Expendable mold casting process pdf

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Production rates of 1–10 units/hr can be achieved with plaster molds.[1][2] Parts that are typically made by plaster casting are lock components, gears, valves, fittings, tooling, and ornaments.[2] Details The plaster is not pure plaster of Paris, but rather has additives to improve green strength, dry strength, permeability, and castability. For instance, talc or magnesium oxide are added to prevent cracking and reduce setting time; lime and cement limit expansion during baking; glass fibers increase strength; sand can be used as a filler.[1] The ratio of ingredients is 70–80% gypsum and 20–30% additives.[2] The pattern is usually made from metal, however rubber molds may be used for complex geometry; these molds are called Rubber plaster molds. For example, if the casting includes reentrant angles or complex angular surfaces then the rubber is flexible enough to be removed, unlike metal.[1] These molds are also inexpensive, reusable, more accurate than steel molds, fast to produce, and easy to change.[citation needed] Typical tolerances are 0.1 mm (0.0039 in) for the first 50 mm (2.0 in) and 0.02 mm per additional centimeter (0.002 in per additional inch). A draft of 0.5 to 1 degree is required. Standard surface finishes that are attainable are 1.3 to 4 micrometers (50–125 μin).[1] Process First, the parting line is determined - either simple two part or more complex (3 or more). A box is made around the pattern to hold the plaster. Then plaster is mixed and the pattern is sprayed with a thin film of parting compound also called a release agent to prevent the plaster from sticking to the pattern. The plaster is then poured over the pattern and the box holding the plaster and pattern is vibrated by mechanical means in order to fill all gaps and to release air bubbles. The plaster sets, usually in about 15 minutes, and the pattern is removed. The mold is then baked, between 120 °C (248 °F) and 260 °C (500 °F), to remove any excess water. The dried mold is then assembled, preheated, and the metal poured. Finally, after the metal has solidified, the plaster is broken from the cast part. The mold is usually damaged from the metal so reusing is usually not done. Discarded plaster can be recycled by grinding but care must be used since silica dust causes lung damage.[1][2] Advantages and disadvantages Plaster mold casting is used when an excellent surface finish and good dimensional accuracy is required. Because the plaster has a low thermal conductivity and heat capacity, the metal cools more slowly than in a sand mold, which allows the metal to fill thin cross-sections; the minimum possible cross-section is 0.6 mm (0.024 in). This results in a near net shape casting, which can be a cost advantage on complex parts.[1] It also produces minimal scrap material.[3] The major disadvantage of the process is that it can only be used with lower melting temperature non-ferrous materials, such as aluminium, magnesium, zinc and sometimes copper alloys. The most commonly used material is aluminium. The maximum working temperature of plaster is 1,200 °C (2,200 °F), so higher melting temperature materials would melt the plaster mold. Also, the sulfur in the gypsum reacts with iron, making it unsuitable for casting ferrous materials.[1][2] Another disadvantage is that its long cooling times restrict production volume. Onetime molds are often quenched in water but only after completing solidification so hot metal does not fly everywhere. Proper quenching can aid in mold removal and it makes some alloys stronger.[1] Plaster is not as stable as sand, so it is dependent on several factors, including the consistency of the plaster composition, pouring procedures, and curing techniques. If these factors are not closely monitored the mold can be distorted, shrink upon drying, have a poor surface finish, or fail completely.[4] Notes ^ a b c d e f g h Degarmo, Black & Kohser 2003, p. 315. ^ a b c d e Kalpakjian & Schmid 2006. ^ Todd, Allen & Alting 1994, p. 283. ^ US 4818287, Ravins, Thomas L. & Greve, Dale R., "Fiber reinforced plaster molds for metal casting", issued 1989-04-04 . References Degarmo, E. Paul; Black, J T.; Kohser, Ronald A. (2003), Materials and Processes in Manufacturing (9th ed.), Wiley, ISBN 0-471-65653-4. Kalpakjian, Serope; Schmid, Steven (2006), Manufacturing Engineering and Technology (5th ed.), Pearson, ISBN 0-13-148965-8. Todd, Robert H.; Allen, Dell K.; Alting, Leo (1994), Manufacturing Processes Reference Guide, Industrial Press Inc, ISBN 0-8311-3049-0 Retrieved from " RELATED APPLICATIONS This application claims the benefit of U.S. Provisional application Ser. No. 60/003716 filed on Sep. 13, 1995. FIELD OF THE INVENTION The present invention relates to improved investment powders (with and without silicates) for use in making improved investment molds for casting metals, and the use of such molds in conjunction with vacuum and/or either conventional kiln or furnace, or microwave heating apparatus, to rapidly cure, dehydrate and eliminate the wax (and residual carbon from such wax) from the mold cavity(s) at temperatures lower than the