IJRSET JUNE 2017 Volume 4, Issue 6 Pages: 23-27
ISSN 2394-739X
International Journal for Research in Science Engineering and Technology

OPTIMIZATION OF RISER DESIGN PARAMETERS: A REVIEW

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ABSTRACT: Casting is a age old production technique wherein cavities are formed by a pattern into a porous and refractive material, usually sand, and then liquid metal is poured into the cavity so that it takes up the shape of the cavity, thus forming the required metal product. The riser involves in casting for regulating the solidification time and gives defect free product. Now the objective of this review paper is to optimized riser design parameter by Design of Experiment method such as Response Surface Optimization method. The RSO is a powerful solving method to optimized the shap of the design.

Keywords: [Casting, Mold, ANSYS Thermal Thrnsient Analysis, Response Surface , Optimization.]

1. INTRODUCTION

Casting design which includes the gating and riser system design has a direct influence on the quality of cast components. The design should provide a minimum volume of gating and riser system but warranting the quality of the casting. Due to the lack of fixed theoretical procedures, the gating and riser system design is carried out on a trial-and-error basis that results in a feasible solution but not always an optimum one. The followings techniques are used for optimizing the riser system in casting process.

1. Genetic Algorithm
2. Taguchi Approach
3. Multi-Objective Evolutionary Algorithm (MOEA)
4. Theory of Inventive Problem Solving (TRIZ), and
5. Design of Experiments(DOE)

2. LITERATURE REVIEW

Syrcos (2003) analyses various significant process parameter of the die casting method of AlSi9Cu13 aluminium alloy. An attempt has been made to obtain optimal setting of the die casting parameter, in order to yield the optimal casting density of the AlSi9Cu13 aluminium alloy casting. The process parameters considered were: piston velocity (first and second stage), metal temperature, filling time and hydraulic pressure. The result indicated that the selected parameter significantly affects the density of AlSi9Cu13 aluminium alloy casting [12].

Verrana (2008) discusses the application of a design of experiments (DOEs) experimental method for analysing the influence of three injection parameters (slow shot, fast shot and upset pressure) on the internal quality of die casting SAE 305 alloy parts. The quality

assessment of the die casting parts was based on density measurements and qualitative image analysis. Results were evaluated by means of variance analysis, which assessed how the variation in the three different injection parameters influenced the integrity of the components [14].

Kumar et. al. (2009) optimized pull down defects in iron casting by identifying parameters like pouring temperature, carbon equivalent and gating system are more significant. The identified factors were analyzed using 'Design of Experiments' approach. 'Signal-to-noise' ratio was estimated. Robust design factor values were estimated from the 'signal-to-noise' calculations. ANOVA analysis was done for robust design factor values. It was identified that the optimized values had improved the acceptance percentage from 86.22% to 96.17%. The improved acceptance percentage had enhanced productivity of the foundry [13].

Sahroni et. al., (2012) did a remarkable work on simulation of investment casting with Metal Matrix Composite Material. This paper presents the design and simulation on investment casting mold for metal matrix composite material. The study was investigating the design parameters for the casting mold and simulated the temperature and pressure on the mold. Compressor impeller selected as the product of the study. Among the various types of casting techniques, investment casting process is the most suitable process to produce the compressor impeller. The alternative design of casting mold of investment casting was generated using CAD software. Concept scoring was prepared to select the suitable design for the investment casting process. Material selection of compressor is Aluminum Silicon Carbide. Stainless steel AISI H13 is selected as the material for the mold. The parameter for the mold design is included branch, gating, sprue and runner. The analysis was presented to the mold by using ANSYS simulation tool to determine the temperature and pressure of the mold. In addition, three case studies were presented and compared the static pressure in different velocity and temperature of the mold design. The result showed the runner and the branch size were important to produce the molten metal flow into the mold pattern. As a result, the design of investment casting mold was proposed [1].

Upadhye (2012) discussed to optimize the sand casting process parameters of the castings manufactured in iron foundry by maximizing the signal to noise ratios and minimizing the noise factors using Taguchi method. The process parameters considered are moisture, sand particle size, green compression strength, mould hardness, permeability, pouring temperature, pouring time and pressure test. The results indicated that the selected process parameters significantly affect the casting defects in the foundry. The improvement expected in reduction of casting defects is found to be 37.66 percent. The optimum conditions for the factors computed are:

Moisture (%) – Level 1 – Minimum 3.5

Green compression strength (g/cm^2) – Level 1 – Minimum 900

Permeability – Level 2 – Minimum 185

Pouring temperature (deg. Celsius) – Level 3 – Maximum 1420

The improvement expected in minimizing the variation is 37.66 percent which means reduction of casting defects from present 6.16 percent to 3.84 percent of the total castings produced in the foundry [2].

Kumar et. al. (2012) analyses different parameters of pressure die casting to minimize the casting defects. Pressure diecasting is usually applied for casting of aluminium alloys. Good surface finish with required tolerances and dimensional accuracy can be achieved by optimization of controllable process parameters such as solidification time, molten temperature, filling time, and injection pressure and plunger velocity. Overall 2.352% reduction in defects has been observed with the help of suggested optimum process parameters [11].

