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A Review of Various Mould Attributes in the Sand Casting Process

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Abstract

An integral part of developing a product to fulfil needs and satisfy consumers is casting. There is an assortment of casting methods available in the industrial sector. Many materials, both ferrous and nonferrous, are cast using sand casting or another casting technique. The solidification range of the molten metal is a key factor in determining the product quality in the sand casting process. There has to be a standardised approach to casting design, and that might be found via experimentation. Casting defects including shrinkage, porosity, and hot tears are eliminated during the solidification process. Aluminium has been involved in several recent advancements in the nuclear, marine, automotive, and industrial sectors (6063). This study takes a look at the several mopuld characteristics and analyses research publications on the subject.

Keywords: *Sand Casting Process, Aluminum (6063), Design of Experiments, Hardness, ANSYS, ANN*

1. Introduction

Common manufacturing techniques include machining, casting, forging, and welding. For both ferrous and non-ferrous materials, sand casting is a crucial casting technique. Sand casting has several benefits over die casting, the most important of which are shorter solidification times, faster production rates, less difficulty in developing patterns, and better dimensional geometry. Tolerances, vent holes, gating systems, riser and spruce designs, and pattern allowances are the most crucial process parameters to think about while sand casting. It is the crystal structure, intermetallic compounds, physical and mechanical properties, and other variables that impact the bonding processes. The quality of the test specimen is determined by the input process parameters and materials that are chosen. Prior to the sand casting procedure, it is essential to do a literature research to forecast the hardness of the test specimen.

More than 10,000 manufacturing enterprises may be found in India. Sand casting is the method of choice for 69 to 70% of these industries when it comes to production. Saving both time and money during manufacturing is the main objective of this project. This project aims to reduce the lean manufacturing process by integrating many mould boxes.

2. Literature Review

Jeet Desai et al. [1] investigated methods to reduce porosity in alloy steel castings. A variety of issues brought about by casting sand's porosity were investigated and addressed in this research. Using sprue flow analysis as a case study, Mohd Imran Ansari et al. [2] investigated the casting process. This work models and meshes the sprue shape and uses computational fluid dynamics (CFD) simulation, GAMBIT 6.3.16 and FLUENT 6.2.26, to investigate the flow pattern of molten metal in sprue for several ideal forms.The purpose of the study by Shashank.V. Gulhane et al. [3] was to investigate ways to improve the casting method by reducing the weight of the gating system. The many defects brought about by the ginning dead weight gating system's difficulties are examined by the researchers.

The impact of various CNC turning-optimized cutting settings on EN8 steel using Al2O3 and CuO nanofluids as coolants was investigated by M.Alagar et al. [4]. This research used a L9 orthogonal array to find the optimal CNC cutting parameters. Maryam.S et al. [5] investigated how different sprue shapes affected the mechanical and physical properties of casting alloys. Surface roughness and marginal fit were evaluated by comparing four distinct sprue designs in this investigation.Atinderpal Singh Sandhu et al. [6] identified the causes and remedies to the most prevalent solidification errors in casting as part of their research on casting faults and various industrial processes.

While investigating the effect of gate design on the mechanical properties of aluminium alloy during sand casting, Muhammad Huzaifa Raza et al. [7] discovered that bottom gating systems outperform top gating arrangements. We covered the mechanical parts of sand casting using sophisticated approaches, as stated by G. Mahesh and colleagues [8]. The Design of Experiment and artificial neural networks (ANN) were the main techniques used in this investigation. To enhance the design of the gating and feeding system, Sachil L. Nimbulkar et al. [9] used a simulation technique in their work on sand casting of wear plates. Examining the present gating and feeding system architecture, optimising the system using auto-CAST X1 for sand moul preparation and part casting, and comparing the outcomes from simulations and experiments. The impact of various vent hole and vent angle parameters on the hardness of the sand casting process was investigated by G. Mahesh et al. [10] using a design-of-experiment technique. Finding the best parameters is done by the design of experiments.

Olawale Olarewaju Ajibola et al. [11] investigated the properties of cast 6061 aluminium alloy in connection to the pouring temperatures and permeability of the moulding sand. We tested four different mixtures of coarse and fine particles in moulding sand permeabilities, and we purged it at various temperatures to see how it affected pore size, hardness, and strength. According to research by Sumaiya Shahria et al. [12], the ideal combination of moulding sand and Al alloy was carefully studied. Applying a water-to-bentonite ratio maximising solution to a mould constructed of recycled sand can decrease aluminium casting defects. The optimisation and evaluation of riser designs in the sand casting process were investigated by G. Mahesh et al. [13] via the use of modelling. Our team used the ANSYS program to analyse several riser geometries until we found the best one.

Colleagues of Hyung-Yoon Seo's [14] Developed a system of gates and optimised the riser to fit the turbine housing; used computational methods and experimental data to find the optimal stone casting procedure. This study's overarching goal is to develop the best gating method for making turbine housing while simultaneously reducing the riser's size by making use of a heater.Citation: C. Narayanaswam et al. [15] I analysed the cast iron foundry process, located the faulty steps, and planned out the ways to fix them. Delivered results.

