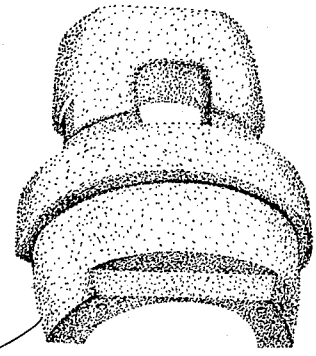
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FOUNDRY CORE SAND COMPOSITIONS

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Foundry core bonded with core oil binder containing a minor proportion of an organosilicon additive.

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FOUNDRY CORE SAND COMPOSITIONS

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The present invention relates to the use of certain organosilicon additives in oil-containing or bonded sand compositions to improve the physical properties of foundry cores and molds (especially the former) fabricated therewith for use in metal casting operations. It also relates to an improved method for casting metals, particularly ferrous metals, in molds or mold assemblies that are at least partially fabricated from the improved core-oil bonded sand compositions of the invention.

Certain oils or oleaginous materials of the several well known types that are commonly referred to as "core oils" are extensively employed binder materials for foundry sands, particularly when foundry cores (as well as certain molds) are being fabricated for specialty applications. Core oils, which are drying type binders for foundry sands, are of three general varieties. These are the vegetable drying oils, the so-called "manufactured" or mineral oils which have been processed by polymerization of relatively crude, unsaturated petroleum fractions, and marine animal oils such as certain of the fish oils. The use of such binding agents for foundry sands has been described by H. W. Dietert in chapter 3 of his book "Modern Core Practices and Theories" (1942 ed.) published by the American Foundryman's Association. Advantageously, a mineral type core oil is utilized for the bonding of the foundry sands in the practice of the present invention although, if desired, vegetable oils of the drying or semi-drying type (such as linseed oil and corn oil, respectively) and marine animal oils may also be employed. It is usually desirable for the quantity of core oil that is employed in the composition to be between about 1 and 4 percent by weight, based on the total weight of the composition. Frequently, an amount in the neighborhood of 2 weight percent is most desirable, especially when mineral type core oils are utilized. Beneficially, a minor proportion of water is also incorporated in the composition to permit the fabrication of green or moist sand cores and the like having a satisfactory degree of rigidity and a suitable temper for their most efficient and effective utilization.

It is known from foundry practice that the ease with which a sand core, for example, may be removed from a metal casting is influenced by the quantity of binder employed. The greater is the proportion of binder in the composition, the harder is the sand core. This, of course, makes the casting more difficult to remove. It is also known that "burn-on" and "penetration" of the casting are decreased by the employment of baked cores and dry sand molds having relatively lower moisture content.

It would be an advantage, therefore, to provide improved sand compositions containing core oil as a binding constituent for foundry cores and molds, particularly the former, that would be capable of providing stronger bonded structures of the indicated variety having greater surface hardness while using minimized quantities of binder. It would also be an advantage if such compositions would have a significantly decreased tendency to absorb additional moisture after having been heat set or baked in their desired physical form. This would permit the articles fabricated from such compositions to have better shelf life as well as possibilitating better performance during their use in casting operations.

These and corollary advantages and benefits may be achieved by practice of the present invention which comprises uniformly incorporating in a foundry sand composition for the preparation of molds and cores which contains a core oil as the essential binding constituent (in combination, if desired for green cores, with water and/or also the usual cereal, starch and the like ingredients), a minor proportion of an additive, compatible with the core oil, that is an organosilicon compound (or an organo-substituted polysiloxane) of a particular type (as is particularly described in United States Letters Patent No. 2,706,723, particularly as Fluid "D" of Example 3 thereof) which may be characterized as being a partial hydrolyzate of an alkoxylated siloxane having at least about 3 percent by weight of silicon-bonded alkoxy groups and an average of from about 0.9 to 1.2 monovalent hydrocarbon atoms per silicon atom. More precisely, the type of organosilicon compound that is utilized for present purposes is identifiable as the partial hydrolyzate of the alkoxylated mixture of by-produced chlorosilicon compounds obtained from the reaction of methyl chloride (CH_3Cl) and silicon (Si). Advantageously, the quantity of the indicated variety of organosilicon additive that is incorporated in the core oil-containing sand composition in the practice of the present invention is an amount between about 1 and 15 percent by weight based on the weight of the core oil in the composition, and, more advantageously, an amount between about 0.1 and 0.3 percent by weight of the entire composition or total core oil-containing mixture.

