3,211,560
MOLD WASH COMPOSITION AND CASTING MOLD COATED THEREWITH

Jack E. Fair, Peoria Heights, Ill., assignor to Caterpillar Tractor Co., Peoria, Ill., a corporation of California

No Drawing. Filed Dec. 18, 1961, Ser. No. 160,348
8 Claims. (Cl. 106—38.22)

The present invention relates to a novel mold wash for use in the centrifugal casting of heavyweight products, the preparation of this wash and, as an article of manufacture, a sand mold having disposed thereon a continuous insulating layer of said wash.

In the past, mold washes have been developed to produce rough or porous coatings on sand molds employed in the centrifugal casting of heavyweight items such as track rollers. This surface was felt necessary to induce acceleration in the spinning process. The heavyweight castings so produced, however, possessed rough surfaces necessitating time consuming and costly machining. Only in the casting of lightweight items where the degree of acceleration during spinning is less critical has centrifugal casting been employed to produce lightweight items of smooth finish.

It is consequently the principal object of the present invention to provide a mold wash which can be used for casting heavyweight products to produce a smooth "as cast" surface. Yet another object of the present invention is to provide the novel combination of centrifugal mold and insulating coating of mold wash which produces a smooth finish on heavyweight centrifugal castings. Still another object of the present invention is to provide a novel method of centrifugally casting, whereby smooth surface heavyweight casting is produced in a simple yet efficient manner. Other objects, features and advantages of the present invention will be apparent from the following description read in conjunction with the appended claims.

The smooth finished castings prepared in accordance with the process of the present invention may be made employing either the Shell or carbon dioxide process of centrifugal casting. The carbon dioxide process of molding consists essentially of mixing sodium silicate (water glass) with sand, ramming the mixture into a pattern, and thereafter introducing carbon dioxide gas which acts to harden the sand mix in approximately 30 seconds or less to produce exact contours on the sand. More specifically, the pattern is coated with a release agent such as powdered aluminum graphite or the like and the flask positioned on the pattern. The pattern and flask are then positioned in a blowing machine under the blow plate or head which produces the desired mold by blowing sodium silicate coated sand into the cavity between the pattern and the flask. The air is vented out and the sand remains to form the mold. Carbon dioxide is then introduced into the mold to harden the sodium silicate binder thus producing a hard, strong mold. The blowing and curing step requires a total of approximately 90 seconds. In the present process, the mold is then sprayed with the described mold wash to produce a surface of greater strength and refraction.

In the Shell process the pattern and flask are heated to approximately 450° F. It will be understood, however, that this temperature may vary significantly without departing from the scope of the invention. The pattern is then sprayed with release agent such as silicone, fuel oil, stearic acid, colloidal graphite, etc. Silicone is preferred. The flask is positioned on the pattern and the unit disposed in the blowing machine under the blow plate or head. The machine produces the desired mold by blowing resin coated sand from the blow plate into the cavity between the pattern and the flask. The air is removed

by venting and the sand remains to form the mold. The heat from the pattern and flask sets the thermo-plastic binder thus producing a strong, hard mold. The blowing and curing requires approximately 75 seconds. The mold may then be sprayed with the mold wash of the present invention thus strengthening the surface and producing a surface of greater refraction.

In the past, sand molds produced by both of these known methods have proven unsatisfactory because of the penetration of metal into the mold. Consequently, extensive research has been carried out to find methods of preventing or at least limiting the mold penetration. However, in spite of this extensive research, up to this time a mold has not been developed manifesting adequate resistance to molten metal penetration in the preparation of heavyweight castings.

It has now been discovered that the metal penetration problem may be avoided in the centifugal casting of heavyweight items by employing a sand mold coated with the newly discovered zircon base mold wash of the present invention. Additionally, it has been found that the employment of this zircon base mold wash produces a heavyweight casting having a smooth finish unlike heavyweight castings heretofore made employing the centrifugal casting method.