casting temperature range of the mold at the time of casting. BACKGROUND OF THE INVENTION The name "lost-wax" casting owes its origin to the fact that an expendable wax pattern of the article (e.g. jewelry) to be cast was first made in wax. This is pattern was fastened to a conical wax sprue rod and then encased in a mold of plaster of paris or some other refractory material. An opening is left in the mold so that most of the wax, when melted, could drain away. The residual wax is then burned away by heating the mold slowly in a kiln at prescribed temperatures for prescribed periods of time. When the wax melted and burned away, the cavity is left in the mold. Molten metal was then poured into the cavity of the mold through the same opening that is used to eliminate the wax, and upon solidification, it assumes the shape of the cavity. After cooling, the mold is broken open to free the casting. Wax trees (i.e., wax patterns and the sprue to which they are attached) are usually formed from several materials which can be combined, including natural wax, synthetic wax, resins (such as damar, balsam, gum, shellac and rosin, plastic compounds, fillers (such as talc, starch, chalk, soapstone, pumice and wood flour) or even polymeric foam as disclosed by U.S. Pat. No. 2,830,3443. Regardless of the specific composition, the materials employed as the wax tree must be made of materials which will melt, burn and vaporize completely and leave little or no residue in the mold structure. Some plastics don't melt, but burn and vaporize completely leaving no residue. As seen in FIG. 1a, 1d and 1e, wax tree 13 is attached to sprue base 17, enclosed in a flask 16, typically of metal (e.g. stainless steel; perforated or non-perforated; with or without a flange; tapered or non-tapered; and then surrounded with a heat-resisting plaster compound, typically referred to as investment, 11 in order to form the mold for the metal casting. Typically, the investment is composed of cristobalite, gypsum, silicas, and modifying agents. Cristobalite is a mineral of volcanic origin. It is now made by heating silicas to 2680° to 3040° F. (1471° to 1671° C.). The cristobalite is an expanding and contracting form of silica which permits the mold to expand without cracking when it is heated and the very hot molten metal is poured into it. Gypsum chemically is hydrated calcium sulphate (CaSO4)+2H2 O. When gypsum is heated gently it becomes Plaster of Paris (CaSO4)2 +1/2H2 O. Gypsum acts as a binder, that is, it rigidly holds all the ingredients in the investment together. Silica is a refractory material. It is infusible, that is, it is not melted or changed by the hot metals cast into it. Silicon dioxide (SiO2), one form of which is finely crushed ordinary beach sand, is used as a silica. The silica cushions or stabilizes the investment while it is being heated during burnout and when it is being cooled just prior to casting. Modifying agents are minerals (copper powder or carbon) in the mixture which produce a reducing (checks oxidation) effect in investment. Modifying agents also include wetting agents (that increase the ability of the investment to flow over the wax tree), chemicals that control the setting time, and debubblizing agents (to assist in removing air from the slurry). The investment powder also must not contain any corrosive or acid producing ingredients which would damage the furnace, flasks or castings. The investment material must be able to be removed quickly and easily from the flask and castings after the metal has been cast into it. Roma-Vest, Kerr Satin Cast and R & R Ultra-Vest are three investments now on the market that are used by jewelers and sold by casting supply houses. The mixture of investment powder with water is a slurry. The proportion of water to investment powder must be controlled accurately, especially by commercial casters in order to obtain uniform usable castings. Too much water will result in a weak mold. Too much investment powder will make the mold surfaces too coarse and important details in the wax pattern will be lost. All investment manufacturers specify the water-powder investment ratio that should be used with their product. Their recommendations are similar and approximate the following average for jewelry casting: weight of water =40% weight of investment (e.g. 40 parts by weight of water to 100 parts by weight of powder). For very fine, intricate castings, slightly more water (up to 2%) can be added to the investment powder in order to obtain a finer slurry that would flow into smaller crevices more smoothly. For heavier castings, slightly less water (2%) is used with the investment powder in order to obtain a slightly less fluid slurry that would be sturdier for heavier castings. As those skilled in the art know, the working time of slurries made with commercial investment powders is approximately 8-9 minutes. Setting time is usually 12-14 minutes. The working time of the investment process starts as soon as the investment powder is added to the water and ends when the flask is totally filled (i.e., capped) with investment slurry and left undisturbed to harden. Working time involves 2-4 minutes of mechanical