"Wax Defects in Investment Casting" and it's Minimization

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Abstract-- In any kind of manufacturing, there are defects in materials, process, or products that need to be minimized or eliminated. In this paper study has been done about wax defects and there minimization, generally in this method defects occur during waxing. This process uses wax pattern which is subsequently melted from the mold, leaving a cavity having all the details of the original pattern. This method produce a part of very close tolerances and this process does not need a parting line or any form of spilt mould.

Keywords: *Investment Casting; Pattern wax; soluble wax; Wax preparation; Wax defects.*

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1. INTRODUCTION:

[1] Investment casting process is also called as lost – wax process or precision casting; this process consists to two stages. First a master pattern is made of steel or brass and it is replica of the part to be cast. Around it, a spilt mould is formed from gelatine or an alloy of low melting point. This alloy is poured over the master pattern. After solidification master mould is obtained. This master mould is used for making the wax or lost pattern. Materials for preparing master mould are plaster of paris or gypsum products for non- ferrous castings, ethyl silicate, sodium silicate and phosphoric acid for steel castings and sometimes fine-grain silica sand is also used for preparing master mould. [2] The process is generally used for small castings, but has been used to produce complete aircraft door frames, steel castings of up to 300 kg and aluminum castings of up to 30 kg. It is generally more expensive per unit than die casting or sand casting, but has lower equipment costs. It can produce complicated shapes that would be difficult or impossible with die casting, yet like that process, it requires little surface finishing and only minor machining. Investment casting is used in the aerospace and power generation industries to produce turbine blades with complex shapes or cooling systems. Investment casting is also widely used by firearms manufacturers to fabricate firearm receivers, triggers, hammers, and other precision parts at low cost. Other industries that use standard investment-cast parts include military, medical, commercial and automotive. [3] Pattern waxes are blends consist of components like petroleum waxes, natural waxes, natural and synthetic resins and organic fillers. Paraffin is the most commonly used petroleum waxes because it is less expensive compare to other raw materials also controls or enhances the rheological properties, which in turn affect the injection temperature and fluidity of the pattern wax blend. Microcrystalline wax gives some control to flow, hardness and strength of the pattern wax.

The introduction of organic fillers has become an important development in the formulation of investment casting waxes.

Following points should be considered while selecting fillers.

- Organic
- Low ash content
- Relatively high melting point
- Non-reactive towards the base wax – ceramic and metallurgical processes
- Fine particle size distribution
- Specific gravity close to the base wax

The most commonly used fillers are Isopthalic, polystyrene (Thermosetting & Thermoplastic), Bisphenol A and Hydro-fill. The quality of wax pattern has direct affect on this process.

Following are the defects while making wax pattern and should be solved:

- **Deformation of wax pattern:**

After getting wax pattern from mould, sometimes deformation is caused by workers wrong operation; in addition to size change narrow itself. Because it is common that wax pattern flexure deforms in the cooling process, so we should keep it carefully placed from pattern. Also too

soft wax material, unreasonable design of mould could be a factor for deformation.

- **Wax is not fully filled into mould**

It is due to the temperature of wax material i.e. too low.

- **Wrinkles on the surface of wax pattern.**

Soluble Wax:

Majority of soluble wax consists of three raw materials binder, filler and effervescing carbonate. The binder is polyethylene glycol commonly known as PEG. PEG is available in numerous molecular weights and is used in various combinations to achieve the desired viscosity, hardness and melting point characteristics. Filler improve shrinkage characteristics it also helps the overall structural strength of the blend, fibrous materials are used to improve the strength and elastic properties of the wax, sodium bicarbonate acts as the bulking agent.

Following are the important properties to be considered during the development of investment casting:

- Ash Content
- Hardness
- Viscosity
- Ductility
- Surface Tension
- Wet ability of primary Coat
- Volumetric Expansion
- Surface Smoothness
- Melt
- Shrinkage, Cavitations or Sink.
- Thermal Conductivity

Wax preparation: Wax preparation is an important step in the investment casting process. If the wax surface is not clean, the final casting surface will show defects. Likewise, if the slurry is unable to adhere to the wax surface, the final casting can have lifting defects, cracking and run outs.

Following are the wax defects which develop during wax preparation and should be minimized and eliminated. [4]

1. Air Bubbles

Bubbles under the surface of the wax appear either when air is injected into the mold along with the wax, or when air in the mold is trapped during the wax injection process. In either case, these air bubbles can pop when the casting investment is vacuumed. When the bubbles pop, the void fills with the investment slurry. Later, the metal fills around these investment formations and presto-investment inclusion defects. They most often appear as small rounded holes in the castings. Inspect waxes for the presence of bubbles by holding them up to a small table lamp and looking through them. Light spots indicate bubbles in the wax, although how easy it is to see them will depend on the "readability" of your wax. repair these bubbles by popping them with a heated wax tool and filling the exposed hole with wax A better solution, however, is to eliminate the source of the bubbles whenever possible. How that will be accomplished depends on whether the air is being trapped during the wax injection process, or whether it is being introduced with the wax.

2. Trapped Air

Air must be able to escape from the mold at an equal, or faster, rate than the wax being injected or it will be trapped. These types of trapped air bubbles can be reduced by the proper application of powder in mold vents, which allows air to escape from the mold cavity during injection. It is also possible to reduce trapped air in molds by reducing injection pressure and slowing the injection rate.

3. Introduced Air

Bubbles that are introduced into the mold along with the wax can come from several sources. One source is dissolved gas in the wax. Another is air that becomes trapped when new wax chips or dots are loaded into the wax pot: If small air spaces between the cold waxes chips are covered over by a molten surface before the air can escape, it is possible for these tiny bubbles to remain trapped until they are injected into the molds. To resolve this issue is to pre-melt wax in a reservoir unit and vacuum de-gas it before loading it into production wax pots. Another source of introduced air that causes bubbles in wax is water vapor from condensation in compressed air lines.

4. Powder and Silicon Spray

There should be the proper use and application of powder and silicon spray for rubber molds. Silicon sprays are used as lubricants or mold release agents to facilitate easy, distortion-free removal of the wax from the rubber mold cavity. Powder is used to create a microscopic path for the air in the mold to escape through the air vents during the injection process. Each of these products must be used correctly for better solution.

5. Wax Tree Defects

Another defect is the wax tree. One of the most important issues here is the quality of the connection between the gate and the sprue. The gate/sprue connection (filet) should be sealed and smooth all the way around.

CONCLUSION:

Investment casting is best known for its ability to produce parts having excellent surface finish, dimensionally accuracy and complex shapes due to defects in wax it result in poor quality of finish. Problems should be prevented

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early in the process, rather than fixed at the end. To reduce or eliminate these defects injection condition, gate positions should be modify, it is important to fully understand all parts of the investment casting process, so that problems can be easily identified and solved quickly. The production of investment castings requires stringent control of quality, handling of pattern wax during melting, conditioning and injection stages directly reflect the quality of casting.

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