United States Patent Office 2,763,626
Patented Sept. 18, 1956

2,763,626

MOLDING SAND COMPOSITION COMPRISING A HALOGENATED ALIPHATIC HYDROCARBON AS A RELEASE AGENT

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No Drawing. Application June 21, 1951, Serial No. 232,871

5 Claims. (Cl. 260—17.2)

The invention disclosed in this application deals broadly with foundry sand molding methods; deals particularly with foundry sand compositions especially suitable for foundry cores, which contain substantial quantities of synthetic resin adhesive to hold the grains of sand together in the form of a core, after a baking step; and provides a molding sand composition containing a synthetic resin adhesive, fillers, binders, moisture, and the like, and in addition a high molecular weight halogenated organic compound which serves to prevent sticking of sand particles to the core box or to a pattern when a baked mold is used or to other associated equipment.

In the making of metal castings, it has been customary to produce a pattern of wood or metal having a size and shape closely similar to the metal article desired, with allowances for draft, metal shrinkage, and the like; and to ram moist sand around the pattern making provision for a parting surface between cope and drag, together with appropriate sprues, gates, and vents; then to open the mold, remove the pattern, and pour the resulting cavity full of molten metal. However, the making of holes in such a casting has required the use of cores made of sand in which the sand particles are held together with an adhesive, since considerably more strength is required in a core than is required in the sand mold proper. Early usage made a core out of a mixture of sand and linseed oil which was baked for many hours to develop the necessary strength and cohesion in the core structure. The strength obtained was barely adequate, however, and the baking operation was tedious and generally unsatisfactory. Current practice tends toward the use of synthetic resin adhesives to hold the grains of sand in a core together into a unitary structure, since by the use of setting catalysts and a small amount of heat a strong core is obtained which permits much more rapid operation and much more satisfactory foundry practice. In addition, there is a definite trend toward the use of the same resin-containing sand mix for the making of molds in general, especially "shell" type molds which are highly efficient and satisfactory. However, great difficulty is experienced in obtaining a clean separation of the core or molding sand from the core box or pattern since all of the adhesives tend strongly to cause the sand particles to stick to the core box or pattern.

According to the present invention it is now found that, if a small amount of a halogenated high molecular weight organic compound is added to the core sand mix or foundry sand mix with the adhesives, the separation of the core sand or molding sand from the core box or pattern is improved so greatly that there is no significant tendency for the sand to stick to the pattern surface; yet adequate green strength is obtained, and excellent baked strength is obtained.

The preferred anti-sticking component is lauryl bromide, but a wide range of other relatively high molecular weight halogenated organic compounds are also usable. It appears that a carbon atom number between about 5 and 25 is desirable; it does not appear that the presence of one carbon-to-carbon double linkage interferes, nor does it appear significant which of the halogens are used, although a bromine substituted compound is preferable. Other objects and details of the invention will be apparent from the following description:

The primary raw materials for the composition of matter of the present invention are, first, foundry sand; second, synthetic resin adhesive; third, various addition agents; and, fourth, the halogenated high molecular weight anti-sticking compound.

For the foundry sand, any of the usual types and grades of molding sands are suitable. Molding sands are generally fine in grain size and contain some clay, either naturally present or specially added. Core sands are coarser and are usually washed free from clay although clayey materials may be added in small amounts. Generally the sand is of silica particles though there is occasional use also of zirconium silicate, which is a combination of the oxides of silica and zirconium. Although the beneficial effect of my invention in the inclusion of the halogenated organic compound with the sand applies to all of these grades of sand, it appears to have its most marked effect in core sands whether the sand is used for cores or for molds in the foundry.

For the synthetic resin adhesive, any of the synthetic resins which are in part water-soluble or are of the hydrophilic type of resins may be used. The preferred resins are the phenol-formaldehyde and urea-formaldehyde types. In preparing these resins the phenol and formaldehyde or urea and formaldehyde are mixed, the condensation catalyst added, the material warmed to an appropriate reaction temperature, and the condensation carried to a stage short of insolubilization in water. Preferably the condensation is conducted in such a way as to yield a resin which can be dried to a solid, and ground or powdered, without losing its water solubility. This is desirable, to permit of the making of a dry or nearly dry material suitable for storage before admixture with the foundry sand.

To the sand-resin mixture there may be added a wide range of auxiliary materials. Usually a small amount of water in the range of from 1 part to 6 parts per 100 parts of sand is added to make the sand cohere sufficiently for the necessary handling operations, and give the necessary "green strength." It is also usually convenient to add more or less of a cereal binder, which usually is corn flour, but can be an analogous material selected from a wide range of such products. Instead of corn flour, such materials as wheat flour or wood flour, or other inexpensive finely powdered organic material, may be used. In addition, other substances may be added for special purposes, such as silica flour, iron oxide, bentonite, or the like.

