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SYNTHETIC MOLD COMPOSITION

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This invention relates to the casting in green sand molds of ferrous and non-ferrous metals and their alloys, more especially heavy ferrous metal castings of thick section.

The principal objects of the invention are the expeditious and economical production of such castings from which the sand layer, constituting the mold-metal interface, can be readily stripped or peeled, due to absence of burnt-on sand grains in the surfaces of the castings whereby without resorting to costly mechanical finishing operations, such as now required, it is possible to obtain smooth clean, pattern-true castings. Another object of the invention is the provision of a molding composition which is peculiarly adapted for accomplishing the production of such superior castings. Still other advantages of the invention will hereinafter appear.

It is well established in the foundry art that when such difficultly oxidizable metals are cast in molds formed from either naturally bonded or naturally unbonded sands, to which latter a clayey bond has been added, rough castings are obtained that have burnt-on sand covering the surfaces thereof which necessitates resorting to expensive, time-consuming mechanical cleaning operations in an attempt to remove the same. In an effort to overcome such objections, various facing materials such as powdered or ground graphite, coke and other materials have been either dusted, sprayed, brushed or slicked onto the surfaces of the finished mold and also ground granular carbonaceous materials as sea coal (a ground bituminous coal of high volatiles content), pitch, gilsonite and the like, have been mechanically mixed with the molding sand to form a special "facing sand" which was applied as a layer of substantial thickness to the inner surface of a green mold, whose backing sand consisted of ordinary molding sand.

The results obtained either with such facings or with facing sands, insofar as concerns the elimination of burnt-on sand, were seldom wholly satisfactory and, in the case of the facings, they could not be successfully applied to vertical mold surfaces, except by slicking or spraying the same thereon. The proper slicking of molds with facings is a delicate, laborious and relatively expensive procedure which often results in mold disturbance and, even if spraying is resorted to, that also is time-consuming since it is necessary to drive out the water in the mold surfaces sprayed with the facing, by means of a torch or other-

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wise, before the pouring of the mold is undertaken.

It may be here noted, that the facing or sand-peeling action of sea coal is essentially due to the deposition of soot at the mold-metal interface as a result of the incomplete combustion, due to the limited supply of air in the mold cavity, of the volatiles of sea coal which constitutes around 35% thereof and comprise principally coal gas and various coal tar derivatives of benzene, toluene, tar acids, all of which are relatively inefficient soot producers, and substantial quantities of ammonia which has no sooting capabilities whatsoever. It is for this reason that it is customary to employ relatively rich mixtures of ten to fifteen parts by volume of molding sand to one of sea coal. It is, therefore, quite apparent that sea coal and like bituminous coals are not entirely satisfactory in their facing actions in view of their relatively poor sooting capabilities. Such coals, furthermore, as such, have no tendency to increase the green bond strength of the sand.

If it be attempted to improve the facing or peeling action of sea coal by increasing the amount thereof in the special facing sands made therewith, the sand heap will tend to become diluted by the fixed carbon present in sea coal, some 55% thereof, and troublesome molding difficulties will result. Again, sea coal tends to swell when heated and such swelling acts to disturb or distort the mold surfaces and any undue increase in the sea coal content of the facing sand would aggravate this action and deleteriously affect the castings produced therewith.

Attempts have even been made to prevent the burn-on of sand grains to heavy castings of thick section, by mulling sufficient powdered graphite with the molding sand to thereby coat the sand grains and render the same resistant to the effect on the sand of prolonged heat-dissipation from a heavy casting and consequent prolonged oxygen attack. However, such direct coating of the grains was not successful, as if enough graphite was used to render the sand grains sufficiently resistant to the effect of the prolonged heat, under such circumstances, then the grains become so slippery, due to the inherent "slip" of the graphite, that the sand becomes unmanageable and unmoldable. Even the bonding clay present in such a molding composition, seems to be affected by the graphite and the resulting molding composition becomes so short and brittle that it cannot be molded readily.

It has also been proposed to incorporate a hy-

drocarbon in the molding sand that will decompose during the casting stage into a semi-graphitic soot-like film which will be deposited at the sand-metal interface and assist to face the casting. However, it is impossible to obtain a synthetic semi-graphitic film deposited in situ, as a result of such decomposition of a hydrocarbon admixed with the molding sand, which will be sufficiently refractory to withstand the aforesaid prolonged heat-dissipation and oxygen attack, such as are experienced in the production of heavy castings, as the soot-like film will burn away before the casting is set with consequent burn-on of the sand grains.