mixing of the investment powder with the water (and not the other way around as it creates lumps and is very hard to mix) at moderate speed in a bowl. The slurry in the mixing bowl is then placed under a bell jar until the investment slurry rises and collapses in the mixing bowl. Typically, a vacuum of 23-27" Hg is pulled. This takes 30-45 seconds (1 minute maximum). The vacuum is typically held for another 10 seconds before releasing. The vacuumed slurry is poured into the flask through the side of the flask, gently allowing it to flow around and through the wax tree pattern(s) until the pattern(s) are all covered (1/2" above the top pattern). Lightly tapping the flask while filling helps reduce the amount of entrapped air which is reintroduced by pouring. The invested flask is then vacuumed under the bell jar for another 1-2 minutes. The trapped air, if not removed, will cling to the wax patterns as small or large air bubbles which will also be surrounded by the investment. This will ruin the castings for the air bubbles will be cast usually as small or large metal balls (nodules) clinging to the castings. Both the temperature of water and investment should approximate room temperature 70° F.-80° F. (21°-27° C.). Increasing the temperature of water or the investment will accelerate the setting, hence shorten the working time. Conversely, lower temperature of water or investment could affect the quality of the castings. Some people use distilled water to avoid contaminants of ordinary tap water. Commercial retarder like dry citric acid or sodate are sometimes used in very minute percentages. (i.e., 0.03-0.30 gm for every 100 gm of investment powder) to retard the setting time if desired. Retarder's effect on the properties of plaster in regard to initial setting time. After being invested, flasks must be permitted to set undisturbed to solidify for at least one hour for small flasks (2" dia.) and two hours for larger flasks. After solidification the sprue base is removed from the flask to expose the bottom of the wax sprue itself. The bulk of the wax is then eliminated, the mold dehydrated and the residual wax vaporized, and the carbon from such wax ("wax carbon") burned out by heating the flasks in a kiln or furnace to 1300° F. to 1400° F. (704° C. to 788° C.). Many casters now use a steam dewaxer, which removes approximately 90% of the wax before burnout. Molds can be stored for many days before burnout, providing they remain moist. However, if the investment in the flasks becomes dry from being in a dry room for several days, the flasks should be placed in water for a few minutes or better yet, to avoid damaging the mold, they should be wrapped in wet towels to absorb moisture slowly. The investment should be heated only when wet, for dry investments tend to crack when heated. If the mold is heated dry, it can act as a sponge and draw the wax into its pores. Also, water in the wet molds turns to steam when heated and the steam helps in eliminating the wax from the walls of pattern cavities in the mold. As seen in FIG. 2a, after mixture 11 is created as described above, it is inserted into an oven 25, such as a conventional oven, and held at a number of different temperatures above the wax melting point for a long period of time. This process is generally referred to as "burn out" because it is during this time frame that the wax tree is eliminated (or "lost"). The wax melts and disgorges out through sprue opening 10, the mixture 11 is cured into mold 21 as water is vaporized from the mixture, the carbon from the wax is burned off from cured mold 21, and finally, the mold is heated to a proper casting temperature. This period of time can vary depending on the size and shape of the mold, the type of tree being eliminated and the size and shape of the flask. For example, as seen in FIG. 3, for a conventional 4 inch diameter by 8 inch high mold, the time to vaporize water and burn the wax is approximately five hours, and requires the oven temperature to reach 732° C. (1350° F.). Carbon must then be eliminated from the mold at this high temperature for approximately 4 hours. Finally, the mold must be allowed to cool down to the casting temperature of the metal being cast, which can take more than 2 hours depending on the metal alloy being used. While FIG. 3 demonstrates that conventional investment cast processing for small projects takes up to 11 hours, those skilled in the art realize that investment casting usually takes more than 11 hours for larger cast products. Preferably, as seen in FIG. 2a, the mold is positioned in an elevated location in oven 25 by any conventional thermal pad 23, such that as the heat is applied and the wax reaches its melting point, it runs out of the mold to create sprue hole 10. As disclosed in U.S. Pat. No. 3,847,202 to Vaughn, melted wax can be captured for future use, or as disclosed in U.S. Pat. No. 4,854,368 to Vezerian, distilled foam can be vacuum evaporated prior to pouring the alloy into the completed mold. Complete burnout is usually indicated by the disappearance of the sooty black stain around the mouth of the sprue hole. When the stain is gone, the residue has been vaporized. When the