The mixture of sand, resin, and these auxiliary substances makes a foundry sand which follows reasonably closely the prior art and can be used for some purposes. However, very great difficulty is encountered in getting smooth, true-shaped cores and molds, because of the very great stickiness of the cereal binder and resin which causes considerable quantities of the sand to stick to the pattern or core box rather than to the body of sand, and accordingly it is extremely difficult to strip the core from the core box or the pattern from the mold in a clean fashion so as to leave a perfect core or mold behind.

The essence of the invention, then, is the use or provision of a further addition agent in the form of the above described halogenated high molecular weight aliphatic compound. The preferred compound, as far as is now known, is lauryl bromide. The addition of lauryl bromide to the above described components yields a core sand or foundry sand which has a good green strength, an excel-

lent baked strength, and is completely free from any tendency to adhere to the core box or pattern, resulting in practically 100 per cent perfect cores or molds having little tendency for adhesion of the sand to either core box or pattern, and accordingly no defects in cores or molds from removal of sand particles by adhesion to core box or pattern occur.

As above pointed out, lauryl bromide is the preferred substance, but any aliphatic compound having a minimum of about 5 carbon atoms in the linear chain, and at least one halogen substituent, is usable, the maximum feasible number of carbon atoms being between 25 and 30.

In the practicing of the invention, the sand and resin are conveniently mixed in any desired way, the most satisfactory procedure being dry mixing in a muller. All of the dry components, if desired, may be mixed together in the muller and at an appropriate stage in the mixing the necessary amount of water may be added. The moist prepared mix is then ready for use. The mix is conveniently placed in the core box or around the pattern in any desired way. A core box may be filled by hand if desired, or the newer blowing method may be used, depending upon the number of cores to be made and many other factors. The core is then stripped from the core box and the halogenated organic compound serves to give excellent release properties to the sand mix to cause the grains of sand in the core to adhere together and to release very easily from the core box. That is, the adhesivity of grain to grain is higher than the adhesivity of grains to core box, or pattern. The core shows an adequate green strength, sufficient to permit of the necessary handling to put the core into the baking oven. The resin, with a contained setting catalyst if desired, hardens very quickly in the core oven so that little more heating is required than enough to bring the entire core up to setting temperature through the entire body. The resulting core shows a very excellent baked strength, yet after casting it collapses sufficiently easily to permit of the necessary shrinkage of metal around the core and does not solidify within the casting to such an extent as to be difficult to remove.

The details of preferred methods of operation are shown in the following examples:

Example 1

100 pounds of core sand of New Jersey origin having a grain fineness number of 80 is mixed with one pound of gelatinized corn flour and 2 pounds of a water syrup of phenol-formaldehyde resin existing in the so-called A stage of condensation. This mixture is wetted by mixing with 5 pounds of water. When used at this stage to fill a core box, it is very sticky and will refuse to leave the surfaces of the core box clean and free fron sand grains. However, if now to this mix there is added 0.03 pound or 13.62 grams of lauryl bromide and mixing means provided for thorough distribution of this addition among the sand grains, the nature of the sand is changed to one of non-sticking characteristics and there is no appreciable adherence of sand to core box or pattern surfaces.

Example 2

The sand mix formula of Example 1 is repeated except that the lauryl bromide is predissolved in kerosene before addition to the sand. An amount of kerosene sufficient to provide a concentration of 1 part of lauryl bromide in 5 parts of kerosene by weight will aid in the dispersion of the parting agent on the sand grains, the formula then being 0.03 pound of lauryl bromide in 0.15 pound of kerosene to 100 pounds of sand, containing also the synthetic resin binder.

Example 3

For lauryl bromide in kerosene solution as described in Example 2, there may be substituted halogenated kerosene. Ordinary commercial kerosene is capable of absorbing enough halogen by mere contact at a warm temperature to produce a compound having the effect sought. This is accomplished by passing chlorine into kerosene at a temperature of 140°–150° F. until the hydrocarbons of the kerosene have absorbed at least one per cent of chlorine as determined by analysis.

Example 4

Lauryl chloride is available on the chemical market and has shown the effect of eliminating sand stickiness to a degree closely approaching that of the bromide. Lauryl chloride, like the bromide, is the alkyl halide of normal structure, $C_{12}H_{25}Cl$, having the chemical identification, 1-chlorododecane. While not as effective as the bromide, its cost is lower thus permitting the same high sand release property at equal cost in many core sand mixes. As an example, 100 pounds of core sand is mixed with one pound of corn flour, 2 pounds of phenol-formaldehyde resin, and 4 pounds of water. Lauryl chloride in amount of 0.05 pound or 22.70 grams is dissolved in 0.15 pound of kerosene and this added to the wet sand mix. After mixing for 1 or 2 minutes, the sand loses its sticky nature and can be used in forming molds or cores or on patterns with a high degree of release of sand grains.

