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METHOD OF TREATING A METALLIC PATTERN FOR SHELL MOLDING

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This invention relates to materials and methods for preventing sand molds from adhering to metal patterns and particularly to mold release agents which permit the ready and complete removal of thin-walled sand-resin molds from hot metallic patterns after the molds have been cured.

Recently developed techniques in foundry practice incorporate the use of thin-walled dispensable molds and cores composed of sand and plastic binders. These procedures, frequently generally referred to as "shell molding" processes, employ molds and cores which are particularly suitable for the production of precision castings in a wide variety of metals.

In these shell-resin molding processes, the advantages obtained by the use of thin-walled sand-resin molds and cores in casting metal parts to close dimensional tolerances requires that these castings have very smooth as-cast surfaces. Accordingly, it is imperative in the formation of the molds that there is a clean separation of the sand from the surface of the metal pattern. Heretofore, some difficulty had been encountered from stripping the mold from the pattern because of the inadequacy of the parting material used, thereby often resulting in the partial breaking or tearing in the mold edges and control details.

A principal object of this invention, therefore, is to provide a mold release agent which is especially suitable for use with the aforementioned shell molding processes and which permits only a negligible amount of residue build-up on the metal pattern surfaces. A further object of the invention is to provide such a mold release agent which may be applied to the pattern equipment by spraying or brushing prior to the molding operation and which functions equally well on cast iron, aluminum and other metallic patterns and core boxes.

These and other objects and advantages of my invention are attained with a mold release agent or parting mixture which comprises a high melting point hard natural wax in a liquid vehicle. Such a parting mixture may be easily and inexpensively prepared and safely and quickly applied to the pattern surfaces. Furthermore, the use of such a mold release agent permits excellent reproduction of the pattern details and eliminates the danger of any measurable portion of the sand mold adhering to the pattern.

It will be understood that the term "mold" as used herein, is generally applied in its generic sense to mean a casting form which includes both molds and cores, this invention in no manner being limited to the former. Similarly, unless indicated otherwise, the word "pattern" is used herein as including both mold patterns and core boxes.

Essentially, the shell molding process consists of using a thermosetting plastic or resin as a binder for the sand grains to form rigid molds having high gas permeability, good surface smoothness and dimensional stability. The molding material, which is generally a dry mixture of a major proportion of silica sand and a minor proportion

of a plastic binder, is used in powdered form with no water being added. Phenol formaldehyde and melamine formaldehyde resins are typical examples of the type of thermosetting binders preferably used. The sand employed is preferably free of metal oxides, clay, moisture and organic matter.

These sand-resin molds are prepared by allowing the dry mixture of sand and resin powder to come into contact with a hot metal pattern for a short period of time. A layer of the mix adheres to the metal surface due to the heating of the resin which entraps the sand with which it is intimately mixed, thereby accurately reproducing pattern details. Metal patterns must be employed because they are subjected to elevated temperatures. The half patterns, gate and runner are usually all permanently fixed on metal plates. Pattern temperatures in the range between 250° F. and 350° F. are typical, but temperatures up to 600° F. may be advantageously employed under particular conditions. The pattern temperatures and the length of time the molding material is allowed to remain in contact with the hot pattern surface determines the resulting thickness of the mold. Mold build-up times ranging from a few seconds to approximately one minute are appropriate for various applications. After this short time interval the excess dry sand and resin are removed, and the closely adhering sand-resin layer is preferably cured by heating to a temperature within the range of approximately 300° F. to 600° F. for a short period of time, usually from a few seconds to five minutes, while in contact with the metal pattern.

The baking operation results in the conversion of the resinuous material to a hard insoluble plastic binder which securely bonds the sand grains together. The formed molds are, in effect, thin shells which have sufficient strength and stiffness to make them suitable for many casting operations. After the removal of the pattern and mold from the curing oven, the mold is stripped from the pattern. As hereinbefore explained, partial breaking or tearing of the mold edges has been often experienced in this stripping operation in the past because of the unavailability of any satisfactory parting material.

In accordance with my invention, I have found that a mold release agent containing a high-melting wax, such as carnauba wax, in a suitable liquid vehicle is of great utility in the shell molding processes. The liquid vehicle may be water, kerosene or a mixture thereof, the water-base parting mixture being preferable in most instances for the reasons which will be hereinafter set forth.