Because sections of the castings are keyed to the sand in the sand molding process, contraction may tear the castings in areas located between such restraining points. In casting of heavyweight objects such as track rollers, little restraint can be tolerated. In order to produce as little restraint as possible, coatings must be employed which break during the cooling process. At the same time, however, high resistance to metal penetration is required. Because resistance to penetration and erosion are, from a practical standpoint, opposed to the required breakdown of sand to prevent tearing, it becomes necessary to form a continuous, smooth, tough refractory coating on the mold itself so that the basic mold may be made to break during solidification in cooling. Another unique advantage of the preesnt mold wash is that it fulfills this demanding requirement.

Broadly considered, the mold wash of the present invention comprises a refractory, suitable solvent and binder. This novel composition may be employed with both carbon dioxide and Shell process molds with only minor variations in the components.

Coatings for the carbon dioxide product mold cannot contain water because water solubilizes the sodium silicate binder thus breaking down the mold surface. Hence, volatile organic solvent such as isopropyl alcohol, methanol, acetone ethylene trichloride, etc. are employed. The multitude of organic solvents which may be employed will be immediately apparent to those well versed in the art. Of these, isopropyl alcohol is preferred.

From the standpoint of the refractory which may be employed, zircon has been found preferable though silicon and graphite are acceptable for purposes of the present invention. Other non-metallic refractories which are resistant to the action of heat, such as chromium oxide, aluminum oxide, magnesium oxide and silicon carbide may also be employed though they are not as satisfactory. For example though zirconium oxide, commonly used in the form of ash, is a known non-metallic refractory it is clearly inferior to zircon for purposes of the present invention.

Extensive experimentation has led to the conclusion that binder and grain size are exceedingly important. The grain size should be extremely fine so that the grains will not pack and not obtrude to any extent. A strong, stable binder is, therefore, required to lock the grains together onto the sand of the mold itself. This binder also acts to bind the sand grains together beneath the wash.

It has been found that additional curing of the carbon dioxide sand at the surface beneath the wash results from a short low temperature heating of the coated mold as the wash coating is dried. Spraying of the wash is required to obtain a smooth uninterrupted coating which retains the tolerances required of the mold itself. The preferred binder of the mold wash of the present invention is nickel chloride. However, other inorganic compounds soluble in the solvent employed, having a melting point in excess of 1000° F. and possessing considerable chemical stability, are acceptable. Examples include barium oxide, magnesium sulfate, nickel chloride, aluminum sulfate, magnesium chloride, manganese sulfate, iron chloride, manganese chloride and lithium chloride, among others. It will be understood, however, that the invention is not restricted to the specifically enumerated binders. When the Shell method, as distinguished from the carbon dioxide method, is employed common inorganic binders which require the addition of water may be employed. Examples include sodium silicate, aluminum phosphate, bentonite and others.

A preferred wash of the present invention constitutes a solution of nickel chloride which precipitates when dried to form a solid around and between the zirconium grains. Additives are employed to thicken and increase wetting in the mixture. A preferred wash of the present invention is prepared by saturating ethyl alcohol with nickel chloride and adding thereto zircon flour. The mixture is subsequently diluted to spraying consistency with isopropyl alcohol. This binder eliminates penetration of metal into the mold surface. Broadly considered, 2 to 10 percent saturated nickel chloride solution in ethyl alcohol is employed. When this solution is sprayed and dried on the mold, penetration is eliminated and refinement in evaluation of all stages of the process becomes possible.

Though this composition produces a satisfactory coating on the mold, it has been found that the addition of a wetting agent such as "Tergitol NPX," which is an alkyl phenyl polyethylene glycol ether atnd a thickening agent such as polyethylene oxide improve the wash Other wetting and thickening agents which may be added to the present invention follow:

Polyethylene glycol
Carboxymethyl cellulose
Polyvinyl alcohol

The mold wash of the present invention is particularly important because it produces an excellent "as cast" surface condition and allows the production of cores to close dimensional tolerances. The wash, after firing, coats the core surface with a high refractory abrasion resistant surface which prevents sand penetration and produces a smooth finish. This smooth "as cast" surface is a significant advance over prior art methods of centrifugally casting wherein the surface invariably produced was rough. In the past, others have used mold washes for producing a rough or porous coating on the surface of the sand molds in centrifugal casting. Up to this time, however, no one has intentionally produced a smooth mold coating which is highly refractory in texture.