mold is fully cured, it is generally allowed to cool to about 260° C. (500° C.) less than the melting point of the metal being cast. At this point the mold should be completely dry, otherwise any moisture will turn to steam as molten metal contacts the mold and creates defects in the casting. In many cases, the presence of moisture may also cause the hot metal to disgorge out of the cavity, making it dangerous for the operator. In a typical burnout cycle the flasks are heated slowly in a kiln to 400° F. (204° C.) so that the water as moisture turns to steam at 212° F. (100° C.) and can escape through the pores of the mold. Water that is chemically combined with some of the chemicals in the investment powder as water of hydration will be driven off at approximately 375° F. (191° C.). If heated very quickly in the initial stages, vapor pressure could cause cracks in the mold, and the escaping steam, in addition to the vapor pressure along with the thermally expanding wax in the cavities, could break the thin investment walls (dividers) between the wax patterns or in the intricate wax pattern itself (especially when the mold is dewaxed and dehydrated simultaneously in a kiln) resulting in damaged castings. At 200° F. to 300° F. (93° C.-149° C.), most of the wax (if not earlier removed by steam) immediately melts and flows out through the sprue opening. The steam from the water in the heated moist investment helps to push the wax off the walls of the pattern cavities in the investment. Wax which does not flow out turns to carbon (a black powder) at 1000° F. (538° C.). This carbon is almost completely eliminated between 1300° F. and 1400° F. (704° C. and 788° C.) by combining with oxygen of the air (the furnace or kiln must be ventilated) forming carbon monoxide (CO) and carbon dioxide (CO2). The gases escape through the sprue opening and also through the pores of the mold. All that is left in the mold cavity is ash (i.e., microscopic trace residue). This residue is comprised of trace metals, salts, silicas, and other inorganic elements. Typically, its value should be no more than 0.015% by weight because waxes with a high ash content can cause porosity and inclusions in a casting. The furnace temperature will rise faster (be hotter) than the temperature of the wet investment in the center of the flask. The difference in temperature can be more than 100° F. (38° C.). To permit the furnace temperature and flask temperature to equalize, the furnace temperature should be held for at least 1/2 hour for small molds and up to 3 hours for larger molds. Doing so permits the molds to have a uniform temperature throughout. If the flask is heated over 1500° F. (816° C.), the gypsum binder (calcium sulphate, CaSO4 +1/2H2 O) begins to break down into sulfur dioxide (SO2) and sulfur trioxide (SO3) and, if a casting is poured over 1500° F. (816° C.), these gases will discolor (form sulfides with) the cast metals and stain the metal. Not only will the resulting casting be dark, but the sulphide layer can be so deeply and firmly bonded to the metal that it cannot be removed. This breakdown can also be accompanied by a loss of detail in the mold wall and could also cause metal porosity. On page 73, in "Centrifugal or Lost Wax Casting" by M. Bovin and P. M. Bovin (14th Printing, 1992) the following burn-out cycles were recommended: ______ 5 Hour Cycle 8 Hour Cycle 12 Hour Cycle ______ For flasks up to 21/2" × 21/2" For flasks up to 31/2" × 4" For flasks up to 4" × 8" preheat furnace to 300° F. preheat furnace to 300° F. preheat furnace to 300° F. (149° C.) (149° C.) (149° C.) 1 hour - 300° F. (149° C.) 2 hour - 300° F. (149° C.) 2 hour - 300° F. (149° C.) 1 hour - 700° F. (371° C.) 2 hour - 700° F. (371° C.) 2 hour - 600° F. (316° C.) 2 hour - 1350° F. (732° C.) 3 hour - 1350° F. (732° C.) 2 hour - 900° F. (482° C.) 1 hour - See note 1 hour - See note 4 hour - 1350° F. (732° C.) 2 hour - See note ______ In Bovin & Bovin (supra) at page 73 the following investment casting temperatures are recommended: ______ White Gold Thin objects 1050° F.-1150° F. (566° C.-621.degree . C.) Thick objects 900° F.-1000° F. (482° C.-538° C.) Yellow Gold Filigree 1050° F.-1150° F. (566° C.-621° C.) Thin objects 900° F.-1000° F. (482° C.-538° C.) Thick objects 800° F.-850° F. (427° C.-454° C.) Silver, Brass 800° F.-850° F. (427° C.-454° C.) Bronze 900° F. (482°°C.) ______ It is also typically recommended that the furnace temperature should be held at the desired investment casting temperature for at least 1/2 hour to permit the investment temperature to drop to the furnace temperature. The foregoing procedure is generally represented by FIG. 3 in which: A represents the point where the flask was just poured or invested, and then set aside undisturbed to let the invested flask (mixed, vacuumed slurry) to set; A-B represents the minimum time (1 hour) for allowing a mold to set before it could be processed for steam dewaxing or heated slowly for simultaneous dewaxing and dehydrating. Normal setting or hardening of mold requires 1-2 hours; B-C represents the slow rise in the temperature of the mold to 1350° F. (732° C.) whether the mold was dewaxed in a steamer for 1 hour