If the water-base type of mold release agent is used, an emulsifier or suspension agent should be employed to maintain the wax in suspension in the water. Among the emulsifiers which have been found to be satisfactory are the so-called "soluble oils" and polyoxyethylene sorbitan monooleate or monopalmitate surface active agents. The product currently commercially available under the trade name Penola No. 2210, manufactured by Penola, Inc., and Seco, an emulsifiable cutting oil manufactured by the Sun Oil Company, are examples of the former, while the Atlas Power Company's emulsifier G9446N is an example of the latter. Equal proportions by weight of the suspension agents currently available under the trade names Tween 80 and Span 80 may also be used to produce good results. Generally, I have found it preferable to use the aforementioned monooleates or monopalmitates as emulsifiers inasmuch as they may be used in smaller quantities than the "soluble oils" in most applications and leave practically no residue. These emulsifiers are normally especially effective in concentrations of 0.3% to 2.0% by weight, although they are beneficial when added to the mixture in amounts as small as 0.05% by weight or as large as 6.0% by weight. To effectively maintain the wax in suspension,

however, I have found that the emulsifier preferably should be used in a quantity equal to at least 25% of the weight of the wax. Use of an emulsifying agent in amounts greater than 50% of the weight of the wax appears to produce no additional beneficial results.

Accordingly, in these entirely water-base type of mold release agents, satisfactory results have been maintained with a mixture containing 0.1% to 20% by weight of carnauba wax, 0.05% to 6% by weight of emulsifier, and the balance substantially all water. In most instances particularly good results are obtained when the aforementioned constituents are combined in quantities within the following more limited ranges: 1% to 4% by weight of carnauba wax, 0.3% to 2% by weight of emulsifier, and 95% to 98.7% by weight of water. Specifically, I have obtained excellent results with the parting mixture wherein the wax constitutes approximately 2% by weight of the total mixture and with parting agents which contained approximately 0.6% by weight of an emulsifier. Accordingly, for most applications I have found it desirable to use a specific mixture of 2% wax, 0.6% emulsifier and 97.4% water.

In the above parting mixtures the basic constituent which affects the mold release from the pattern is the carnauba wax, a hard natural wax having a high melting point. Such a wax is not easily vaporized upon contact with metallic patterns which are kept at proper temperatures, thus permitting the formation of a substantially unbroken film of wax on the hot pattern surface. Highly satisfactory results have also been obtained wherein less expensive candelilla wax, another hard natural wax, is substituted for a portion of carnauba wax in the aforementioned parting mixtures. Where these waxes are used together to constitute the desired content, it is preferable to maintain the percentage of the carnauba wax in the total wax content to at least 75% by weight. Hence an excellent mold release agent results where 1.5% by weight of carnauba wax and 0.5% by weight of candelilla wax are mixed with the required amounts of emulsifier and water.

In the preparation of this mold release agent the wax is preferably melted and heated with the emulsifier to a temperature within the range between 170° F. and 200° F. The water, after being heated to its boiling point, is slowly set into the molten wax solution, the mixture of the two liquids being preferably accomplished by vigorous stirring. The mixing of these constituents results in a milky colored emulsion which possesses extremely low viscosity.

The aforementioned wax, emulsifier, and water mold release agent can be most easily applied to the pattern by spraying. A fine mist directed onto the pattern surface for a few seconds provides adequate protection against sticking of the cured molds on the pattern. Whereas many lubricants heretofore used for such purposes have been heavy, flocculent suspensions which were difficult to evenly apply to a surface, the mold release metals prepared in accordance with my invention are low-viscosity liquids capable of being easily sprayed. Upon contact with the hot metal patterns the water evaporates almost instantly, leaving a very thin evenly distributed layer or film of wax on the pattern.

Sand-resin molds may be easily and completely removed from the most intricate pattern equipment when the above parting mixtures are employed. Furthermore, inasmuch as the use of these mixtures causes a negligible amount of residue build-up on the pattern equipment, there results no deviation from desired dimensions in the cured core as would otherwise be the case. Excessive residue build-up, moreover, would increase the sticking tendency of the mold on the pattern. High melting point hard natural waxes, such as carnauba wax and candelilla wax, are particularly advantageous in this respect. For example, if after use of a pattern for a considerable period of time the residue build-up becomes greater than would normally be desirable for precision casting operations, this mold release agent is of such a nature as to be easily, quickly and completely burned off by the simple expedient of merely heating the pattern to a temperature above that used in forming the molds on heated metal patterns in the shell-molding process.