The core oil-bonded sand compositions which contain the organosilicon additive in accordance with the invention may be fabricated into excellent foundry cores and molds having improved physical properties including high bond strength and better surface hardness at any given core oil content as compared to identical compositions save for the additive. The compositions of the invention also generate minimum quantities of gas in use and have marked moisture repellency after baking. Such feature prevents or retards moisture pick-up in the compositions and imbues articles fabricated therefrom with good shelf life. Cores and molds fabricated from the present compositions exhibit excellent release characteristics from a solidified casting prepared therein. Their collapsibility after the casting has been finished is entirely satisfactory, usually being complete in such regard. The sand compositions also have remarkably good flowability, allowing the mixture to flow easily into desired cavities wherein it may be rammed or blown easily into good and solid structures. The presence of the organosilicon additive in the sand mixture also tends to avoid fouling or sticking on core boxes and the like and to minimize requirements for cleaning of mixing equipment, storage hoppers and mold patterns.

The organosilicon resin additives that are used in the practice of the present invention may be incorporated in the sand compositions in any desired manner. Thus, the siloxane may be directly mixed or mulled into a core oil-containing sand mixture. It is usually more convenient, however, to incorporate the organosilicon additives that are employed by dispersing or dissolving them in the core oil that is used as a binder for the sand prior to the mixing of the binder with the sand to form the foundry core and mold compositions. The core oil bonded sand compositions can be cured after fabrication in the usual manner, as by subjecting them to heat at elevated temperatures or baking them in an oven according to the conventional technique.

Any ordinary sand or other refractory material may be employed in the practice of the invention. Advantageously, the sand or its equivalent that is employed has a

fineness in accordance with the values proposed by the American Foundryman's Society (AFS) that is in the numerical range between about 25 and 180. Such sands, for example, as the types which are known as Berkeley Float Sand, Juniata Sand, Lake Sand, Vassar Sand, Wedron Sand, and the like are quite suitable. It is not necessary in the practice of the present invention that clean sand be utilized. In many cases, it may be more advantageous to utilize a sand having an AFS fineness number from about 50 to 125. Very frequently, sands that have an AFS fineness number in the neighborhood of 50–75 may be preferable for foundry cores and mold-making operations.

By way of further illustration, a series of core oil bonded sand mixtures were prepared according to the present invention by individually incorporating minor proportions therein of an organosilicon additive in the form of an 85 percent by weight xylene solution of 85 percent by weight of a methoxylated partial hydrolyzate of direct process residue from the reaction of methyl chloride and silicon and 15 percent by weight of a methylsiloxane resin having a ratio of methyl groups to silicon atoms of about 0.9 to about 1.2, in accordance with the material described as Fluid "D" in Example 3 of the referred to U.S. Patent No. 2,706,723. The core oil employed was a mineral type, polymerized petroleum fraction that had been obtained commercially as Cities Service "Delco No. 36" core oil. About 7 percent by weight of water and 1.25 percent by weight of powdered corn flour cereal, based on the total weight of the composition, was also incorporated in each of the mixtures to facilitate the binding. Vassar Bank Sand (AFS 95–100) was employed in the preparation of all of the compositions. The compositions were then formed into standard size figure 8 briquette-sand cores by exerting about 80 p.s.i.g. pressure on the mixture which had been mulled in a conventional manner in order to intimately and uniformly blend the additive-containing core oil with the sand. The briquettes were then cured at about 350° F. for one and one-half hours. The results are set forth in the following tabulation wherein the compositions of the present invention are identified with the "S" designations.

For purposes of comparison, a blank or control sample (identified as "A" in the table) which contained no additive was also tested. Several compositions containing organosilicon additives not in accordance with the invention were similarly tested. These are identified by the letter designations "U" through "Z," inclusive. The "U" samples were prepared with a straight methylsiloxane resin additive; the "V" samples with a methoxylated direct process residue, as is also referred to in the mentioned U.S. Patent No. 2,706,723; the "W" samples with a monoamylsiloxane resin additive; the "X" samples with a water solution of a mixture of 75 weight percent of $CH_3Si—(OCH_2CH_2OCH_3)_3$ and 25 percent polytriacetoxysilane; the "Y" samples with a monopropylsiloxane containing from 15 to 25 percent by weight of silicon-bonded ethoxyl groups; and the "Z" samples with a 45 percent by weight solution in xylene of a siloxane copolymer composed of about 75 mo'e percent of monomethylsiloxane, 24 mole percent dimethylsiloxane and 1 mole percent trimethylsiloxane, which copolymer contained about 6 percent by weight of silicon-bonded isopropoxy groups.