or it was directly put in the kiln for dewaxing and dehydrating simultaneously. During this time the wax that didn't drip out through the mouth of the main sprue, and was left entrapped in the cavities of the mold, or the wax that has penetrated into the walls of the mold due to its thermally expanding nature, turns to wax carbon at around 1000° F. (538° C.); C-D represents the time at which the mold is held at 1350° F. (732° C.) for several hours to essentially eliminate the wax carbon from the mold cavity; D-E1 /E2 - the gradual dropping of the mold temperature to the desired casting temperature (typically 850-1250° F. (454-677° C.)). Molds at this stage are fragile and should be handled with care. Dropping or bumping can break thin investment dividers within the cavities. Also, uneven heating of the mold during the foregoing process can cause cracks in the mold, which will result in bad castings. The foregoing process, while still the standard process in many industries, has a number of drawbacks both from the standpoint of the investment powders used and the process. Several problems exist with the typical investment powder used for casting gold, silver, brass and bronze alloys (e.g., 25-40% gypsum and 75-60% silica (various forms), with small percentages of modifiers (as indicated above)). For example, this type of investment powder can be hazardous to the user, as silica compounds are known to cause respiratory problems. Secondly, because silica is a dielectric material, it does not suscept to microwave energy (which is important for the reasons set forth with regard to one of the preferred embodiments of the invention). Further, because silica is also a refractory material, heating by conduction is time-consuming. Moreover, molds produced from this investment powder are structurally weak and typically cannot be used in flaskless applications. Finally, molds made from such powders cannot withstand rapid thermal shock and temperature differentials during any phase of the casting process as they crack easily. In addition to the foregoing, molds made with typical investment powder should not be heated much above 1350° F. (732° C.). As already mentioned, if the mold is heated over 1500° F. (816° C.), the gypsum binder (CaSO4 +1/2H2 O) begins to break down into sulphur dioxide (SO2) and sulphur trioxide (SO3). CaSO4 is sensitive to high temperature. At about 1200° C. (2192° F.), thermal decomposition results in the formation of calcium oxide, sulphur dioxide and oxygen, and, possibly, sulphur trioxide. 2CaSO.sub.4 →2CaO+2SO.sub.2 +O.sub.2 CaSO.sub.4 →CaO+SO.sub.3 The addition of silica (SiO2) to calcium sulphate lowers the temperature of decomposition to 1000° C. (1832° F.), producing: CaSO.sub.4+ SiO.sub.2 →CaSiO.sub.3 +SO.sub.3 The foregoing breakdown can also result in a loss of detail in the mold walls. Thus, conventional CaSO4 bonded investment powders cannot be used to cast platinum or palladium. Platinum has a melting point of 3225° F. (1773° C.); palladium, 2831° F. (1555° C.). Instead, platinum/palladium investment casting requires a mold capable of heating to extremely high temperatures (i.e., 1600° F. (871° C.)), like a phosphate bonded investment binder. Further, since the resultant mold is very hard and has very little porosity and since platinum and palladium chill quickly (because of their high melting points) high torque, centrifugal casting equipment is required. Finally, because of the differences between investment powders used for platinum, it is very difficult to remove the casting from the mold. Hammer and chisel techniques are required, as such molds will not break up/or dissolve when immersed in water, while molds used for gold and silver will. There are a number of disadvantages to the conventional heating process generally described above: 1. Heat losses occur due to the furnace being fluted and ventilated. 2. Molds cannot be enclosed in a heat shield in this system, hence they cannot be prevented from radiating heat away. 3. Molds are heated by conduction from exterior of the mold to the interior, which takes a long time to get a uniform temperature. 4. The mold takes several hours to combust carbon at 1350° F. (732° C.) because it uses the O2 of the outside air. 5. The mold has to be heated to 1350° F. (732° C.) for elimination of carbon and then dropped to casting temperature which consumes additional time and energy. The times, temperatures and heat losses involved demonstrate the extensive amount of energy used in the process. Additionally, the mold is capable of cracking if the process is not carefully monitored and controlled. Further, as the wax is heated, it thermally expands prior to melting and eventually decomposing, and may apply force to or penetrate the mold composition which may generate fluid pressure and gases within the mold thereby causing it to crack. If the mold is cracked, the resulting cast product reflects this flaw and, thus, may not be usable commercially. The above described process presents additional problems when casting with precious or semi-precious gems. As described in the American Jewelry Manufacturer, June 1993, gems can be processed in wax and cast which results