The optimal gating system for steel casting was investigated by R. Dojka et al. [16], who also detailed a technique for evaluating filling systems that try to remove as much air as possible while still filling to capacity. As a result, surface turbulence and bubble entrainment will be reduced or eliminated. In order to lessen the occurrence of casting errors, Tharoon T et al. [17] investigated the

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optimisation approach. The improved, error-free casting products are the result of a number of optimisation techniques.

Premvrat Kumar et al. [18] discussed how mechanical mould vibration could alter the properties of sand cast aluminium (A-1100) alloy. By using mechanical mould vibration, researchers aimed to alter the properties of sand casting alloys. John O. OJI et al. [19] investigated the effect of mould and pouring temperatures on the ultimate tensile strength of aluminium alloy sand castings. This research suggests investigating how the sand casting process affects the final tensile strength of a sand cast aluminium alloy using an analysis of variance (ANOVA) method.

Using green sand moulding and non-pressurized gating, Victor ANJO et al. [20] investigated the design of a gating system that could produce thin aluminium cast alloy plates of different sizes and thicknesses. In their study, "Nandagopal et al. [21]" Examine the methodology of sand casting gating. All the necessary parts of a gating system, such as the various riser types and gates, are described. Rahul T. Patil et al. [22] looked at casting issues, trying to find their causes and possible remedies. The article explains the causes and remedies to a number of die casting defects that may occur in aluminium alloys. Jain examined a number of furnace parameters, including heating time, melting point, percentage of excess air, flame temperature, and rotation speed [23]. Analysing the modelling, optimisation, and simulation processes using an artificial neural network allowed us to produce the optimal model for future study.
In addition to developing bottom blowing metal for acid converters, Kraev et al. [24] have created furnace ladle units that provide stable argon pressure. Daily inspection of the argon and nitrogen pipes in metal FLU and FLU is essential for reducing the forty minutes needed for melt processing. The next step is to swap out the steel casting's joints. Extensive testing was conducted in industrial settings to identify the best stable operating index for processing metals with argon in FLU. To make steel more stable at a lower cost, Shishimirov [25] employed a number of furnace-tested procedures, including as de-oxidation, alloying, inert gas blowing, and degassing.

Using an OBLF spectrometer, we were able to determine the chemical combustion of many metal samples. Research into semi-product and average density discovered techniques for producing stable steel. To solve the problem of slag segregation in casting and transport ladles, Filatov et al. [26] were consulted. Carbon content and temperature at which coating samples were taken by the particular sampling equipment indicated the coating's composition, which in turn causes hot metal contamination. To get the mass of the coating, multiply the apparent density by the volume. Decreases in Si and other component concentrations may be used to reduce coating thickness and slag segregation. Tim Heinemann [27] looked into the value chain structure of die casting aluminium. We simulated several value chains for Al die casting. It was necessary to conduct sample analysis in order to establish a general flow of materials and energy.

Martin et al. [28] state that managing non-metallic inclusions in Al melts is a laborious technique due to the difficulty in estimating the parameters to remove inclusions for diverse procedures. We improved our knowledge of the physical processes involved in settling by integrating mathematical models with targeted data. Zhe Xu et al. [29] states that while utilising the electro magnetic induction heat process for the continuous casting of billets for the hot rolling line, it is difficult to attain the billet temperature of steel due to the normal voltage. This research aims to improve the output voltage by creating the ARX model. The temperature range that the casting billet might be regulated to a greater extent after the tuning.

Researchers Narasimha Murthy et al. [30] observed that foundry companies are moving away from using sand and towards using granulated blast furnace slag as a mould material. There has been some investigation into silica slag using various sodium silicate-CO2 compositions. Three distinct types of sand slag were combined. Both in-house and external tests confirm that slag models provide a flawless, high-quality surface. Mahrabi et al. [31] discussed ways to lessen the use of energy and the amount of trash produced by the casting process. This article took a look at a number of casting processes. By optimising the input parameters, we were able to increase efficiency.

Die casting is an element of modern manufacturing processes; Jerald Brevick et al. [32] looked into how efficient it was in terms of energy and money. Die casting has tremendous advantages, but internal design and operational choices cause it to produce more carbon dioxide than necessary. When compared to the old-fashioned die casting approach, the Markov chain model offers many advantages, such as operational choices and model subparts.

Eskin et al. [33] studied the impact of melting temperature and casting flow on structure during direct chill casting of aluminium alloys experimentally. The distribution of melt flow and sump temperature of the cast billets were studied. The amount of non-equilibrium eutectic in the core of the billet and its melting point were both somewhat impacted by the porosity. Christian Schmidt et al. [34] state that twin-roll's primary disadvantage is that it slows down the overall solidification process. For that reason, the melting furnace was also doing a heat loss study at the same time as the chain process. We look for heat losses at different stages of solidification.

3. Research Gap

Based on the literature review above, it is clear that several studies have investigated different types of sand casting faults and methods to mitigate them. No studies have looked at how increasing the number of mould boxes might improve sand casting productivity. Reason being: making a mix of mould boxes is fraught with difficulties. A novel intelligent gating mechanism for the combination of mould boxes is being designed as part of this research in an effort to address the issue. Using numerous mould boxes has several advantages, such as:

- Reducing casting time
- Increasing industrial production rate and profit

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