My investigations have led to the discovery of a molding composition which is prepared by mulling molding sand with a thixotropic gel, hereinafter described, which composition is suitable for producing molds in which light castings of thin section, free from burnt-on sand, can be expeditiously and economically cast. Furthermore, that when colloidal graphite is incorporated in such molding composition, in the manner hereinafter described, the aforesaid excessive slippery characteristics ordinarily imparted by graphite are eradicated and all of the advantages of having a highly refractory coating of graphite around the sand grain can be realized while the ability of the coated grains of the molding composition to cohere is not disturbed in any way, with the consequence that the molding composition possesses excellent moldability.

As preferred examples of the method of making the improved molding composition, the following are given, Example 1 being that preferably employed when making light castings of thin section and Example 2 being that employed when making heavy castings of thick section.

Example 1

A still-bottom residuum resin from the cracking of petroleum oils having preferably the following physical characteristics is selected, viz:

S.G.—0.9950 to 1.01

Flash point C.O.C.—550° to 600° F.

Viscosity SSF at 210° F.—about 450

Color A.S.T.M.—3 to 4

A batch of 720 lbs. of the aforesaid residuum is then diluted with 180 lbs. of an air-drying and, desirably, a polymerizable gum, such for example as the by-product gums known as polymers obtained by contacting cracked distillates from petroleum with solid adsorbents all as specified in Patent No. 1,778,329 and which polymers, when subjected to heat and air, dry to form resinous products. The aforesaid resin and gums are intimately mixed in a suitable liquid mixer while maintaining the temperature of the mixture at about 210° F. A gel is then prepared in a second mixer of the high speed type, as for example, a turbine blade-mixer or colloid mill, by mixing therein 100 lbs. of highly swelling western bentonite and 1300 lbs. of water which has been previously heated to about 200° F. When the above gel is in a creamy state and all particles of the bentonite thoroughly dispersed, the above mixture of the resin and air-drying gums is added thereto in a slow steady stream under the constant mixing action of the turbine mixer or colloid mill employed. It is desirable that the temperature of the whole mass during this dispersing phase does not fall below the solidifying point of the resin-gums mix, namely, below about 150° F.

After cooling, the thixotropic gel so formed to room temperature, it is then ready for incorporation with unbonded silica sand grains, all in the manner hereinafter specified.

While the aforesaid thixotropic gel is highly satisfactory for the production of molding compositions for making molds for use in making light castings, say up to about 1½ inches in thickness, it is not feasible to produce heavy castings therewith having a thickness above about 1½ inches since, as the section of the metal increases, the action of molding compositions prepared therewith becomes progressively less as a sand-peeling agent due to the effect of the action of the hot casting on the sand as a result of the prolonged period of heat-dissipation therefrom and the consequent prolonged period of oxygen attack on the sand. Accordingly, when producing such heavier castings, it is highly advisable to supplement the action of the aforesaid thixotropic gel so as to obtain a molding composition that has a more heat-refractory coating or film on the grains thereof than that produced by the thixotropic gel, alone, and which therefore is capable of resisting such prolonged heat-dissipation and consequent prolonged oxygen attack due to the greater thickness of a casting. I have found that colloidal graphite, within certain limitations as to the amount thereof which is employed, is ideally adapted when dispersed in the said gel, to so supplement the action thereof since when the gel is admixed with the molding sand a tacky, resinous, graphite-bearing hydrocarbon film or coating deposits around the sand grains. Such coated grains will be free from excessive slipperiness which results from the inherent tendency possessed by graphite particles to slip on each other, which slipperiness would tend to render the molding composition unmanageable and unmoldable were graphite, alone, used in sufficient quantity to render the same refractory to the said action of prolonged heat-dissipation and oxygen attack. Furthermore, when such colloidal graphite is so dispersed in the gel, the capability of the coated sand particles to cohere and retain their moldability characteristics is not disturbed.

Example 2

The aforesaid graphite bearing thixotropic gel is desirably prepared as follows:

Ten parts of a good grade of colloidal graphite, preferably Ceylon graphite of say 95% C content and a particle size of the nature of about ½ micron in average diameter, are dispersed in a so-called colloid mill in ninety parts of the aforesaid thixotropic gel prepared in accordance with Example 1. After being so treated, the mixture is ready without further processing for incorporation with molding sand, preferably unbonded sand.