in cost savings. However, when gems are processed in an investment casting, extra care must be taken during the burn out phase to protect the structure, beauty and luster of the gems as they are heated to very high temperatures for a very long period of time. It is generally recommended that when casting with gems, one should use lower burnout temperatures (e.g., lower than 427° C. (801° F.)) for, approximately, 14 hours in order to protect the gems. To prevent the gems from being damaged or destroyed, the temperature should never exceed 454° C. (849° F.). Further, it is recommended that alloys be used which flow more easily at lower temperatures than typically used for investment casting. Even if these procedures are followed, only certain gems can be processed (e.g. diamond, ruby, sapphire, garnet and cubic zirconium). Certain gems are not recommended for investment casting under any circumstances, including amethyst, aquamarine, coral, jade, lapis, opal, pearl, peridot, topaz, tourmaline and turquoise. Applicants are aware of a number of patents which disclose the use of microwaves in conjunction with investment casting: U.S. Pat. No. 4,655,276 to C. R. Bird, et al; U.S. Pat. No. 4,126,651 to J. M. Valentine; U.S. Pat. No. 4,180,918 to R. C. Ostowski; U.S. Pat. No. 4,518,031 to A. Yamanishi, et al; and U.S. Pat. No. 3,847,202 to C. D. Vaughn, et al. Bird, et al., disclose a form of creating a shell mold containing external layers of microwavable susceptors. Bird, et al. disclose that the wax tree could be introduced into a mold by first dipping the wax tree in a slurry of conventional molding material such as ceramic, and draining the resulting structure. A stucco layer is then applied to the structure and allowed to dry. Then, subsequent layers of slurry containing microwavable susceptors, such as graphite or metal oxides, are applied. This layering process will continue until the mold walls are of sufficient thickness. At this point, the resulting structure is allowed to thoroughly dry. Microwave energy is then applied to the dry mold and to partially reduce the size of the wax tree such that the wax no longer contacts the mold surface. Finally, the mold is fired in a conventional oven to melt the remainder of the wax in order to avoid cracking of the mold. Bird's disclosure has limited applications. For example, unlike conventional cast molds, shell molds are very thin and incapable of casting delicate and intricate products, especially those found on densely-packed wax trees. Additionally, shell casting is not preferred for casting products having a high quality, non-porous surfaces as the process of dipping necessarily reintroduces air back into the mixture. Because they lack structural strength, shell casts cannot typically retain precious gems. Finally, unlike the present invention, the Bird, et al. disclosure of the use of metal oxides Fe2 O4 (presumably Fe3 O4), MnO2 (presumably MnO), NiO and cobalt oxide (CoO) as susceptors which require heating beyond the desired casting temperature before the susceptors decompose. For example, FeO4 decomposes at 1538° C. (2800° F.), MnO at 1650° C. (3002° F.), MnO2 decomposes at 535° C. (995° F.), NiO at 1990° C. (3614° F.), and cobalt oxide at 1935° C. (3515° F.). None are water soluble. TABLE 1 ______ Melting Point Soluble in Water ______ Fe.sub.3 O.sub.4 1538° C. (2800° F.) (decomposes) No Fe.sub.2 O.sub.3 1565° C. (2849° F.) No MnO.sub.2 535° C. (995° F.) (decomposes) No MnO 1650° C. (3002° F.) No NiO 1990° C. (3614° F.) No CoO 1935° C. (3515° F.) No ______ Another example of the use of microwave heating of gypsum is found in U.S. Pat. No. 4,126,651 to Valentine. This patent discloses using a two-step microwave heating process, wherein a first microwave heating is applied to the investment mold to eliminate water from the mold, and a second microwave heating is applied to the mold to remove the remaining crystallized water. It is an object of the present invention to provide improved investment powders for use in making improved investment molds for casting metals, wherein water, wax and residual carbon from such investment molds are eliminated when heated by conventional (convection or conduction) ovens or microwave ovens at a temperature less than the casting temperature of the metal. It is a further object of the present invention to provide an improved investment powder for making molds by adding at least one modifier to conventional investment powders which, when heated, decomposes producing oxygen, which can combust with carbon to form carbon dioxide gas which can be withdrawn from the mold by any conventional means. It is a further object of the present invention to provide an improved investment powder for making molds by adding at least one suscepting agent to conventional investment powders which, when heated by microwave energy, assists in rapidly heating the mold. It is also an object of the present invention to provide an new investment powder for making molds by combining preferably gypsum and wollastonite (CaSiO3) which, when mixed with water, results in a stronger mold after it is cured and able to withstand high temperatures for prolonged periods. It is a further object of the present invention to provide a process for rapidly curing an investment mold containing modifiers and/or suscepting agents throughout the mold wherein after heating for a predetermined time, the mold is set faster; uniformly heated; wax, hydration and carbon are eliminated at a temperature less than the casting temperature of the metal; and mold cracking is minimized or completely eliminated.

