium alloys poured into the mold. In the case of cast iron it appears that the chlorine lowers the surface tension and increases the fluidity of the molten metal by actually dissolving to a small extent in the metal. It is not unlikely that the hexachlorobenzene also deposits an amorphous carbon layer on the surface of the mold cavity. This layer would function as an insulator to reduce the rate of heat transfer from the metal to the mold. Of course, the consequent retention of the metal at a higher temperature helps maintain it in a fluid condition longer. It also is possible that gas formed from the hexachlorobenzene in the mold may provide a gaseous film or layer on the mold surface which acts as a thermal insulating barrier between the casting metal and the mold.

Tests have been conducted on castings of gray iron, magnesium alloys and aluminum alloys which were formed in molds coated in accordance with this invention. As a result of these tests, it was found that these metals could be successfully cast in thin sections by using the above-described mold wash and that the resultant castings all had exceptionally high ultimate tensile strength, Young's modulus and hardness.

For example, ⅛-inch thick sections of gray iron cast in green sand mold portions coated with a hexachlorobenzene-containing mold wash were compared with gray iron specimens of the same composition from 3/16-inch thick sections cast in the same molds without a coating. The cast iron in the ⅛-inch thick sections had appreciably higher ultimate tensile strength, Young's modulus and hardness than the cast iron in the 3/16-inch thick sections. Attempts to cast ⅛-inch thick sections without first coating the surfaces of the mold cavity were unsuccessful because the molten metal would not properly feed into and fill the narrow mold cavities. The gray cast iron which did feed into these ⅛-inch cavities of uncoated molds was chilled, and hence these portions of the castings were hard, brittle and unmachinable.

It was further noted that the microstructure of the ⅛-inch thick sections of gray iron castings poured into the coated mold portions were slightly more refined than the microstructure of gray iron specimens cast into the 3/16-inch thick uncoated portions of the same mold. No primary carbide was evident in either section.

Green sand molds, each having two cavities four inches wide and 18 inches long, with sections ⅛-inch and 3/16-inch deep, were used in these tests. Test bars with a section 0.09 inch thick x 0.50 inch wide and a gage length of two inches were machined from each slab casting of gray iron. Two SR–4 strain gages were used to indicate tensile strain, one being positioned on each side of the bar to compensate for bending. The bars were pulled in tension and the strain measured as a function of load. Stress-strain curves were drawn from which Young's modulus was determined. BHN hardness values were obtained by conversion from R_B measurements.

While our invention has been described by means of certain specific examples, it is to be understood that its scope is not to be limited thereby except as defined by the following claims.

We claim:

1. A foundry mold for use in producing a metal casting having at least one thin section, said mold being formed of foundry sand and having its casting-defining surfaces coated with a thin layer of hexachlorobenzene.

2. A foundry mold for producing a metal casting having at least one thin section, said mold being formed of foundry sand and having its casting-defining surfaces coated with a mixture consisting essentially of at least 2% by weight of hexachlorobenzene and the balance substantially all at least one inert filler in finely divided form.

3. A foundry mold for producing a metal casting having at least one thin section, said mold being formed of foundry sand and having its casting-defining surfaces coated with a thin layer of a mixture consisting essentially of about 2% to 20% by weight of hexachlorobenzene and the balance substantially all at least one inert filler in finely divided form selected from the group consisting of mica, asbestos, talc, fly ash and silica flour.

4. The method of forming a foundry mold which substantially increases the fluidity of molten metal poured into contact with said mold, said method comprising blending together powdered hexachlorobenzene and a finely divided inert filler material in dry form, mixing a liquid vehicle with the resultant blend to form a slurry, and applying said slurry to the cavity-defining surface of a mold.

5. The method of forming a foundry mold having casting-contacting surfaces coated with a composition which substantially increases the fluidity of molten metal poured into contact with such surfaces, said method comprising blending together powdered hexachlorobenzene and a finely divided inert filler material in amounts to provide approximately 2% to 20% by weight of hexachlorobenzene and 8% to 25% by weight of filler in said composition, mixing a liquid carrier with the resultant blend to form a slurry containing about 50% to 90% by weight of said carrier, and applying said slurry to the cavity-defining surface of a mold at approximately room temperature.

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