In preparing a molding composition from the thixotropic gels described in Example 1 and Example 2 the following procedure is preferable:

The requisite amount of the selected silica sand is introduced into a mixer, for example, a foundry mulling machine and then the aforesaid colloidal thixotropic gel is added. The muller is then started in action and, due to the pressure exerted on the mass by the muller wheels, a strong shearing stress is set up with the consequence that the gel becomes highly fluid, due to its inherent characteristic of changing into a liquid under conditions of shear stresses developed when shaken or stirred under pressure. As the gel thins out, it can no longer hold in the

disperse phase the hydrocarbon resins therein, and accordingly the resins are precipitated out as a fine film over the silica grains, such precipitation being augmented by a reversal of the electrical charge on the resin particles as they impinge with the particles of mineral aggregate. (See in this connection Asphalt and Allied Substances by Abrahams, published by G. Van Nostrand & Co., Inc., New York, N. Y., in 1945, Fifth Edition, vol. 1, page 644.) Under continued mulling, all the hydrocarbon resins and such graphite, if present therein, are precipitated on the silica grains and any bond therein, such for example as colloidal bentonite, is released and is then free to act as a supplemental bonding agent to aid in the formation of a suitably moldable sand. Sufficient additional bond in the form of bentonite, fire-clays, etc., are then added and, if desired, the green bond strength can be further increased to impart the desired workable qualities to the sand by the further addition of cereal binders, dextrin, etc., all in accordance with the usual foundry practice.

When molten metal is poured into molds prepared from the aforesaid molding composition, the heat imparted thereby to the mold accomplishes two important functions, namely, the fine resinous layer surrounding each silica grain is first partly volatilized and then the hydrocarbon volatiles so formed burn in the limited supply of air present in the mold to form voluminous sooty fumes of fixed carbon which particles are deposited in the interstices between the sand grains forming the mold surfaces and also on the grains themselves, or, in other words, the mold surface, especially at the mold-metal interface, is "smoked." This same fine film of carbon, filling the interstices as it does, levels out the mold surface and the resulting casting is exceptionally smooth, much smoother, in fact, than it would be had the sand not been so treated. Such secondary action occurs after the volatiles have been driven off the resins. A large part of the still-bottom petroleum residuum is fixed carbon, some 35% thereof, and once the volatile portion has been driven off, this fixed carbon remains surrounding the silica grains and separating them from the clay bonding material. Thus both the clay bonding agent and the silica grains are effectively protected from the metal by a carbon film.

In order to obtain my improved thixotropic gel which under shear stresses, such as are developed when the same is mulled with sand, changes into a liquid and becomes incapable of holding in the disperse phase the heavy hydrocarbon substances and the gums as well as any graphite present therein, with the result that they will be precipitated on the sand grains, it is essential that the amount of bentonite in such thixotropic gel shall not be less than 3.5%, by weight of the gel. Otherwise, if a lesser amount were employed, a mere emulsion of the bentonite, the resinous hydrocarbons, the gums and graphite if present, and water would be produced which, instead of so depositing its solids on the sand grains during the mulling, would tend to destroy the bonding properties of the bentonite and a creepy, oily or unmoldable mass would be obtained.

While I prefer to employ the aforesaid petroleum still-bottom residuum as one of the resinous ingredients of my improved mold composition, other heavy resinous hydrocarbons such as asphalt, either natural or artificial and the like may be substituted therefor in such mold com-

position. Such hydrocarbons are oily and excessively tacky and, besides, are not efficient soot producers during a casting operation and the said air-drying polymers function to not only modify or overcome such excessive tackiness of these hydrocarbons but, being almost completely volatile at the temperature of molten ferrous metal and efficient soot producers during a casting operation, they also function to substantially increase the sooting capabilities of the hydrocarbons employed.

While I preferably employ but about one and one-half parts of my thixotropic gel to 100 parts of silica sand, owing to the potency of such gel, nevertheless other proportions may be used between the limits of ¼% and 10% of such gel by weight of the sand, if desired.

The aforesaid mold composition can be readily regenerated after each of several successive heats merely by mulling up with the heap mold composition sufficient additional thixotropic gel, bentonite and water to properly bond and temper the same to the extent required.

If the thixotropic gel is to be used with naturally bonded sands, the amount of the air-drying polymers, such as aforesaid, which are used is desirably increased from the said amount of 180 lbs. to about 280 lbs. of such gums, but otherwise the process of making a mold composition from such bonded sands is generally the same as that above described.

Preferably for the preparation of my improved molding composition where the same is to be used for making "green sand" molds, I employ foundry sand of selected grain sizes, between about (50) and (160) based on the Foundry Sand Grading Classification of the American Foundrymen's Association.

When, as specified in Example 2 aforesaid, colloidal graphite of a particle size not exceeding about one-half micron in average diameter, is incorporated in a thixotropic gel containing said air-drying gums polymers, it will supplement the action of the latter in modifying excessive tackiness of the asphalt or like heavy bituminous resins, such as aforesaid, due to the fact that such graphite particles are wholly non-tacky. The excessive inherent slipperiness of the graphite will be, on the other hand, modified to an optimum degree by the tacky characteristics of the resinous components of the gel. As a consequence, a heat-refractory film of the selected hydrocarbon and bentonite will be deposited on the sand grains and also on the graphite particles while the latter which are so coated will be adhesively united to the sand grains and yet will have their inherent slippery characteristics nullified to an optimum degree, as above stated, so that the ability of the particles of the molding composition to cohere will not be disturbed in any way, and the composition will possess excellent moldability and withal will be rendered sufficiently refractory to withstand prolonged oxygen attack such as occurs when producing heavy castings.