predetermined level. As seen in FIG. 6, molds containing susceptors can be set in 5-15 minutes, complete the dehydration and dewaxing of the mold in 35 minutes, and can achieve carbon burn out in less than 1 hour. Again, as noted previously, because carbon burn out takes place at a much lower temperature (e.g., 425° C. (797° F.) and up), the temperature of the mold can then be directly raised to a casting temperature. Processing time employing the present invention, therefore, is a fraction of the time needed to complete the same process under conventional methods. Preferably, 0.1 to 6 percent of KNO_3, 0.1 to 8 percent of $CaNO_3$ or 0.1 to 10 percent of sugar can be used as suscepting agents. Additionally, up to 10 percent of SiC can be further mixed with investment to form a "susceptible mold." Other acceptable susceptors include water and carbon and those compounds listed in Table 2. As those skilled in the art can appreciate, any combination of susceptors may be admixed with conventional investment powders or with the investment powders disclosed herein to obtain the benefits described. Like oxidizing molds, the advantages of a susceptible mold are extensive. First, susceptor agents contribute to the rapid setting of the mold. Second, carbon is eliminated due to the reaction of oxygen from the modifier with carbon particles from the (oxidizing agent) with carbon particles to form CO_2 and CO. Third, because of the nature of microwave energy and the use of susceptors dispersed throughout the mold, uniform heating can occur throughout the mold. If the mold is rotated within the microwave, as seen in FIG. 11, uniform heating will be achieved throughout the mold. Fourth, as seen in FIG. 6, use of susceptors results in significant time and energy savings over conventional casting methods. Finally, use of a suscepting mold allows for casting with gemstones at lower temperatures than conventionally used without harm to the gemstones. Again, recalling FIGS. 1a, 1b and 1c, the process of creating a susceptor mold is similar to conventional mold making processes. Investment powder is mixed with suscepting agents to create a suscepting mixture. The resulting mixture is then poured into flask 15 containing wax tree 13 and the mixture is allowed to set undisturbed in microwave 25 (FIG. 2b). The mixture can then be cured in a microwave oven cavity (shown, for example, as 25 in FIG. 7) while wax tree 13 is dewaxed, thereby eliminating 98 percent of the wax and 100 percent of the moisture. Some plastics don't melt. Molds with such plastic patterns are just dehydrated in the same way. Both plastics that melt or don't melt burn and vaporize completely in the final stages. Plastics normally vaporize at 538° C. (1000° F.), unlike wax which vaporizes at 732° C. (1350° F.) in the conventional heating way. Preferably, sprue hole 10 of mold 21 should face downwards to allow the wax and other undesirable compounds to flow out. Finally, as the mold temperature is directly raised to a casting temperature from 454°-676° C. (850°-1250° F.) in the microwave oven, carbon is eliminated above 425° C. (797° F.). Of course, as seen in FIG. 11a, those skilled in the art will realize that multiple molds may be placed in a microwave oven cavity for processing. When the mold temperature is raised to a casting temperature, as seen in FIG. 8a, sprue hole 10 should preferably face up as gases rise. Because the mold must rapidly achieve high temperatures, mold 21 should be encased in a heat shield 27, such as a thermal blanket, to prevent heat from radiating away and from absorbing the ambient temperature around which could cause cracks in the mold due to uneven heat inside to outside of the mold. When the casting is complete, mold 21 is broken or disintegrated by any conventional method, and final cast metal product 51, as seen in FIG. 9, is retrieved. Additionally, as shown in FIG. 7, optional vacuum system 60 can be directly attached to an opening 32 of microwave oven 30 to assist in the dehydration, dewaxing and carbon elimination processes. Vacuum system 60 includes vacuum flow tube 61 directly attached to microwave oven 25 at opening 32. System 60 further includes stainless steel container 63 having cavity 65 which functions as a depository for melted wax retrieved from mold 21. Vacuum system 60 further includes filter 67 for filtration of water and wax from entering into external vacuum pump line 70 and an interior coolant channel 69 filled with cool water to assist in the cooling of the deposited melted wax from mold 21. System 60 incorporates lid 62 which is attached pressure-tight to container 63 by vacuum seal 64. Lid 62 further includes opening 66 to securely receive vacuum flow tube 61, and opening 68 to securely receive external vacuum