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PRECISION INVESTMENT CASTING: A REVIEW PAPER

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ABSTRACT

This paper consist of brief regarding precision investment casting process and cover all the aspects of this casting process, this article comprises of how precision investment casting carried out, what is the historical background of precision investment casting and how this casting is different from other casting processes. Further advantages and disadvantages of this casting process is analyzed in sub section of this article so that reader must have a deep knowledge regarding this precision investment casting process. Now a day there are different casting techniques which is becoming challenge for precision investment casting , so the future advancement and research in this casting process is also analyzed so that its limitation can be the be minimized.

KEY WORDS

Historical background of precision investment casting process, how this casting process is carried out, advantages over traditional casting process, limitation, application, etc.

INTRODUCTION

Precision investment casting is regarded as one of the modern or semi modern casting process in which casting product is far more superior than the product of other conventional casting process, this casting process has emerged as one of the best casting process in which the intricate shape product can be casted and with little or no machining the product is ready for its use. This precision casting process has replaced so many casting process in which casting defect is likely to occur and those which were time consuming. This casting process has emerged as first choice for jewelers to cast the ornaments with high level of complexity. Talking about its future aspects than it is going to be one of most important and essential casting process in which there is need of complex shape and finer details.

Talking about the difficulty level in the casting process then in the most of the casting process it is impossible or very difficult to achieve dimensional accuracy. In the precision investment casting process two factors is mostly considered one is the dimensional change of wax and the shrinkage property of most of the metal and alloys. Wax pattern or model that is injected into metal dies or rubber dies during its phase transformation (from liquid to solid). The longitudinal

or linear contraction of wax model can be as high as 2.5-3% so this difficulty must be managed while performing precision investment casting process.

In this modern era there are basically the techniques which are broadly used to compensate shrinkage problems and they are classical methods or computer added drawing, other is thermal expansion methods in which focused is totally concentrated on the thermal expansion coefficient of different material, the most advanced techniques is setting of expansion that are taking place during setting process of mold.

HISTORICAL BACKGROUND

The historical background of lost wax casting or precision investment casting is very old it has been used in many different form since last 5000 years, talking about the modern use then beeswax used to make the pattern that is needed for casting process. In modern era lost wax casting process has came into use in late 19^{th} century, when dentist began its practical use by making crown and inlays, it was described by Barnabas Fredericks Philbrook of council bluffs, Lowa in year 1987.

CASTING PROCESS IN PRECISION INVESTMENT CASTING

In lost wax or precision investment casting process mould cavity is basically prepared around pattern which is expandable in nature.

Steps that is required in precision investment casting process is discussed and along with the diagram the working process is explained so to perform precision investment casting process.

Step1: first step in this process is to prepare the pattern for every casting to be carried out, generally the pattern is made with wax that's why is named as lost wax casting process. In this process molten wax is injected at very high pressure around 2.5MPa into pattern so that the impression of that pattern must be printed on the wax.

Step 2: now in this step the pattern is ejected out of the die and wax has taken the shape of pattern.

Step 3: in this step cluster of waxes are attached to gating system by applying little heat to awx so that it can take the shape of final casting products.

Step 4: now to make the mould cavity, the pattern that was prepared earlier is dipped into the sludge or slurry of which generally contains fine ceramic material in the liquid solution such as ethyl silicate or sodium silicate.

Step 5: this step focuses on the drying of excess liquid by applying dry refractory such as zircon or fused silica on the ceramic solution or coating. After this small coating is formed around the

pattern, now the shell is cured and furthers the process of continuous dipping into ceramic slurry starts so that grain size gradually increases, after few times the shell thickness is reached around 7-15mm and the mould cavity is ready for further process. It is not mandatory that shell thickness would be around 7- 15 mm it can be more or less depends on thickness of casting products shape, mass, sizes and type of chemical such as binder and chemical used.

Step 6: next step is to remove the pattern from mould cavity so this is done by heating the mould to the melting temperature of wax and after heating the wax is converted into liquid and comes out from mould, so that's why it is known as lost wax casting process. Now if some amount of wax is trapped inside mould is removed by passing hot air and it ensures that no wax is present inside mould to avoid casting defects.

Pre-heating of moulds starts to temperature around 990-1000 degree Celsius, that depends on the size, shape, material and complexity of casting, this also ensure that no wax is trapped inside mould and allow compact filling of mould section.

Step 7: now molten metal is poured into the mould cavity under the effect of gravity and by applying little pressure.