Colloidal graphite, because of the extremely small particle size which averages less than one micron is capable not only of remaining in suspension in the gel, without any appreciable settling for several days but also such graphite deposits on the grains of molding sand as a continuous refractory film when the gel is mulled with the molding sand in the manner aforesaid.

This application is a continuation, in part, of my co-pending application of the same title,

Ser. No. 757,687, filed June 27, 1947, now abandoned.

The ranges of the percentages of the various components of my improved thixotropic gel, by weight thereof, which may be used in order to obtain a satisfactory product of that nature for incorporation with molding sands, are as follows:

1. Heavy resinous hydrocarbon, 20% to 40%.
2. Air-drying polymers, up to but not exceeding 10%, but at least sufficient to prevent excessive tackiness of the particles of the mold composition such as would impair the moldability thereof.

3. Western bentonite, 3.5% to 6%.

4. Colloidal graphite, from 2 to 10%, depending on the weight and cross-section of the desired casting.

Various changes in and modifications of the above specified composition and method of making the same, within the scope of the appended claims, may be made without departing from the spirit of my invention.

Having thus described the invention, what I claim is:

1. An intermediate product for use in making a molding composition for metal-casting purposes, the same consisting essentially of a thixotropic gel composed principally of water and containing at least 3.5%, by weight, of bentonite and containing from 20% to 40%, by weight, of a resinous film-forming heavy hydrocarbon belonging to the group consisting of a petroleum still-bottom residuum and an asphalt, and an air-drying resinous gummy polymer derived from petroleum distillates by contacting them with an adsorbent.

2. An intermediate product for use in making a molding composition for metal-casting purposes, the same consisting essentially of a thixotropic gel composed principally of water and containing at least 3.5%, by weight, of bentonite and containing from 20% to 40%, by weight, of a resinous film-forming heavy hydrocarbon belonging to the group consisting of a petroleum still-bottom residuum and an asphalt, an air-drying resinous gummy polymer derived from petroleum distillates by contacting them with an adsorbent and colloidal graphite of a particle size not exceeding about one micron in average diameter.

3. A molding composition for making metal-casting "green sand" molds, consisting essentially of molding sand grains individually coated with a film composed principally of a resinous heavy hydrocarbon belonging to the group consisting of a petroleum still-bottom residuum and asphalt, sufficient bentonite to impart desirable molding qualities to the composition and containing a sufficient amount, but not exceeding about 10% by weight of the film, of an air-drying polymer derived from petroleum distillates, by contacting them with an adsorbent, to overcome excessive tackiness of the heavy hydrocarbon employed.

4. A molding composition, as claimed in claim 3, wherein the film contains colloidal graphite

in an amount sufficient to materially augment the heat-refractory qualities of such composition and of a particle size of not more than about 1 micron in average diameter.

5. A molding composition, as claimed in claim 3, wherein the heavy hydrocarbon is a petroleum still-bottom residuum.

6. A molding composition, for making metal-casting "green sand" molds, consisting essentially of individual grains of a molding sand on which are deposited films, which latter consist essentially of the solid contents of a thixotropic gel containing western bentonite, in an amount of at least 3.5% by weight of the gel, and containing from 20% to 40%, by weight of the gel, of a resinous heavy hydrocarbon, belonging to the group consisting of a petroleum still-bottom resin and an asphalt, and said films also containing a sufficient amount of a gummy, air-drying polymer, derived from petroleum distillates by contacting them with an adsorbent, to render the same non-tacky.

7. A molding composition, as claimed in claim 6, wherein the gel employed in making the same contains from 2% to 10% of colloidal graphite of a particle size not exceeding about one micron in average diameter.

8. An intermediate product for use in making a "green sand" mold for metal-casting purposes, consisting essentially of an aqueous thixotropic gel containing at least about 3.5%, by weight, of western bentonite, from 20% to 40%, by weight, of a petroleum still-bottom residuum, and also containing sufficient, but not exceeding 10% by weight, of an air-drying polymer derived from petroleum distillates, by contacting them with an adsorbent, to overcome excessive tackiness of the residuum employed.

9. An intermediate product, as claimed in claim 8, containing from 2% to 10%, by weight, of colloidal graphite, of a particle size not exceeding about 1 micron in average diameter, incorporated therein.

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