pump line 70. Of course, those skilled in the art will appreciate that multiple vacuum systems 60 can be directly attached to oven 25 to assist in the elimination of water, wax and (optionally) carbon. As such, as seen in FIG. 10b, multiple vacuum pressures can be applied to or from any point on the exterior wall of mold 21 within oven 25. Optionally, as seen in FIG. 11, microwave oven 30 can incorporate rotatable pedestal 33. In this oven configuration, oven 30 further includes a conventional magnetron 35, isolator 37, load 39, along with slotted wave guide and array antenna 41 located on a side wall of oven 30, a reflector 43 disposed atop foam pedestal 45 located on another side wall of oven 30. In this configuration, mold 21 is placed upon rotatable pedestal 33 and microwave energy is applied by conventional use of magnetron 35, load 39 and isolator 37. As microwave energy is applied, microwave energy is ricocheted off the oven's interior wall surfaces and off reflector 43 onto mold 21 as it rotates and therefore, uniform heating is achieved throughout mold 21. Of course, heat shield 23 can also be applied to an external surface of mold 21 to prevent heat generated by mold 21 from radiating away, and from absorbing the cold from the ambient temperature which could cause cracks in the mold. Finally, because of the thermal expansion of wax, it is advisable to dewax the mold before dehydration of the mold begins. Therefore, it is preferred to start melting the wax prior to dewaxing the mold in the oven. This can be accomplished by heating a syringe needle attached to a syringe, for example and piercing the wax tree through its sprue rod. Preferably, the syringe needle should have multiple orifices for maximum extraction of melted wax. If possible, the syringe handle should be conventionally engaged as it enters the wax tree sprue rod in order to extract the melted wax. In this fashion, a portion of the sprue rod wax will initially be removed prior to dewaxing and dehydrating the mold. EXAMPLE 6 For a 4 inch diameter by 8 inch high mold, a wax tree with wax patterns to be cast is attached to a rubber sprue base making sure that there is a gap of at least 1/4 inch between the wax tree and the wall of the flask. Conventional investment powder is admixed with 1-10 percent SiC 80-800 mesh, 0-6 percent KNO_3, 0-8 percent $CaNO_3$ and 0-10 percent sugar. The resulting slurry is then poured into the plastic flask which has the wax tree on a sprue based, making sure that the slurry covers at least 1/2 inch above the top of the tree and is vacuumed twice for a total of 21/2 to 3 minutes to eliminate air from the slurry. Microwave heat from a 0.750 KVA oven is then applied to the slurry to accelerate the set up time. The hardened mold is then removed from the flask and the rubber sprue base is pulled from the mouth of the mold. The naked mold is then placed in the microwave oven with its mouth facing down and sealed to the vacuum access. Low power microwave heating is applied for approximately ten minutes to avoid cracking due to vapor pressure. Higher powered microwave heating can then be applied for another 25 minutes, thereby eliminating 98 percent of the wax and 100 percent of water. In our experiments, the temperature of the mold is now approximately 400° F. (240° C.). Next, the mold can be enclosed in a heat shield and with its mouth facing up, be subjected to additional microwave heating for approximately 15 minutes. During this time, carbon is eliminated by combining oxygen generated from the mold composition at approximately 425° C. (797° F.) and up and the temperature of the mold rises rapidly to the casting temperature range of 850°-1250° F. (454° C.-677° C.). FIG. 6 graphically depicts the experimental results, wherein identifier A is the point where the mold is poured into a flask, identifier B denotes the point where the mold is set, hardened enough to take a vacuum pull and is removed from the plastic flask and the rubber sprue base. A 4×8 mold could take 5-15 minutes for setting (hardening) when 5 minutes is the microwave time and 10 minutes is the intermediate intervals of starting and stopping of microwaves, C denotes the elimination of water and wax, D denotes the point where most of the carbon is eliminated and identifiers E through F denote raising the mold temperature directly to the casting temperature range of the mold. As can be seen, total processing time from start to achieving casting temperature range is 55 minutes. It is preferable that the modifiers (e.g., oxidizing agents and special modifiers) not only allow the mixture to be heat conductive, they should also preferably suscept to microwave energy. In this fashion, not only do the modifying agents work rapidly in conventional heating methods, they are also susceptible to other forms of energy which can produce heat within the mold. Whereas the drawings and accompanying description have shown and described the preferred embodiment of the present invention, it should be apparent to those skilled in the art that various changes may be made in the form of the invention without affecting the scope thereof.

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