It is not necessary that only wax used as pattern material other material such as polyethene, mercury, plastics can be used as pattern materials to obtain different shapes of casting. Mercast is process in which mercury is used and mercury is kept under -58 degree Celsius at this temperature the mercury is frozen. Mould preparation is completed at -38 degree Celsius or below this temperature. The question why mercury is used as pattern material than answer is that mercury does not expand when state transformation occur from solid liquid as the wax pattern does. Keeping pattern as low as this temperature is not possible in all cases so this mercury pattern is basically responsible for dimensional accuracy it this temperature can be achieved

To quantify the measurements of both wax models and cast items with extraordinary precision unique kind wax show geometry was outlined. Wax models were readied by infusing the wax softened at 100 °C into a silicon bite the dust. These models were mounted on a vertical wax sprinter to shape a model tree. The model tree was found in a jar. 2 kg powder from each C3 .A reinforced speculation blend was taken and blended with water at a water/ powder proportion of 0·35. The slurry was then filled a cup situated on a vibrating machine. The cup molds are permitted to set for seven days before the dewaxing what's more, wear out procedures. Jar molds were likewise arranged from two distinctive gypsum fortified venture powders which have certain setting and warm extension esteems for correlation purposes. For this situation, the water/powder proportion was 0·38 and the cups were permitted to remain for 2. 5 Hours.

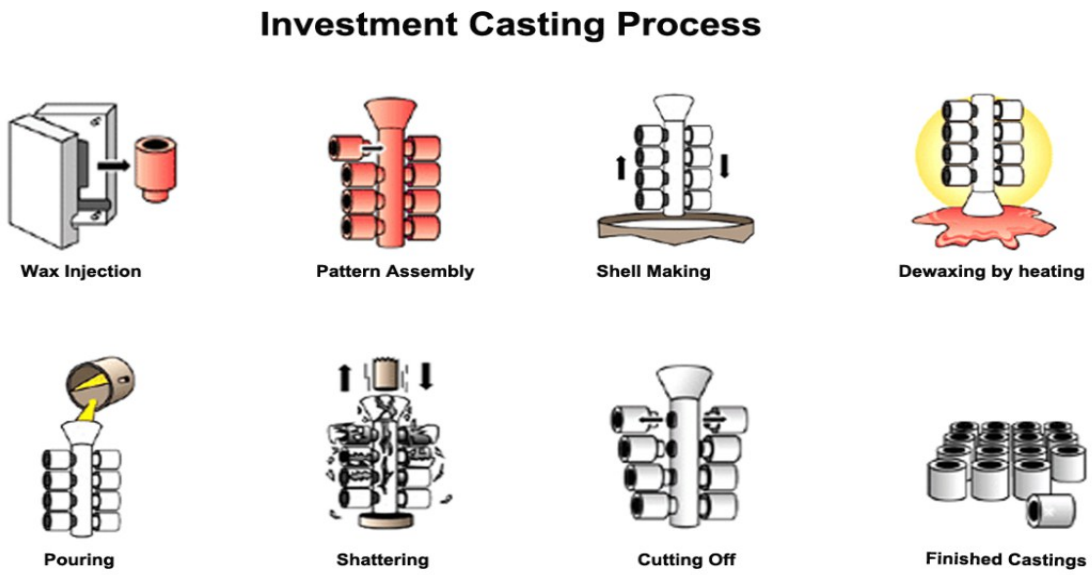

Fig.1. investment casting process (pic courtesy dly-metal.com)

ADVANTAGES

1. Very complex and intricate shape which cannot be casted with other casting process can easily be casted with the help of this process since in this process the wax pattern is melted and escaped out from mould cavity.
2. In this casting process very macroscopic finer details can be achieved because in this process the mould is generally preheated before pouring of molten metal.
3. Tolerance is very close to achieve in this process and also dimensional accuracy is easy to achieve than any other process.
4. This process is economical because casted products of this casting process is ready for use whith very little or no machining.
5. If the proper is taken care then the control of grain orientation and grain size can be achieved.
6. Dimensional is uniform since in this casting process no parting line used.

DISADVANTAGES

1. This process is regarded as one of the most expensive casting process because it is labor intensive and requires large man power.
2. The upper limit of size of casting is limited about 4.5 kg so it is not suitable for casting of large products.

APPLICATIONS

Lost wax casting process was used in older days to manufacture ornaments, surgical instrument, artifacts, jewellery. In modern days its use is very wide and used for manufacture complex things such is gas turbine blades, vanes, eye shuttle for weaving, in animation such as claws and pawls for movie cameras, trigger and bolts for fire arms, in radar system such as wave guides, in electronics such as impellers for turbo charger, body valves of stainless steel etc.

FUTURE WORK

Precision investment casting is regarded as one of the most suitable casting techniques to cast the products which are intricate and cannot be casted with other techniques but there are some limitation like it cannot be used for mass production and it is only suitable for small objects, so this challenges must be cured so that precision investment casting efficiency can be improved and also its production field can be expanded, now a day there are other advanced casting process which are far better this lost wax casting process and are utilized for mass production so this challenges must be expected if precision investment casting efficiency needed to be improved.

CONCLUSION

In this paper all the process and steps needed to cast the product from precision investment casting process is discussed and all the experimental aspects of lost wax casting process is covered. Reader can have a brief knowledge about precision investment casting process and he/she can now able to know what precision investment casting actually means and in which field this investment casting is used , reader can also know what is setup and material required to perform the precision investment casting process its limitation and application of precision investment casting process. This paper also covers the research work that is need in the field of precision investment casting process so as to improve its efficiency.

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