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Estimation of solidification time and shrinkage porosity using design and process parameter of investment casting process.

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Abstract— Today, investment Casting is a highly specialized method of producing near net shape. Its advantages are smooth and pleasing finish, reduced machining allowances, close tolerances, flexibility of alloy selection etc. The steps of investment casting are wax injection, assembly; shell building, de-waxing, pouring, knock-out, cut-off and finishing. Investment casting is known for its precision casting. In investment casting process various design and process parameters are responsible for the quality of end product. Practically identify the effect of those parameter is vary laborious, costly and time consuming and to overcome these problems various simulation software like ANSYS, Pro-cast, Autocast etc can be used.

Keywords-investment casting, solidification time, shrinkage porosity, simulation

I. INTRODUCTION

In investment casting process the quality of casting is depend on the direction of solidification. Directional solidification is always preferable to make defect free casting. But to achive directional solidification various types of design consideration is requaired. It is also obseraved that pouring temperature and mould temperature is also responsible for generating defect like porosity, hot spot etc. S. Lun Sin, et.al[1] In this paper they examined behavior and effect of fluidity of AZ91D magnesium alloy. They made a vertical model for their experiment and examine it by varying the various process and design parameter like vacuum assistance, pouring temperature, mould preheating temperature, strip thickness and distance between the strips. Basically they show the importance of vacuum assistance to fill the molten metal in to the thin section which is really difficult task as compare to thick section in casting process. They also conclude that metal head is also play in significance role in pouring the molten metal effectively in thin section. So we can say that this paper demonstrated that vacuum assistance is very efficient for filling thin sections, removing trapped air, and drawing the molten metal into generalization. A large number of software simulation runs were conducted for a number of different small parts, with varying runner geometry and casting conditions. In this paper they conclude that the scope of an ANN is defined by the number of parameters whose value is assumed constant and the number of parameters whose value is considered as variable. The ANNs developed can be expanded by generating new data vectors and using them for training the respective ANNs from the beginning. This is easily achieved by means of the software developed that enumerates all possible architectures and trains the respective ANNs to select the architecture that performs best. The only drawback perceived is that a number of additional data vectors need to be generated until training and generalization error results are low enough to render the ANN practical and trustworthy as a replacement to simulation models. D.R. Gunasegarama[3] believed that shrinkage porosity defects occurring in castings are strongly influenced by the time-varying temperature profiles inside the solidifying casting. This is because the temperature gradients within the part would determine if a region that is just solidifying has access to sufficient amounts of feed metal at a higher temperature. Shrinkage pores will emerge in regions experiencing volume reduction due to phase change with no access to feed metal. M.Sutaria, et al[4] In this paper they shows the importance of feeding system to accomplish any casting process. As we know the volumetric contraction accompanying solidification of molten metal manifests in defects like shrinkage cavity, porosity, centerline shrinkage, corner shrinkage and sink. These defects can be minimized by designing an appropriate feeding system to ensure directional solidification from thin to thick sections in the casting.

In this paper they work on the major parameters of a feeding system include: feeder location, feeder shape and size, sleeves and covers, feeder neck shape and size, chills, and fins and investigate the effect of these parameters on directional solidification by mapping the temperature gradients between the hot spot in the casting to the hot spot in the feeder. Taufik Roni Sahroni1, et al[5] In this paper they investigate the design parameter which is very effective for producing a highly accurate casting product. The parameter for the mold design is included branch, gating, sprue and runner. They uses ANSYS simulation tool to determine the temperature and pressure of the mold. According to the result, they conclude that the temperature and velocity of the molten metal will affect to the pressure of the mold and it also affects the flow of the molten metal. A smooth fluid flow will increase a life longer and hardness. The suitable temperature and the velocity of the molten metal showed lead to the quality of casting product. The runner and the branch size are important to allow the molten metal flow into the mold pattern. Vipul Vasava, et al[6] Believed that casting is a blind process and Shrinkage cavity may be detrimental to mechanical performances of casting parts. So in this paper the other shows the importance of casting simulation software to reduce the casting defects and achieve a good quality cast product without shop floor trial. casting simulation technology become a powerful tool for casting defect troubleshoot the mould. C. Vosniakos et.al[2] Believe that simulation results cannot help the engineer for work pieces other than the one simulated. In this paper a series of feed forward artificial neural network (ANN) models is presented aiming at such in and method optimization. It will reduce the lead time for the sample casting; improved productivity and knowledge of software can be maintained for future use and for training new engineers in this caster's field. In the casting design process, mostly shrinkage defect occur in most of part. In practice, these defects are eliminated by iteratively designing casting filling (gating) system through experience and experiments, but it requires large number of shop floor trials; taking huge amount of resources (cost) and time. This can be avoided by conducting trials on computer using casting simulation technology. Nikhil Yadav1 et al[7] In this paper they used different levels of process parameters like wax composition, binders, firing temperature and the pouring temperature to minimize the surface roughness of A713 alloy. They used different types of wax(Carnauba Wax, Montan Wax, Bees Wax, Paraffin Wax, Ceresin Wax) with different amount, different types of binders(Sodium Silicate, Bentonite, Plaster of Paris) and perform their experiment. On the basis of their experimental data they conclude that surface roughness does not significantly depend upon the type of binder used. Surface roughness decreases with the increase in the firing temperature and Surface roughness decreases with the increase in the poring temperature. Ramazan Kayıkc[8] In this paper computer simulation of the solidification process with 3D CAD data of the geometries was also performed. Results from simulation were in excellent agreement with the result from calculations. This confirmed that casting simulation technology might substitute the casting laboratory in engineering education. This can be even more useful for such experiments where high temperature and expensive experimental set-up involves.

II. METHODOLOGY

The initial step of this work is to select one investment casting product on which experiment will be executed. Once we identify the product we need a 3D model on which simulation can be performed. Accuracy in selection of process and design parameters is very important to obtain a defect free casting.

Procedures to improve the design of new casting.

III. CONCLUSION

As we know the investment casting process is a blind process as we will not be able to see what is happening while the molten metal is poured in to the mould cavity. Various process and design parameter will play their important role during the solidification of molten metal. We can easily understand that the experimental procedure to finding out the effect of these parameters will be so much laborious and costly. So to overcome this problem casting simulation softwares are use to predict the effect of various process and design parameters of casting.

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