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MAKING CORES FOR CASTING LIGHT METAL ALLOYS

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The invention relates to the production of cores for casting light metal alloys such as magnesium and aluminum alloys.

The binders heretofore used in making cores for casting light metal alloys have been vegetable oils, which harden or polymerize during the baking of the green sand core so as to knit the grains of sand together into a rigid structure. However, a core containing such a vegetable oil binder must be heated to a temperature above 400° F. in order to cause the vegetable oil to polymerize.

If satisfactory results are to be obtained in casting light metal alloys, it is necessary that the cores employed in the casting operation contain a "metal protector" such as sulphur or urea. A metal protector is a substance that sublimes or vaporizes when the molten metal comes in contact with the core, and prevents the air that is present in the core from causing the metal to burn. If a metal protector is not present in the core, the molten metal reacts with the air or with the slight amount of moisture in the core, and causes an explosion or other damage to the casting.

Since sulphur sublimes at about 350° F., it cannot be used in a core containing a vegetable oil as a binder. Such a core must be baked at a temperature above 400° F. in order to "set" the vegetable oil binder, and any sulphur present would disappear during such baking. When a vegetable oil is used as the binder, it is necessary to use a metal protector in the core which does not sublime at the "setting" temperature of the binder. The metal protectors that have such high subliming temperatures are extremely expensive, inefficient in their action and otherwise unsatisfactory.

The core binders heretofore known are unsatisfactory for the further reason that they do not volatilize completely upon solidification of the molten metal so as to permit the core to "collapse" during cooling of the casting. A binder which does not volatilize upon solidification of the molten metal, and thus causes the core to retain its rigidity, may cause the casting to crack during the shrinking that takes place upon cooling. Moreover, since the binders heretofore known do not completely lose their binding action during the casting operation, a core containing such a binder is extremely difficult to remove from intricate passages in a casting such as a cylinder head for a liquid-cooled airplane engine. The operation of digging such a core out of intricate

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passages in a casting is very tedious and time-consuming.

The principal object of the invention is to provide a novel binder for sand cores used in casting light metal alloys which sets at low baking temperatures and volatilizes substantially completely after solidification of the metal during the molding operation. More specific objects and advantages are apparent from the description, which discloses and illustrates the invention and is not intended to impose limitations upon the claims.

A green sand core embodying the invention comprises a hardenable urea-formaldehyde reaction product as a binder, which sets to an infusible resin when the core is baked at a low temperature.

The present binder is not dissolved or otherwise affected by the molten metal, and the decomposition of the binder is slow enough at molten metal temperatures so that no substantial decomposition has occurred by the time the molten metal has solidified in the mold. For that reason, there is no premature liberation of gas by decomposition of the binder, which might cause the formation of gas bubbles or blowholes in the casting. Nevertheless the decomposition of the present binder is not so slow at these temperatures that it is not completed before substantial cooling of the solidified metal occurs.

The present binder decomposes and volatilizes so completely after solidification of the molten metal that the residue of the core consists of loose sand, which can simply be poured out of the casting. Because of the complete decomposition and volatilization of the present binder, it is not necessary to restrict the percentage of binder in the core, and a sufficient amount can be used to make the core as strong as desired. A core embodying the invention has a high porosity, which permits gases evolved from the molten metal to pass off through the core, and minimizes the formation of gas flaws in the casting.

The binder used in preparing a core in accordance with the present invention may be in the form of a solution of a urea-formaldehyde reaction product in an organic solvent which is mixed with the sand. However, the urea-formaldehyde reaction product is preferably water-soluble, so that water can be used as the solvent in the binder solution. Preferably, the urea-formaldehyde reaction product is in granular or powder form, because it is easier to incorporate the usual small proportion of binder uniformly with the sand by making a dry mixture of the binder and

the sand. The water or other solvent for the urea-formaldehyde reaction product is then added to the dry mixture to produce the green sand.

A hardening agent is preferably included in the green sand in order to accelerate the hardening or setting of the urea-formaldehyde reaction product during the baking of the core. The hardening agent may be any substance that gives an acid reaction under the conditions of baking, such as an acid, an acid salt, or a substance that liberates acid at the baking temperture. The mount of the hardening agent is simply an amount such as to cause the hardening to take place at the desired rate during baking. The hardening agent may be omitted if desired, and the amount used should not be so great as to cause substantial hardening of the binder to occur at ordinary temperatures prior to molding of the core.

A water-soluble urea-formaldehyde reaction product is much more stable in dry form than in the form of an aqueous solution. The preferred form of core binder embodying the invention is a dry stable mixture of a hardenable water-soluble urea-formaldehyde reaction product and a hardening agent therefor. Hardening agents that may be used to give such a stable mixture are zinc sulphate, zinc chloride, ammonium sulphate, ammonium dihydrogen phosphate, diammonium hydrogen phosphate and ammonium oxalate. Other hardening agents, such as ammonium chloride, ammonium thiocyanate and various other acids and acid salts, should not be left in admixture with the dry urea-formaldehyde reaction product, because they cause it to harden gradually at ordinary temperatures.

A dry stable mixture of a hardenable water-soluble urea-formaldehyde reaction product and a hardening agent therefor, embodying the invention, is highly advantageous as a binder for use in sand cores for casting light metal alloys, because such a mixture can be kept on hand for indefinite periods and used as needed. Since the hardening agent is already incorporated in the mixture, it is not necessary for the foundrymen to take the responsibility of mixing the proper amount of hardening agent with the urea-formaldehyde reaction product. The amount of urea-formaldehyde reaction product used in making up a small quantity of green sand is minute, and the proper amount of hardening agent therefor might have to be weighed out on an analytical balance.