As hereinbefore indicated, kerosene may be partly or wholly substituted for the water in my wax-depositing mold releasing mixture. This substitution of kerosene for water permits the reduction of the amount of emulsifying agent used or completely eliminates the need for such an emulsifier because the waxes used are readily soluble in hot kerosene. Hence, a mold release agent which permits excellent reproduction of pattern details may be formed by a mixture containing 0.1% to 20% by weight of carnauba wax in kerosene or in a mixture of kerosene and water. When no water is used and the liquid vehicle is comprised entirely of kerosene, an emulsifying agent is not necessary because of the solubility of the wax in hot kerosene, as hereinbefore indicated. Where any substantial amount of water is added, however, an emulsifying agent is desirable to obtain the proper dispersion of the wax in the parting mixture.

In accordance with these findings specific examples of parting agents containing kerosene and carnauba wax which have proved particularly satisfactory are mixtures of 1% to 2% by weight of carnauba wax in kerosene and of approximately 1% by weight of carnauba wax, 1% by weight of emulsifier, 7% by weight of kerosene and 91% by weight of water. Similarly, good results are obtained with a mixture, by weight, of approximately 1% carnauba wax, 7% kerosene, 3% emulsifying oil and 89% water. Of course, in these latter types of mold release agents, the quantity of the wax and emulsifiers used may be varied within the ranges hereinbefore indicated, but for best results the dispersion should be kept at a temperature above approximately 125° F., if the emulsifier content is lowered much below 3%. Below this temperature, the use of an emulsifier in a concentration of about 2% maintains the dispersion only fairly well, while only 1% by weight of the emulsifier causes a flocculent precipitate to sometimes partially separate from a portion of the water when cooled below 125° F.

As in the water-base type of mold release mixture, up to ¼ by weight of the carnauba wax may be replaced with candelilla wax without appreciably reducing the parting qualities of the mixture.

When the kerosene-base type of mold release material is to be used, the carnauba wax is dissolved in the kerosene by heating a mixture of the two materials in the desired ratio. The use of a steam plate at 180° F. provides a relatively safe heating method. The wax dissolves more readily if pulverized, pulverization through 20 mesh proving satisfactory. Upon cooling, the wax may re-form as a finely divided precipitate; however, moderate agitation of the dispersing container gives a satisfactory dispersed condition from which good results may be obtained.

The essentially water-base mold release material which also contains some kerosene may be produced by first pulverizing the carnauba wax to permit more rapid solution. After heating the kerosene to a temperature in the order of approximately 180° F., the wax is preferably dissolved in approximately one-half of the kerosene to be used. An appropriate emulsifying agent, such as one of those hereinbefore discussed in conjunction with the suspension of carnauba wax in water, is dissolved in the remainder of the hot kerosene. These two kerosene-base solutions are then mixed together, the temperature of the mixture being retained in the vicinity of the 187° F. The water, which is preferably heated to approximateely its boiling point, is subsequently slowly poured into the kerosene solution of wax and emulsifier, accompanied by vigorous agitation. The mold release material obtained

in this manner is an ivory-colored, permanent dispersion or emulsion which has a relatively low viscosity.

Although this emulsion is more viscous than the kerosene-free mold release agent hereinbefore described, all of the aforementioned mixtures can be easily sprayed or brushed on the hot metallic patterns. Moreover, the kerosene, as well as the water, evaporates almost instantly upon contact with the pattern surfaces, leaving a thin layer of wax deposited thereon to provide excellent mold releasing properties.

The aforementioned mold release agents of the water-base or essentially water-base types, as compared with a kerosene-base type, are of particular utility when the mold release material is to be applied to metal pattern equipment having very high temperatures because the kerosene-base type may prove hazardous under these circumstances. The use of the essentially water-base mold release agent, on the other hand, eliminates all fire and explosion hazards during application. Moreover, the water-base type is superior to other mixtures in most instances from the standpoint of ease of preparation and application to the pattern equipment, the latter feature resulting from the lower viscosity of the water-base mixture. Furthermore, the water-base type has the added advantage of causing an even smaller residue build-up on the metal pattern surfaces than results when kerosene is used in the liquid vehicle.

In the "shell molding" process, upon pouring the liquid metal into the mold or core cavity in the usual way, the hot metal, on coming into contact with the mold or core, burns the plastic binder to essentially carbon. The gases which are generated readily escape through the high permeable sand-resin shell. As a result of this plastic breakdown, the shake-out is easily accomplished.