In the table, the term "bonded strength" refers to the maximum tensile stress necessary to rupture a test briquette of standard dimensions. It is measured in pounds per square inch (p.s.i.) and is also representative of the maximum tensile stress which a sand mixture is capable of developing. "Surface hardness" is measured on the smooth side of the briquette specimen with a Dietert No. 673 Dry Hardness Tester. In this test the instrument is pressed down on the specimen. The maximum hardness reading on a hard surface would be 100 units. "Collapsibility" or "shake-out" is a term used with regard to the disintegratability of the sand mold after solidification of the molten metal therein. The collapsibility test consists of determining the tensile strength of a specimen which has been heated without access to air for one-half hour at 1832° F. A "hot strength" test is similarly performed. From practice, one can determine the proper hot strength that will prevent hot cracking of castings due to weak cores at 650° F., 1000° F., and so on up to 2500° F.

TABLE

Effect of additives on core oil bonded sand compositions

Test Sample	Percent by Weight Composition					Physical Properties, All Specimens Cured at 350° F. for 90 Minutes				
	Sand	Water	Corn Flour	Core Oil	Organosilicon Additive	Bonded Strength, p.s.i.[a]	Surface Hardness [b]	Tensile Strength, p.s.i. of Cores after Exposure to 650° F. for 1 Hr.	Collapsibility of Sand Cores after exposure to 1,832° F. for 30 Minutes	Percent Increase in Tensile Strength over Control Specimen [c]
"A"	89.75	7.00	1.25	2.00	None	170	94	200	Complete Disintegration.	[d]
"S-1"	89.75	7.00	1.25	1.90	0.10	200	95	[d]	[d]	17.3
"S-2"	89.75	7.00	1.25	1.85	0.15	223	94	[d]	[d]	31.2
"S-3"	89.75	7.00	1.25	1.75	0.25	231	93	[d]	[d]	35.9
"S-4"	89.75	7.00	1.25	1.70	0.30	220	93	155	Complete Disintegration.	29.4
"U-1"	89.75	7.00	1.25	1.90	0.10	160	92	120	do	[d]
"U-2"	89.75	7.00	1.25	1.85	0.15	227	97	125	do	32.0
"U-3"	89.75	7.00	1.25	1.75	0.25	162	96	185	do	[d]
"U-4"	89.75	7.00	1.25	1.70	0.30	182	93	120	do	[d]
"V-1"	89.75	7.00	1.25	1.90	0.10	185	95	170	do	8.7
"V-2"	89.75	7.00	1.25	1.85	0.15	197	93	195	do	15.9
"V-3"	89.75	7.00	1.25	1.75	0.25	155	95	165	do	[d]
"V-4"	89.75	7.00	1.25	1.70	0.30	167	92	160	do	[d]
"W-1"	89.75	7.00	1.25	1.83	0.17	144	92	[d]	[d]	[d]
"W-2"	89.75	7.00	1.25	1.75	0.25	185	94	[d]	[d]	[d]
"X-1"	89.75	7.00	1.25	1.80	0.20	170	94	[d]	[d]	[d]
"X-2"	89.75	7.00	1.25	1.75	0.25	180	93	[d]	[d]	[d]
"Y-1"	89.75	7.00	1.25	1.83	0.17	170	92	[d]	[d]	[d]
"Y-2"	89.75	7.00	1.25	1.75	0.25	135	95	[d]	[d]	[d]
"Z-1"	89.75	7.00	1.25	1.83	0.17	177	90	[d]	[d]	[d]
"Z-2"	89.75	7.00	1.25	1.75	0.25	122	92	[d]	[d]	[d]

[a] Average tensile strength of three sand cores.

[b] Surface hardness is measured with a Dietert No. 673 Dry Hardness Tester. Maximum hardness would be 100 units.

[c] Percent increase in tensile strength $= \frac{\text{Average p.s.i. tensile strength}}{\text{Average p.s.i. of control sample}} \times 100$

[d] Value not determined.

All of the "S" samples pursuant to the present invention had excellent moisture resistance and good shelf life without intolerable moisture pick up.

Results similar to the foregoing may be obtained when other proportions within the scope of the invention of the same organosilicon additive or others fitting the described variety contemplated are employed and when compositions without cereal binders are utilized. Excellent results are also obtained when the foregoing is repeated excepting to employ linseed oil or other suitable vegetable or marine animal-type oils as the core oil constituents in the compositions.