Choudhariet. al., (2013) Optimum design of a riser is obtained by simulation. This paper

attempts to study heat flow within the casting, and from the casting to the mould, and finally obtains the temperature history of all points inside the casting. ANSYS software is used to obtain the last solidifying region in the casting process by performing Transient Thermal Analysis [3].

Choudhari et. al., (2013) Casting is one of the earliest metals shaping method known to human beings. It is one of the cheapest methods for mass production of any part and can be effectively used to make complex shaped parts which are not easy to manufacture by other production process. Casting process is subjected to many defects and it is necessary to eliminate them. One of the main defects in castings is "Shrinkage Cavity", which can be eliminated by attaching a Riser to the casting. This paper describes the parameters to be considered while designing a Riser of an optimum size to get higher Casting Yield. Theoretically designed model has been analyzed thermally in ANSYS 12.0 simulation software to ensure that shrinkage cavity is eliminated from casting [10].

Dabade and Bhedasgaonkar (2013) analyzed the optimized levels of selected process parameters obtained by Taguchi method are: moisture content (A): 4.7 %, green compression strength (B): 1400gm/cm2, permeability number (C): 140 and mould hardness number (D): 85. With Taguchi optimization method the % rejection of castings due to sand related defects is reduced from 10 % to a maximum up to 3.59 %. Design of experiments method such as Taguchi method can be efficiently applied for deciding the optimum settings of process parameters to have minimum rejection due to defects for a new casting as well as for analysis of defects in existing casting [6].

Ambekar and Jaju (2014) The optimized casting which is produced by foundry with internal shrinkage as a major defect was analysed and identified that the riser system was not properly designed. The designed riser system reduced defect and increase yield. Finally, a reasonable riser system was obtained by analysis of simulation results [7].

Khade and Sawant, (2014) An optimized casting of brake disc is analysed and studied to solve the issue of lower casting yield. Then the risers for brake disc are redesigned based on feeding rules, conventional method and casting simulation. The different models of risers are first made, then 3D CAD model of casting with these altered risers are simulated to analyse the effectiveness of modified risers. On analysing, the most suitable design is selected so that it will give the good sound quality of casting with the higher casting yield, profit and high productivity [8].

Prasath (2014) An optimized design will provide a minimum volume of riser system but warranting the quality of the casting. Genetic algorithm has been used to optimize the riser system design [7].

Lisca and Machado (2014) It is determined that the shape of the casting will affect the size of the riser necessary to meet its feed requirements for the obvious reason that the longer time the casting takes to solidify, the longer the riser should maintain a reservoir of liquid metal. The different methods have been used to calculate the riser size (shape factor method, geometric method, the modulus method).

In this research, it has been determined that the riser geometry by different methods for the piece type wheel and the simulation is used to determine which of the methods is more efficient [8].

Joshi and Jugulkar(2014) Pareto principle and cause effect diagram are used to identify and evaluate different defects and causes for these defects responsible for rejection of components at different stages of manual metal casting operations. The correct identification of the casting defect at initial stage is very useful for taking remedial actions. This paper presents the systemic approaches to find cause of defects occurred due to manual operations. So finally, it was found that the manual metal casting operations are done with some negligence and

carelessness. So by suggesting some other remedial issues and by implementing possible of them reduces total rejection more than 30%. If suggested remedy of automation will be implemented it reduces all defects more than 70%. This systematic study proves that by means of effective analysis of tools and processes, it is possible to control the casting defects [9].

Chaudhari and Thakkar(2014) they have to develop casting components in very short lead time. Casting process is still state of art with experienced people, but these experience needs to be transformed in engineering knowledge for the better growth of the foundry industries. Some foundries are working with trial and error method and get their work done. Factually, most of the foundries have very less control on rejections, as they are always on the toes of production urgency; hence they ignore the rejections and salvage the castings. Majority foundries are failed to maintain a satisfactory quality control level. Defect free castings with minimum production cost have become the need of the foundries. This study is aimed to review the research work made by several researchers and an attempt to get technical solution for minimizing various casting defects and to improve the entire process of casting manufacturing [7].

Swapnil et. al., (2015) Casting simulation technology has become an essential tool for casting defect troubleshooting and optimization method. It improves quality product without shop-floor trials. With the use of optimization techniques gating system of the casting are improve and increase the yield percentage of the casting. This would result reduction in cost and material saving. Many design rules, are developed over the years through experience and study. But For wide spread application, simulation programs must be easy to use, fast, an reliable. This can been achieved by integrating method design, solid modeling, simulation techniques. The Simulation software has proven its reliability and accuracy in predicting internal defects which help to reduced shop floor trials, and optimization using a single software program [8].

Badhushaet. al., (2016) The riser is designed for an optimal diameter to reduce the defects in the aluminium castings, through simulation by Solid cast software [9].

CONCLUSION

After study of many literatures it is concluded that the riser has been important role in the casting for regulate solidification time during casting periods. The main objective is conculuded that the study is to optimized parameter of the riser design for better performance.

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