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FOUNDRY SAND BINDER AND PROCESS OF PREPARATION

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This invention relates to a binder composition for foundry sand. The invention is particularly useful in bonding sand cores, and for that reason will be illustrated by description in connection with such use.

Foundry cores are customarily formed of sand and a binder including ordinarily starch or the like and a core oil. The binder holds the sand together during the forming and drying of the cores. In the ultimate use of the cores, to provide hollow spaces in castings made by pouring hot, molten metal around the cores, the binder is burned out. The cores are thus reduced more or less to free flowing sand that falls away from the solidified casting.

For best results, the binder composition should minimize the tendency of the dried core, even when bonded with a water absorptive adhesive, to soften on exposure to atmospheric humidity or to the humidity of a green sand mold. In addition, the binder composition should provide adequate green strength of the core so that it may be handled safely up to the drying stage; give sufficient strength to the core, after drying, to cause the core to withstand handling and also pressure of metal against the core without breaking or premature collapse; and give a minimum of gas pressure in contact with the hot metal being cast, so as to decrease the hazard of porosity being induced in the metal casting on contact with the core. Also, the time required for baking the core should be brief.

This invention provides a binder composition for foundry covers that is an improvement over binders heretofore used in meeting this combination of requirements.

Briefly stated, the invention comprises a foundry sand binder composition including an aqueous dispersion of water absorptive adhesive, a resin, and a wax, the wax being dispersed in water as the continuous phase and the water suitably containing an emulsifying agent for the wax. The invention comprises also sand bonded with the composition and the herein described process of bonding the sand.

Use of wax has been described as a lubricant of sand grains. Lubricating is the opposite of bonding. Yet I find the wax actualy more effective, when used jointly with starchy adhesives, in imparting green strength to sand cores than are such adhesives themselves.

There is made an aqueous dispersion of relatively low melting wax, such as petroleum wax, dispersed itself in water or in an aqueous solution. The dispersion of the wax so made is mixed into sand, with a starch adhesive, a resinous formaldehyde condensation product, and water in amount to moisten the sand and cause adherence when the moistened sand is molded into the shape of a core. The core is then dried.

In use the core is suitably disposed in a mold and molten steel or like metal is poured around the core and allowed to cool and solidify, so as to form a hollow space of desired shape, size, and location within the casting thus produced. The pressure of gas developed from the binder composition, as the latter burns out at the ignition

temperature reached during the casting, is considerable. Preformed gas escape vents are sometimes necessary in the foundry core, therefore, in order to minimize passage of gas into the cast metal as the gas escapes from the region of its formation.

Since water is the continuous phase in the wax emulsion, the wax is prevented from forming a water repellent coating or layer over the sand before the aqueous dispersion of starch or similar adhesive makes contact with the grains of the sand. The water absorptiveness of the adhesive, on the other hand, brings the wax in the aqueous emulsion into such association with the adhesive that, in the dried core, the wax decreases the water absorptiveness of the adhesive.

The wax, at the temperature of drying and higher temperatures to which the cores are exposed, volatilizes in parts. The volatilized part escapes as heavy molecules of relatively low volume in proportion to the mass, in distinction from the large specific volumes of the permanent gases developed by the combustion of conventional adhesives of the type of starch. Also the use of the wax decreases the proportion of the said adhesive required.

As to materials used, the sand may be any good foundry sand, a number of commercial grades of which are shown in the examples later herein.

The adhesive is one that is combustible. It is water absorptive, that is, swells, or finally dissolves in water and suitably both. Examples of adhesives that meet the requirements and illustrate the class of materials to be used are the polymeric carbohydrates such as starchy materials, particularly pregelatinized corn starch, and cereal and tuber products of high starch content, as for instance, corn, rice or potato flour or starches therefrom.

Supplementary binders are used to advantage with the water absorptive adhesive. Examples are resins such as water dispersible condensation products of formaldehyde with urea, phenol, or the like.

The wax used is one that vaporizes or "smokes" at the temperature of use of the core. Petroleum waxes give a special effect. In contact with the hot metal being cast, as in either liquid or vapor form at 1000° F. or higher, they are decomposed by the heat, with deposition of carbon on the surface of the core. They improve the smoothness of the metal cast thereagainst. Examples of waxes that are suitable and that may be used are the various grades of petroleum wax including such usual paraffin waxes as refined, slack, sweat, scale, block, para-, and microcrystalline wax.

The wax, as introduced into the binder composition, may be emulsified in water by any conventional emulsifying agent and method. Typical effective agents include fatty acid soaps such as alkali metal oleates and stearates, ethanolamine oleates and stearates, and alkyl amine oleates and stearates. The separation method of preparing the emulsion may be conventiently used. In this method the fatty acid is dissolved in the paraffin and the alkali in the water, the molten mixture then being poured into the alkaline solution under agitation. Protective colloids, such as alkaline caseinates, may also be incorporated to provide good stability to the emulsion. The whole formula (wax, water, and emulsifying agent) may be passed through a colloid mill or other fine dispersal mill to attain small particle size of the dispersed phase. Emulsions of average particle size in the range of 0.2–2.0 microns are readily attained and are satisfactory for the practice of this invention.

The ratio of wax to water in the final product may vary in a wide range. However, the emulsion is most conveniently made and handled in concentrations within the range of 20%–40% of emulsified wax on the weight of wax and water.