A specific example, together with the preferred ranges of components of a mold wash of the present invention follows:

Component	Quantity of Component (Percentage by Weight)	Preferred Range of Component (Percentage by Weight)
Nickel Chloride (anhydrous)	0.9	.2-3.9
Ethyl Alcohol	4.8	0-30
Water	2.7	0-10
Tergitol NPX	.05	0-5
Polyethylene Oxide	.05	0-5
Zircon	53.9	50-90
Isopropyl Alcohol	37.6	0-40

The portions of the isopropyl alcohol, "Tergitol NPX" and polyethylene oxide may be varied considerably to obtain a suspension more suitable for dipping or brushing without changing the character of the bond. The carbon dioxide mold wash may be prepared in the following manner.

First, 0.9% nickel chloride is dissolved in 4.8% ethyl alcohol. The nickel chloride is added to the ethyl alcohol until it reaches its saturation point. The quantity of nickel chloride may vary slightly from the 0.9% indicated as noted in the table "Preferred Range of Components." For purposes of discussion, this mixture of nickel chloride and ethyl alcohol may be designated Solution A. .05 percent polyethylene oxide is added to 2.7 percent water, this solution being designated Solution B. A small quantity of water is necessary to dissolve the polyethylene oxide and obtain the desired thickening of the solution. Such small amounts of water as 2.7 percent associated with the ethyl and isopropyl alcohol remain with the alcohol and are removed with the alcohol during heating of the wash after application by spraying to the mold itself. .05 percent "Tergitol NPX" is added to 37.6 percent isopropyl alcohol, this solution being designated Solution C. Solutions A, B and C are subsequently combined and 53.9 percent zircon added to the combined solutions. It will be understood by those well versed in the art that other methods may be employed for obtaining solution of the components. The foregoing steps, however, have been found to be the most advantageous method for the preparation of the wash. The above described solution may be employed for Shell molding. However, it will be understood that water may also be used in place of the ethyl and isopropyl alcohols. Water may be so employed in Shell molding because Shell molds are produced with a resin bonded sand, the resin binder of which retains its stability under conditions of relatively high moisture content whereas the sodium silicate binder employed with the carbon dioxide molds is highly soluble in water.

More specifically, Shell molds use a resin bonded sand whereas carbon dioxide molds employ sodium silicate bonded sand (water glass). Since resin binders are relatively insoluble in water whereas sodium silicate is highly soluble in water, alcohol can be employed with the wash for either carbon dioxide or Shell molds while water as a vehicle in the wash lends itself principally to Shell molds. If a water base solution were used on sodium silicate bonded sand, the bond throughout the mold would not be entirely destroyed. However, the desirable characteristics of the bonding particularly in surface areas would be lost because the sodium silicate would tend to dissolve in the water. Hence, the close tolerances necessary in the mold for centrifugal casting particularly of heavy mold products such as track rollers necessitates the employment of an alcohol base solution as a vehicle for the mold wash in order to avoid serious deterioration of the mold.

In operation the mold surface is sprayed several times, i.e. multiple applications have been found necessary. A coat of approximately .005 to .050 preferably .020 inch thick, is built up which is then fired at approximately 400° F. for about five minutes to remove the alcohol. The firing results in a hard and smooth refractory surface on the mold. Because of the weight of the molten material required to produce heavy casting such a track roller, the strength of the mold washed surface is exceptionally high. Employing this unique combination of mold and fired mold wash it is now possible to produce smooth "as cast" heavyweight castings by the process of centrifugal casting method whereas in the past the casting method was considered undesirable for all practical purposes.

In operation, the complete mold is turned at a rate sufficient to eliminate turbulence in the last metal introduced and sufficient to displace slag, etc. into the bore surface.

