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STUDY ON OPTIMIZATION OF GATING SYSTEM FOR REDUCING DEFECT IN DIE CASTING PROCESS

Pratik Choubey[1]*, Manish Gangil[2]

[1]PG, Scholar, [2]Head of Department, Department of Mechanical Engineering,

[12]Sri Satya Sai College of Engineering, Bhopal (M.P.), INDIA.

Abstract

Thousands of consumers, commercial, and industrial products can be produced by die casting process with high volume ranging from small to large components and hence die casting can be referred as mass production process. Die casting process is significantly used in the industry for its high productivity and less post machining requirement. Due to light weight and good formability, aluminum die casting plays an important role in the production of transportation and vehicle components. Some of the products produced by die casting was defective and hence needs to improve the performance of the process. The objective of the present work is to evaluate the effect of injection pressure parameter (process as well as dimension) on the dimensional stability of the die cast part. In order to investigate the effect, process parameters such as injection pressure the RSM model and GA was developed for each response. Analysis of variance (ANOVA) for each response has been also carried out to find out the influence factors and their interactions.

Keywords: *Die Casting Process; Gating; Process Parameter, Response; Optimization.*

** Corresponding author*

1. Introduction

Die casting is a moulding process in which the molten metal is injected under high pressure and velocity into a split mould die. It is also called pressure die casting. The split mould used under this type of casting is reusable. Die casting is categorized two types namely- hot chamber and cold chamber as shown in Figure 1.1. Die casting is a manufacturing process for producing metal parts by forcing molten metal under high pressure into a die cavity. To ascertain consistent good quality of the end product in die casting, a proper monitoring of the raw materials and process parameters used in die casting is essential. From literature review, it has been found that most of the researchers over the years, have dealt with various process parameters.

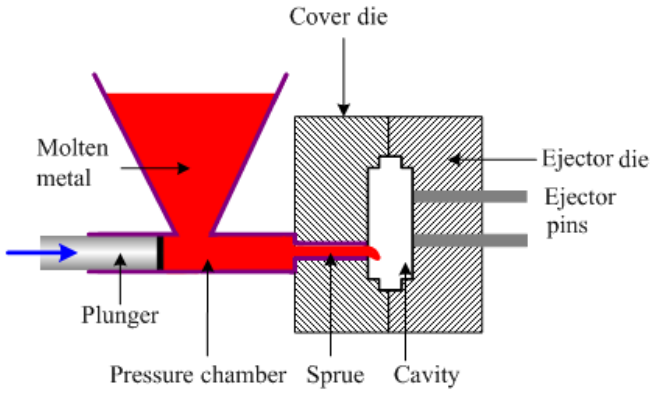

Figure 1. Basic circuit diagram of arc welding process

1.1 Gating System

It is the basic design, which is needed to construct a smooth and proper filling of the mold cavity of the casting without any discontinuity, voids or solid inclusions. A proper method of gating system is that it leads the pure molten metal to flow through a ladle to the casting cavity, which ensures proper and smooth filling of the cavity. This depends on the layout of the gating channels too, such as the direction and the position of the runner, sprue and ingates.

2. Literature Review

Jayakumar et al. (2014) simulated the most appropriate location is selected for incorporating the gating system (gate, sprue, runner and riser) so that the "Hot spot" will be shifted to the Riser and hence we get defect free components. This task is achieved through software known as WINCAST, which is exclusively used for casting process.

Ramnath et al. (2014) studied a Commutator End (CE) bracket, a cold chamber die casted product was chosen. Initially when the component was casted numerous defects such as Cold shuts, Misrun, Shrinkage porosity and Gas porosity were found.

Mohanty and Jena (2014) investigated the optimization of process parameters of an aluminium die casting operation. The quality problem encountered during the manufacturing of a die casted component was porosity and the potential factors causing it are identified through cause- effect analysis.

Adke (2014) optimized the die-casting process parameters to identify optimized level for cycle time using Taguchi method. There are four machining parameters i.e. melting temperature, Injection pressure, Plunger speed, cooling phase. Different experiments are done based on these parameters.

Amran et al. (2014) presented the design and optimization of runner and gating systems for permanent mould casting. Fluid flow effect influences the casting quality. The design parameters for permanent mould casting were identified.

Panchal et al. (2015) designed and done analysis of gating and risering system for casting of ball valves. CAD model of ball valve has been developed and simulation has been carried out using ProCAST. ProCAST results are compared with the experimental results for validation.

Kulkarni Singh et al. (2017) studied that simulation is now well accepted as a scientific approach to designing the gating, internal quality, optimal yield of casting process. The simulated results can be used to predict the quantity of these defects, optimize the design and take corrective steps to minimize these defects thereby increasing the quality of casting.

Ravi and Kumar (2017) studied the casting produced by foundry with internal shrinkage as a major defect was analyzed and identified that gating and feeding system was improperly designed. The designed gating system reduced defect and increase yield.

Raveendran and Patil (2017) studied that in die casting, the die often has more than one cavity with multiple cavities producing the same or different parts. Multiple cavities require the application of branch runners connecting to a main runner.

Apparao and Birru (2017) research, the use of the Taguchi approach has been conceptualized to obtain optimal settings of the die casting parameters, in order to increase the Al-Si8Cu3Fe (EN AC-46500) aluminium alloy die casting quality and efficiency by reducing the porosity formation. The effects of the selected parameters on the porosity formation and the subsequent optimal setting of the parameters have been accomplished using Taguchi approach.

Balikai (2018) carried out to optimize the die casting process parameters using ANOVA and Taguchi method in order to achieve the improved quality of high pressure die casting (HPDC) products, which is the challenge for the small and large-scale manufacturers of HPDC products.

Xavier et al. (2019) experimental study was conducted using air-water and air-water-oil mixtures in a 0.075m diameter pipe. Superficial gas and liquid velocities ranged from 0.03 to 0.13 m/s and 1.26 to 41.58 m/s respectively. Slug flow was the main flow pattern observed. In addition, the transition from churn to annular flow and annular were also observed.

3. Noteworthy Contributions in the Field of Proposed Work

Pressure die casting is primarily affected by the process parameters such as solidification time, molten temperature, Filling time, and injection pressure and plunger velocity. It is therefore essential that the optimum casting technique

with minimum defects be adopted to reduce the manufacturing cost of die casting component during mass production. The optimization of the process parameters poses a challenge for defects since the interplay among the parameters needs to be captured for setting the process for each component. In manufacturing processes, there are various parameters with different adjustment levels, which may influence the final characteristics of the product.

To optimize a manufacturing process, the trial and error method is used to identify the best parameters to manufacture a quality product. However, this method demands extensive experimental work and results in a great waste of time and money. Thus, design of experiments appears to be an important tool for continuous and rapid improvements in quality. These experimental methods may be employed to solve problems related to a manufacturing process, to substitute a process for another one, to develop different products and to understand the influence of various factors on the final quality of a given product

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