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An Experimental Investigation of Wax Pattern in Investment Casting

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ABSTRACT

Investment casting process used for precision component manufacture, call for accurate method design. It gives good surface finish and high dimensional accuracy with complex shape. This is the main reason that it is also called as the precision casting. The important factor in the investment casting is the dimensional change of the wax pattern. Dimensional changes between a die and its wax pattern occur as a result of complex phenomena such as thermal expansion–contraction and hot deformation. Due to these defects in the wax patterns, it results into the poor quality of the final casting product. Some common defects are shrinkage, inadequate surface finish, and improper dimensional accuracy in the wax patterns. So there is need to remove these defects.

The following parameters like injection temperature, die temperature and holding time affect the wax pattern. The purpose of the present study is to optimize these parameters using Taguchi's method and experimentally investigate the wax pattern for the investment casting process. Starting from the identification of the different waxes with ten different compositions of samples was prepared by mixing the waxes together for pattern making. Measurement of the volumetric shrinkage as well as the linear shrinkage helped in calculating the dimensional tolerances of the cast component.

After conducting the experiment it was analyzed that wax can be used as a low cost wax pattern. The sample with proportion of 80 % paraffin wax, 5 % bee wax, 5 % Montan wax, 5% carnauba wax and 5% china wax will gives the better result of linear shrinkage as well as volumetric shrinkage.

Keywords---- Casting, Wax, Holding Time, Temperature

I. INTRODUCTION

Casting is a manufacturing process by which a liquid material is usually poured into a mould, which contains a hollow cavity of the desired shape, and then allowed to solidify. The solidified part is also known as a casting, which is ejected or broken out of the mold to complete the process. Casting materials are usually metals or various cold setting materials.

Metal casting process begins by creating a mold, which is the 'reverse' shape of the part we need. The mould is made from a refractory material, for example, sand, ceramic etc. The metal is heated in an oven until it melts, and the molten metal is poured into the mould cavity. The liquid takes the shape of cavity, which is the shape of the part. It is cooled until it solidifies. Finally, the solidified metal part is removed from the mould.

A large number of metal components in designs we use every day are made by casting. The reasons for this include.

1. Casting can produce very complex geometry parts with internal cavities and hollow sections.
2. It can be used to make small (few hundred grams) to very large size parts (thousands of kilograms).
3. It is economical, with very little wastage: the extra metal in each casting is re-melted and re-used.
4. Cast metal is isotropic. It has the same physical/mechanical properties along any direction.

II. CLASSIFICATION OF CASTING PROCESSES

There are the different types of the casting usually used in the industry

- Sand casting
- Shell mold casting
- Plaster mold casting
- Ceramic mold casting
- Investment casting
- Vacuum casting
- Permanent mold casting
- Die casting

- Centrifugal casting

III. INVESTMENT CASTING

Investment casting is an industrial process based on and also called lost-wax casting, one of the oldest known metal-forming techniques. From 5,000 years ago, when beeswax formed the pattern, to today's high-technology waxes, refractory materials and specialist alloys, the castings allow the production of components with accuracy, repeatability, versatility and integrity in a variety of metals and high-performance alloys. Lost foam casting is a modern form of investment casting that eliminates certain steps in the process.

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.

IV. INVESTMENT CASTING WAX

Waxes are a universal choice as pattern material for investment casting, barring few exceptions. As the ultimate quality of castings in this process depends primarily on quality of wax patterns, it is necessary to understand how best performance of wax blend can be achieved. For the purpose, we begin with a look into basics of wax molding process. The wax used to make moulds for investment casting requires special properties, it needs to be neither to soft or pliable nor too brittle, it needs to be solid at room temperature this part is tricky depends entirely on where you live. There are many waxes are used for the investment casting but in the present study we are using the following waxes

1. Paraffin wax
2. Bee wax
3. Montan wax
4. Carnauba wax
5. China wax

V. LITERATURE REVIEW

Investment casting is an important process that has wide application in automobile, aerospace, defense, agriculture in view of its inherent properties such as dimensional accuracy, high degree of surface finish. It is mainly used for making the small components which are difficult to make by the other types of casting. The main problem in the investment casting is the compatibility of the wax pattern, because it affects the quality of final casting. To overcome these problems, many researchers worked on this technique and gave their findings.

From the literature review, it can be concluded that the wax pattern affects the quality of the final casting due to the defects in the wax pattern. The literature review reveals that many researchers have worked on the investment casting. Some of the researcher works on the wax blend pattern. Some uses the pattern material like ice pattern, plastic, mercury, wax (paraffin wax). However the volume of work done on investment casting using the blended wax pattern is very less. The investigations carried out by these researchers proved that a low cost wax could function as a good pattern wax when an appropriate additive is added to it in an appropriate amount. However, the effects of similar additives on blends made by mixing up of different waxes are yet to be investigated.

VI. EXPERIMENTAL PROCEDURE

This paper is about the experimental procedure adopted for studying the wax pattern in the investment casting. Experiments were conducted based on the waxes used in the pattern making in investment casting. The material to be used is five types of waxes which are paraffin wax, Montan wax, China wax, Carnauba wax, Bees wax. Each wax is solid at the room temperature. The weight of each wax is measured through electronic balance the each wax blend is mixed and melted then samples were produced to find the least value of linear shrinkage and volumetric shrinkage at that value a total 9 experiments were conducted i.e. 9 samples are being prepared. Experiments were conducted based on Taguchi's method and as per L_9 orthogonal array with considering three controllable factors injection temperature, die temperature and holding time having three levels each. Linear shrinkage and volumetric shrinkage were being measured and studied.

VII. RESULTS AND DISCUSSIONS

In this paper mainly the influence of different parameter like injection temperature, die temperatures, holding time and the effect on the linear shrinkage, volumetric shrinkage and the properties of the wax are being discussed.

After the conduction of the experiment it has been seen that linear shrinkage is varying according to the sample it is varying from 1.07% to the 3.27% as the value of the wax sample changes the value of the linear shrinkage. It can clearly be seen that injection temperature is the most predominant factor which influence the volumetric shrinkage.

VIII. CONCLUSIONS

In the present work, Experimental Investigation of Wax Pattern in Investment Casting was carried out number of blended wax pattern has been prepared and we

find out the linear shrinkage as well as volumetric shrinkage. Results obtained by taking readings from experiment are plotted in graphs to check the validity of pattern and accuracy and consistency of results. Taguchi Method helps in finding the best optimal results. The readings were taken at small intervals of time to get better results. On the basis of experimental observations made on wax pattern components following conclusions can be drawn:-

1. It was found that in an investment casting, wax can be used as a low-cost pattern wax having better properties than a high-cost commercial one by blending and mixing economically/environmentally non-hazardous chemicals.
2. The sample with proportion of 80 % paraffin wax, 5 % bee wax, 5 % Montanwax , 5% carnauba wax, 5% china wax will gives the better result of linear shrinkage as well as volumetric shrinkage.
3. The lowest linear shrinkage is 1.07% is noted at injection temperature 70°C, die temperature 46°C and holding time 11 min.
4. The lowest volumetric shrinkage is 2.49% is noted at injection temperature 70 °C, die temperature 46°C and holding time 9 min.
5. The most predominant factors for linear shrinkage is die temperature, rest two factor (injection temperature and holding time) has less impact as compare to the Die temperature.
6. The most predominant factors for volumetric shrinkage is injection temperature, rest two factor (die temperature and holding time) has less impact as compare to the injection temperature.

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