As to proportions, I may use somewhat less than the customary amounts of the water absorptive adhesive or of the combination thereof with the supplementary adhesives such as urea-formaldehyde resin. The wax provides a sparing action on the other materials needed. Suitable proportions of the whole binder composition are 1–10 parts for 100 of the sand, all being on the dry basis and all proportions being expressed here and elsewhere herein as parts by weight unless specifically stated to the contrary.

The binder composition itself is of the following proportions for 100 of sand to be used in core making.

BINDER COMBINATION

Ingredient:	Parts
Water absorptive adhesive	0.25–5
Supplementary, non-absorptive adhesive	0.25–5
Petroleum wax	0.01–0.1
Water, including that in the wax emulsion, approximately	2–10

When cores are made with such binder combinations, heated to dryness and partially cured, the core binder does not swell, crumble, or soften appreciably on exposure to water or humidity under the conditions of use of the cores.

Example 1

The example shows the effect of inclusion of the wax emulsion on the green compression and also the dry tensile strength of the cores.

The following test data are for cores made and tested in comparable manner, except that cores #1 were made with a binder composition including no wax emulsion, for contrast with cores #2 and #3 containing different proportions of the said emulsion according to the present invention.

CORES MADE WITHOUT AND WITH WAX

	Proportions		
Cores	#1	#2	#3
Materials:			
Foundry sand, N. J. #80	2,000	2,000	2,000
Foundry sand McConnelsville #180	2,000	2,000	2,000
Corn flour, Mogul (adhesive)	40	20	20
Water (added with corn flour)	180	177	174
Boric acid (accelerator)	10	10	10
Urea-formaldehyde cond. product	40	40	40
Stearic acid (parting agent)	5	0	0
Kerosene (to disperse parting agent)	16	0	0
Paraffin wax emulsion (25% wax)	0	4	8
Gas forming ingredients in the core, percent	2.12	1.60	1.70
Results:			
Stickiness in mulling operation	None	Very slight	Very slight
Green permeability	35	42	41
Green comp. strength p. s. i.	1.3	1.6	1.6
Tensile strength of dried cores—			
30 min. at 375°F	107	168	188
45 min. at 375°F	123	158	158
60 min. at 375°F	83	167	154

The urea-formaldehyde product in the compositions tabulated above was made with 1 mole of urea to 1.8 moles formaldehyde and condensed with alkaline catalyst to the water soluble, A-stage resin.

When paraffin wax emulsion replaced the combination of parting agent and kerosene, the amount of corn flour could be reduced without sacrifice of green or baked core strength. In fact these strength values are higher when the wax emulsion is used. Also this formula change reduced the gas forming ingredients by 25% in cores No. 2 and by 20% in core No. 3.

Example 2

The procedure of Example 1, preparations No. 2 or No. 3 is followed except that there are introduced 40 parts of phenol-formaldehyde resin made by condensing 1 mole of phenol with 2 moles of formaldehyde to water-soluble resinous condition by usual technique. Other proportions of phenol to formaldehyde may be used to give the water-soluble product.

Also, the kerosene and the parting agent are omitted when the resin is the phenol-aldehyde product.

Example 3

A core sand mix was prepared on the following formula:

Component:	Parts
Foundry sand, N. J. No. 80	100
Corn flour, Mogul (adhesive)	0.5
Water (added with corn flour)	4
Urea-formaldehyde cond. product	1
Paraffin wax emulsion (25% wax)	0.3

The wet core sand mix was taken to an aluminum foundry where two 8 lb. cores were made in a wood core box designed for a casting to be machined and used as a housing for a hydraulic lift truck. The cores were baked for 2 hours at 350° F., one-half of the regular time for these cores made in oil sand. My cores, without being coated, were set in a green sand mold in the usual manner. Aluminum alloy 417 was poured at 1350° F. without any changes in the conventional procedure. The casting was knocked out after 30 minutes, allowed to cool and inspected. The cored surface was completely smooth and free of any roughness, whereas the general run of these castings as ordinarily made showed, upon inspection, areas of sand roughness. The smoother surface of my casting is attributable in part to the evolution of less gas from the core, thereby minimizing disturbance of the core surface as the molten metal contacts it.

The casting was also found to be sound and to pass inspection on every point.

Example 4

The procedure of Example 3 is followed except that the corn flour there used as the starchy adhesive is replaced by an equal weight of any other flour or starch disclosed herein.

It will be understood that it is intended to cover all changes and modifications of the examples of the invention herein chosen for the purpose of illustration which do not constitute departures from the spirit and scope of the invention.

What I claim is:

1. A foundry sand binder composition comprising 0.25–5 parts by weight of starch, water, 0.01–0.1 part of paraffin wax and 0.25–5 parts of resin, the resin being selected from the group consisting of water soluble urea formaldehyde condensation product and water soluble phenol formaldehyde condensation product, the paraffin wax being vaporizable in part at the temperature of casting of metal against foundry sand and being heat decomposable to give carbon at a temperature of 1,000° F., the wax being dispersed in emulsified form and as the discontinuous phase in the water, and the whole being in emulsified condition.

2. In binding foundry sand, the process which comprises mixing 100 parts by weight of the sand with the binder composition of claim 1 in proportion to provide 0.25–5 parts of starch on the dry basis and heating the resulting mixture to a temperature above the boiling point

of water, continuing said heating until the water of the said composition is substantially completely evaporated, and then raising the temperature of the dried mixture to that of formation of vapors of the paraffin wax and to the temperature of heat decomposition of said wax with formation of a carbon deposit over the surface of the sand.

3. The composition of claim 1, the said starch being in pregelatinized condition.

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