Example 5

To 100 pounds of core sand, there are added 2 pounds of corn flour and 1 pound of a water solution of liquid urea-formaldehyde resin solids. Sufficient water is mixed in to give good molding properties to the sand. While mixing is continued, a solution of 0.02 pound of lauryl bromide in 0.15 pound of kerosene is added. A short additional mixing period suffices to disperse the parting solution through the sand and render it non-sticky.

The lauryl or dodecane halides are used in the examples because these are readily available in the chemical market. However, homologues of the dodecane halide of lower or higher molecular weight are also meant to be included in the scope of this invention. It has been observed that the effectiveness of the alkyl halide improves with increasing molecular weight in a uniform manner. Some benefit was observed with the halide of pentane, n-amyl chloride, $C_5H_{11}Cl$, but not with the next lower halide, n-butyl chloride. The halides of lower molecular weight are also too volatile to be of practical use. The halides of n-dodecane are surpassed in molecular weight by a number of compounds, all believed to be effective as such or in solution in an inert solvent as molding sand release agents.

The halide derivatives of the following hydrocarbons belong to this series:

n-Tridecane	n-Eicosane
n-Tetradecane	n-Heneicosane
n-Pentadecane	n-Docosane
n-Hexadecane	n-Tricosane
n-Heptadecane	n-Tetracosane
n-Octadecane	n-Pentacosane
n-Nonadecane	

Although these examples refer to the use of the normal halides because they are being manufactured, it is not intended that the isomers of these compounds, that is, the derivatives in which the halogen is located in other than the 1-position, or the corresponding isomeric compounds with respect to the chain structure of the molecule, shall be disregarded.

The names used here, such as lauryl bromide, are sometimes wrongly used to designate the acid halides, RCOX, where R is the alkyl group and X the halogen. The acid bromide corresponding to lauryl bromide is properly referred to as lauroyl bromide. This invention is not intended to cover the use of the acid halides for this purpose.

Thus, the composition of matter of the invention produces a core, or mold, having good green strength, excellent baked strength, excellent release properties of sand from pattern or core box, quick baking, and ready collapsibility after pouring of the molten metal. The process

involves the mixing together of sand, resin, fillers, and a halogenated organic compound having from 5 to 30 carbon atoms in the linear chain, the moistening step, and forming in a core box or against a pattern, followed by baking of the resulting form to yield an excellent core or mold around or within which molten metal can be poured to yield the desired shape, while the core collapses readily under the contractional forces of the cooling metal.

While there are above disclosed but a limited number of embodiments of the composition and process of the invention, it is possible to provide still other embodiments without departing from the inventive concept herein disclosed; and it is therefore desired that only such limitations be imposed on the appended claims as are stated therein or required by the prior art.

The invention claimed is:

1. A sand molding composition for preparing molds for casting molten metals comprising a mixture of foundry sand constituting the major part of the mixture, a heat-curable binder composition containing a hydrophylic resin selected from the group consisting of condensation products of formaldehyde with phenol and formaldehyde with urea, in proportion adequate to bond the same, and, as a release agent, a kerosene-soluble C_5—C_{30} substituted aliphatic hydrocarbon containing as substituent one halogen atom to the molecule, the halogen being selected from the group consisting of chlorine and bromine and the proportion of the release agent being less than the proportion of the binder.

2. The composition of claim 1 including a ground cereal binder in proportion less than that of the sand.

3. The composition of claim 1 in which the release agent is a monohalododecane in which the halogen present is selected from the group consisting of chlorine and bromine.

4. A sand molding composition for preparing molds for casting molten metals comprising a mixture of foundry sand constituting the major part of the mixture, a heat-curable binder composition containing a hydrophylic resin selected from the group consisting of condensation products of formaldehyde with phenol and formaldehyde with urea, in proportion adequate to bond the same, and, as a release agent, kerosene chlorinated to a content of approximately 1% of chlorine.

5. A sand molding composition for preparing molds for casting molten metals comprising a mixture of foundry sand constituting the major part of the mixture, a heat-curable binder composition containing a hydrophylic resin selected from the group consisting of condensation products of formaldehyde with phenol and formaldehyde with urea, in proportion adequate to bond the same, and, as a release agent, mono-1-bromododecane.

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