For the sake of economy, the amount of the urea-formaldehyde reaction product used in preparing a sand core in accordance with the present invention is simply an amount sufficient to produce a core of the desired strength, which is usually about ½ per cent or more of the weight of dry sand. 1 per cent of the weight of dry sand is ordinarily sufficient.

A green sand core embodying the invention has moderate strength, but if desired the green strength of the core can be increased in the usual manner by adding cereal binders or the like. The green strength of a core embodying the invention is enhanced by the rigidification of the outer surface of the core which occurs as the core dries out at ordinary temperatures.

The amount of water used in making the core depends upon the kind of sand, the amount of cereal binder, if any, and other factors, and is simply an amount sufficient to give the desired green strength and flow properties of the green

sand—usually from about 2 to about 6 per cent of the weight of dry sand.

When a hardening agent is incorporated in the core, the amount of baking necessary to dry out the core thoroughly is usually sufficient to complete the hardening or setting of the urea-formaldehyde reaction product. If no hardening agent is used, a higher baking temperature may be required, but it is never necessary to bake at a temperature above 300° F. Usually, the lower the temperature, the longer the period of baking that is required. In any case, the amount of heating should not be so great as to decompose the urea-formaldehyde reaction product. For example, a core embodying the invention should not be baked more than 4 hours at 350° F. 4 hours of baking at 300° F. is ordinarily sufficient for cores up to 6 inches thick. Thicker cores cannot be uniformly heated throughout in 4 hours, and should therefore be baked for a longer period at a lower temperature.

A water-soluble hardenable urea-formaldehyde reaction product may be prepared as follows: 1 mol of urea is added to a 37 uper cent aqueous solution containing 2 mols of formaldehyde that has been brought to pH 4.5–5.5 by means of sodium hydroxide. The solution is then gently refluxed long enough (about 1 hour) to carry the reaction to the desired stage. Since a urea-formaldehyde reaction product is most stable in a neutral condition, the solution is then preferably neutralized. In order to produce a solid product, the solution may be diluted with water or evaporated under vacuum to the proper concentration, and then spray-dried or vacuum drum-dried. A few per cent of a cellulose filler such as fine wood flour may be added prior to the drying operation.

Example 1

A dry binder for sand cores used in casting light metal alloys is prepared by mixing 5 parts of anhydrous zinc sulphate with 100 parts of a dry urea-formaldehyde reaction product prepared as described above. The resulting mixture remains stable indefinitely at ordinary temperatures. No material increase in the speed of hardening is obtained by using a greater proportion of anhydrous zinc sulphate.

Example 2

1 part of a binder prepared in accordance with Example 1 is mixed with 100 parts of dry sand, a suitable proportion of a metal protector, and any other desired dry ingredients, such as a cereal binder, in a standard mixer such as a foundry muller. Enough water (about 4 parts) to produce a damp mixture of the desired consistency is then added, and mixing is continued until uniform wetting of the sand has taken place. The resulting green sand can be stored until needed. No appreciable deterioration occurs in a period of 48 hours. If the surface of a pile of the green sand becomes dried out, it can be restored to its original condition by spraying the surface lightly with water. The green sand is formed in a mold to a core of the desired shape. The core is baked at 300° F. for about 4 hours, or, if more than 6 inches thick, for a longer time at a lower temperature down to about 200° F. The resulting core has a compressive strength of about 250 pounds per square inch.

Various embodiments of the invention may be devised to meet various requirements.

Having described my invention, I claim:

1. A method of casting light metal alloys that includes preparing a green sand core consisting essentially of sand, water and a hardenable urea-formaldehyde reaction product as a binder, the proportion of binder being sufficient so that the green sand can be molded into an integral core, baking, and casting a light metal alloy in contact with the core whereby said binder volatilizes substantially completely after the metal has taken its shape.

2. A method of casting light metal alloys that includes mixing ingredients consisting essentially of dry sand and a dry, hardenable, water-soluble urea-formaldehyde reaction product as a binder, the proportion of binder being sufficient so that the sand when moistened can be molded into an integral core, moistening, molding, baking, and casting a light metal alloy in contact with the core whereby said binder volatilizes substantially completely after the metal has taken its shape.

3. A method of casting light metal alloys that includes preparing a green sand core consisting essentially of sand, water, a hardenable urea-formaldehyde reaetion product as a binder and a hardening agent therefor, the proportion of binder being sufficient so that the green sand can be molded into an integral core, baking, and casting a light metal alloy in contact with the core whereby said binder volatilizes substantially completely after the metal has taken its shape.

4. A method of casting light metal alloys that includes preparing a green sand core consisting essentially of sand, zinc sulfate and an aqueous solution of a hardenable urea-formaldehyde reaction product as a binder, the proportion of

binder being sufficient so that the green sand can be molded into an integral core, baking, and casting a light metal alloy in contact with the core whereby said binder volatilizes substantially completely after the metal has taken its shape.

5. A method of casting light metal alloys that includes preparing a green sand core consisting essentially of sand, water, a cereal binder and a hardenable urea-formaldehyde reaction product as a binder, the proportion of binder being sufficient so that the green sand can be molded into an integral core, baking, and casting a light metal alloy in contact with the core whereby said binder volatilizes substantially completely after the metal has taken its shape.

6. A method of casting light metal alloys that includes preparing a green sand core consisting essentially of sand, water, a cereal binder, a hardenable urea-formaldehyde reaction product as a binder and a hardening agent therefor, the proportion of binder being sufficient so that the green sand can be molded into an integral core, baking, and casting a light metal alloy in contact with the core whereby said binder volatilizes substantially completely after the metal has taken its shape.

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