Experimentation indicates a minimum force of fifty times gravity is required and a force of seventy times gravity is desirable. However, on thick walled casting, the force on the bore may be held close to the minimum since forces over 145 times gravity on the outside diameter may rupture the casting.

In rotating with the axis of the mold horizontal, a straight bore is obtained, the molten metal being laid onto the surface of the mold as rapidly as possible and with the minimum of turbulence. Erosion of the mold surface is further reduced by pouring approximately a third of the metal with the mold turning slowly, i.e. 100 r.p.m. and then accelerating the mold to full speed. Pouring temperatures above 2870° F. are required to promote solidification from the mold into the center without producing local hot spots in resultant shrink areas.

The practice for rotation with the axis of the mold vertical is similar. The mold is rotated until solidification is complete. During solidification and cooling, the sand must collapse to permit the casting to shrink and further collapsibility is desirable to enhance removal of the casting from the mold. These requirements make the employment of the claimed mold wash particularly desirable.

I claim:

1. A mold wash composition for coating the surface of a sand mold, said mold wash composition consisting essentially of:

(a) a volatile liquid vehicle in an amount to impart a sprayable consistency to said composition, said vehicle being selected from the group consisting of methanol, ethanol, isopropanol, acetone and ethylene trichloride;

(b) powdered zircon suspended in said vehicle, said powdered zircon being of sufficient fineness of size not to pack and not to obtrude to a discernable extent from the surface of the deposited coating; and

(c) a chemically stable inorganic binder material having a melting point in excess of 1000° F. dissolved in said vehicle, said binder being capable, upon volatilization of said vehicle from a coating of said composition, of binding the grains of zircon to one another and to the sand at the surface of said mold,

said composition being capable of forming a continuous, smooth, tough refractory coating on the surface of a sand mold upon volatilization of said vehicle therefrom.

2. A mold wash composition as defined in claim 1, wherein said binder is nickel chloride.

3. A mold wash composition as defined in claim 2, wherein relatively small amounts of a wetting agent and of a thickening agent are incorporated in the composition.

4. A mold wash composition as defined in claim 1, wherein said powdered zircon constitutes about 50 to 90 percent by weight of the composition, wherein said binder is nickel chloride and constitutes about 0.2 to 4 percent by weight of the composition, and wherein said liquid vehicle constitutes the remainder of the composition.

5. A mold wash composition as defined in claim 4, wherein said liquid vehicle is an isopropyl alcohol.

6. As an article of manufacture, a casting mold selected from the group consisting of shell casting molds and casting molds composed of molding sand bonded with carbon dioxide-hardened sodium silicate, said casting mold having a shaped surface against which metal is cast, said shaped surface having an adherent, hard, smooth, continuous refractory surface coating consisting essentially of:

(a) powdered zircon; and

(b) a chemically stable binder material having a melting point in excess of 1000° F. binding the particles of zircon to one another and onto the molding sand at said surface of said mold,

said coating rendering said mold resistant to penetration by molten metal cast against said surface coating and yet enabling said mold to break during solidification of said metal in cooling, whereby a heavy-weight centrifugal casting with smooth "as cast" surfaces may be formed by said casting mold.

7. The article of claim 6 wherein said coating is between 0.005 and 0.050 inch in thickness.

8. The article of claim 6, wherein said binder is nickel chloride.

References Cited by the Examiner

UNITED STATES PATENTS

2,313,674	3/43	Salzberg et al.	117—5.2
2,618,032	11/52	Traenkner	117—5.1
2,627,101	2/53	Clerg	25—126
2,973,563	3/61	Leaberry et al.	117—5.1 XR
2,995,453	8/61	Noble et al.	106—38.27 XR
3,070,982	1/63	McGowan	117—5.3 XR
3,074,802	1/63	Alexander et al.	106—38.8
3,075,847	1/63	Henry et al.	106—38.22

ALEXANDER H. BRODMERKLE, *Primary Examiner.*

MORRIS LIEBMAN, *Examiner.*