Cores and molds prepared from the sand compositions of the present invention (similar to those illustrated in the foregoing) are well adapted and can advantageously be used successfully to cast grey iron according to conventional techniques and to provide excellent results in the finished castings. The castings obtained are precisely formed and have good surface finishes. Very little, if any, burn out or penetration is experienced and the castings are easily and cleanly released from the mold. A foundry sand core fabricated from a sand composition in accordance with the present invention is illustrated in the sole figure of the hereto annexed drawing.

What is claimed is:

1. Composition for the fabrication of foundry cores and molds which comprises (1) a preponderant proportion of sand; (2) a binding minor quantity of from about 1 to 4 percent by weight, based on the weight of the composition, of a core oil; and (3) a small quantity of from 1 to 15 percent by weight, based on the weight of the core oil in the composition, of the partial hydrolyzate of the alkoxylated mixture of by-produced chlorosilicon compounds obtained from the reaction of methyl chloride and silicon as an additive in said composition, the organosilicon material in said alkoxylated mixture having at least about 3 weight percent of silicon-bonded alkoxy groups and an average of from about 0.9 to 1.2 monovalent hydrocarbon atoms per silicon atom therein.

2. The composition of claim 1 containing about 2 percent by weight of said core oil, based on the weight of the composition, and from about 0.1 to about 0.3 percent by weight of said organosilicon additive, based on the total weight of the composition.

3. A composition in accordance with the composition set forth in claim 2, wherein said organosilicon additive is composed essentially of a mixture of about 85 percent by weight of a methoxylated partial hydrolyzate of direct process residue from the reaction of methyl chloride and silicon and about 15 percent by weight of a methylsiloxane resin.

4. The composition of claim 1, wherein said core oil is a mineral type core oil.

5. Method for improving sand compositions containing core oil as a binder and adapted to be fabricated into foundry cores and molds which method comprises uniformly incorporating in said composition between about 1 and 15 percent by weight, based on the weight of the core oil in said sand composition, of an organosilicon additive that is the partial hydrolyzate of the alkoxylated mixture of by-produced chlorosilicon compounds obtained from the reaction of methyl chloride and silicon, the organosilicon material in said alkoxylated mixture having at least about 3 weight percent of silicon-bonded alkoxy groups and an average of from about 0.9 to 1.2 monovalent hydrocarbon atoms per silicon atoms therein.

6. The method of claim 5, wherein said organosilicon additive is composed essentially of a mixture of about 85 percent by weight of a methoxylated partial hydrolyzate of direct process residue from the reaction of methyl chloride and silicon and about 15 percent by weight of a methylsiloxane resin.

7. In the method of fabricating foundry molds and cores from sand compositions containing core oil as a binder, wherein said sand is mixed with from about 1 to 4 percent by weight, based on the weight of the composition, of core oil and said composition is fabricated and subsequently cured, the improvement which comprises uniformly incorporating in said sand composition prior to its fabrication and curing, a minor proportion, in an amount between about 1 and 15 percent by weight, based on the weight of the core oil in said sand composition, of an organosilicon additive that is the partial hydrolyzate of the alkoxylated mixture of by-produced chlorosilicon compounds obtained from the reaction of methyl chloride and silicon, the organosilicon material in said alkoxylated mixture having at least about 3 weight percent of silicon-bonded alkoxy groups and an average of from about 0.9 to 1.2 monovalent hydrocarbon atoms per silicon atom therein.

8. The method of claim 7, wherein said organosilicon additive is composed essentially of a mixture of about 85 percent by weight of a methoxylated partial hydrolyzate of direct process residue from the reaction of methyl chloride and silicon and about 15 percent by weight of a methylsiloxane resin.

9. The method of claim 7, wherein said core oil is a mineral type core oil.

10. A shaped article for molding metals in casting processes, said article being fabricated from a composition in accordance with the composition set forth in claim 1.

11. A shaped article for molding metals in casting processes, said article being fabricated from a composition in accordance with the composition set forth in claim 2.

12. The method of casting metals which comprises mixing sand with a minor proportion of from about 1 to 4 percent by weight, based on the weight of the resulting composition, of core oil and another minor proportion of between about 1 and 15 percent by weight, based on the weight of the core oil, of an organosilicon additive that is the partial hydrolyzate of the alkoxylated mixture of by-produced chlorosilicon compounds obtained from the reaction of methyl chloride and silicon, the organosilicon material in said alkoxylated mixture having at least about 3 weight percent of silicon-bonded alkoxy groups and an average of from about 0.9 to 1.2 monovalent hydrocarbon atoms per silicon atom therein; forming a mold of the resulting sand composition; and casting the metal in the resulting mold.

13. The method of claim 10, wherein said metal that is cast is a ferrous metal.

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