Among the numerous advantages of this process is the fact that the molds and cores so produced offer very little resistance to the expansion and contraction of the molten metal subsequent to pouring, thus minimizing the danger of the formation of cracks or hot tears. This process and the molds formed in accordance therewith can be used to provide castings of extremely thin section because of the unusual smoothness and high gas permeability of the molding material. Such molds permit the production of sound castings in a variety of metals and alloys over a wide range of casting temperatures. Moreover, the molds and cores can be produced and processed without objectionable dust formation; and the cured cores and molds have no affinity for water, are completely stable under atmospheric conditions and may be stored indefinitely.

The use of a mold release agent in accordance with my invention further increases the value of this shell molding process for precision casting by providing molds which faithfully produce pattern details, maintain good dimensional tolerance and possess excellent surface qualities. Accordingly, the resulting castings have unusually smooth and clean surfaces, true dimensions and a minimum of fin at the parting line. The surfaces of these castings are free of residual mold material, thereby eliminating the necessity of shot blasting.

It is to be understood that, while my invention has been described by means of certain specific examples, the scope of my invention is not to be limited thereby except as defined in the appended claims.

I claim:

1. A method of treating a metallic pattern for effecting the release of a shell-type and sand-resin mold therefrom which comprises heating said pattern to at least 250° F. and coating the molding surface of said hot metallic pattern with a mixture of minor proportions of carnauba wax and emulsifier and a major proportion of water for distributing said wax on said molding surface.

2. A method of treating a metal pattern for preventing the adhesion of a shell mold thereto which comprises heating said pattern to a temperature of at least 250° F. and coating the molding surface of said heated pattern

with a parting agent consisting essentially of an emulsion of 0.1% to 20% by weight of carnauba wax, 0.05% to 6% of an emulsifier and the balance substantially all water.

3. The process of forming a sand-resin shell mold which comprises heating a metallic pattern to a temperature of at least 250° F., applying to the surface of said heated pattern a mold release agent comprising minor proportions of carnauba wax and a suspension agent and a major proportion of water, subsequently coating said surface was a sand-resin molding mix, curing the resultant mold shell, and removing the mold from the pattern.

4. A method of effecting the ready release of a shell mold from a metallic pattern which comprises heating said pattern to a temperature of at least 250° F. and coating the surface of said hot metallic pattern with a parting mixture comprising 0.1% to 20% by weight of a high-melting hard natural wax, 0.05% to 6% by weight of an emulsifying agent and the balance substantially all water, placing a sand-resin molding mixture into contact with the hot metallic pattern for a short interval following the vaporization of said water and a portion of said emulsifying agent, curing the formed mold layer while in contact with the pattern, and removing said mold layer from the pattern surface.

5. The process of forming a shell-type sand-resin mold which is readily released from pattern surfaces, said process comprising heating a metallic pattern to a temperature between 250° F. and 600° F., coating the molding surface of said heated pattern with a parting agent comprising an emulsion of 0.1% to 20% by weight of carnauba wax, 0.05% to 6% by weight of an emulsifier for maintaining said wax in suspension and the balance substantially all water, covering the molding surface of said pattern with a layer of a sand and resin mix, curing the resultant shell mold by heating while in contact with the metallic pattern, and removing the mold layer from said pattern.

6. A method of forming a shell-type sand-resin mold for metal casting operations which comprises heating a metal pattern to a temperature of at least 250° F., spraying the molding surface of said heated pattern with a parting agent consisting of 0.3% to 2.0% by weight of an emulsifier, 95% to 98.7% by weight of water and 1% to 4.0% by weight of carnauba and candelilla waxes, the carnauba wax constituting at least 75% by weight of the total wax content, permitting said water and emulsifier to evaporate, coating said heated pattern surface with a mixture of silica sand and a suitable quantity of thermosetting resin binder to bond together a substantial portion of the sand particles, removing any excess sand and binder, curing the formed mold layer by baking while in contact with the pattern, and stripping the formed mold shell from said pattern.

7. The process of forming shell-type sand-resin molds which are readily released from pattern surfaces, said process comprising heating a metallic pattern to a temperature of at least 250° F., coating the molding surface of said heated pattern with a parting agent comprising an emulsion of 1% to 4% by weight of carnauba wax, 0.3% to 2% by weight of an emulsifier for maintaining said wax in suspension and the balance substantially all water, thereafter covering the coated molding surface of said heated pattern with a layer of sand-resin molding mix, subsequently heating the resultant shell mold to cure the same and removing it from said pattern.

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