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A Review of Various Mould Attributes in the Sand Casting Process

BEDARAPALLI SAINATH BHARADWAJ, JAYAM SREEHARI, NAGASAMUDRAM PHANI RAJA RAO

Assistant Professor [1] Assistant Professor [2] Associate Professor [3]

bharadwajbari369@gmail.com,jayam.sreehari@gmail.com,phaniraja.ns@gmail.com
Department of Mechanical Engineering, Sri Venkateswara Institute of Technology,
N.H 44, Hampapuram, Rapthadu, Anantapuramu, Andhra Pradesh 515722

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ABSTRACT

When designing a product to meet the demands and delight customers, casting is a crucial step in the production process. The industrial world offers a wide variety of casting processes. Sand casting, among other casting processes, is widely used for ferrous and nonferrous materials. The sand casting process relies heavily on the solidification range of the molten metal to determine the product quality. A standardised casting design method is needed, and it may be attained by experimental inquiry. The solidification process eliminates the outcomes of casting faults, such as shrinkage, porosity, and hot tears. A lot of recent developments have included the nuclear, marine, automotive, and industrial sectors with aluminium (6063). Research papers are examined and analysed in this report about the numerous mopuld attributes.

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I. INTRODUCTION

Machining, casting, forging, and welding are some of the most common manufacturing processes used to create items. One of the most significant casting processes for ferrous and non-ferrous materials is sand casting. When compared to die casting, sand casting has many advantages, the most notable of which are reduced solidification time, higher production rates, easier pattern development, and good dimensional geometry. Vent hole, gating system, spruce and riser design, pattern allowances and tolerances are the most important process characteristics to consider while sand casting. Physical and mechanical characteristics, crystal structure, and intermetallic compounds are the factors that influence the bonding processes. Choosing the right input process parameters and materials determines the test specimen quality. In order to predict the test specimen's hardness during the sand casting process, a literature study is crucial. In India, you may find over 10,000 manufacturing companies. For manufacturing purposes, sand casting is chosen by 69 to 70% of these sectors. The goal of this project is to reduce the time and money needed for production. By merging several mould boxes, this study hopes to lessen the lean manufacturing process.

1.LiteratureReview

Researchers Jeet Desai et al. [1] looked at ways to make alloy steel castings with less porosity. This study examined a range of problems caused by the porosity of casting sand and offered solutions to these problems. Research on the casting process's sprue flow analysis was conducted by Mohd Imran Ansari et al. [2]. This study utilises computational fluid dynamics (CFD) simulation, GAMBIT 6.3.16 and FLUENT 6.2.26 to examine the flow pattern of molten metal in sprue for various optimal forms, as well as to model and mesh the sprue geometry.ResearchersShashank.V. Gulhane et al. [3] looked into With the goal of making casting technique more productive by making the gating system lighter. Researchers look at the many flaws caused by the ginning dead weight gating system's problems. In their study, M.Alagar et al. [4] examined the effects of several cutting parameters optimised for CNC turning operations on EN8 steel with Al_2O_3 and CuOnanofluids used as coolants. This study determined the best CNC cutting settings by using a L9 orthogonal array. The impact of various sprue forms on the physical and mechanical characteristics of casting alloys was studied by Maryam.S et al. [5]. This research compared four different sprue designs in order to assess surface roughness and marginal fit.In their study of casting faults and numerous industrial processes, Atinderpal Singh Sandhu et al. [6] introduced the reasons and solutions to the most common solidification flaws in casting. Researchers Muhammad Huzaifa Raza et al. [7] found that bottom gating systems are superior than top gating configurations while studying the impact of gating design on the mechanical characteristics of aluminium alloy in the sand casting process. According to G. Mahesh and colleagues [8] Using clever methodologies, we discussed the mechanical aspects of sand casting. This study relied heavily on the Design of Experiment method and ANN as its primary tools. In their study on sand casting of wear plates, Sachil L. Nimbulkar et al. [9] used a simulation approach to optimise the design of the gating and feeding system. Analysis of the current gating and feeding system design, optimisation of the system utilising auto-CAST X1 for sand moul preparation and part casting, and comparison of experimental and simulated results. Through the use of a design-of-experiment approach, G. Mahesh et al. [10] examined the effects of different vent hole and vent angle parameters on the hardness of the sand casting process. Through the use of design of experiments, the optimal parameters are examined. Cast 6061 aluminium alloy characteristics were studied by OlawaleOlarewajuAjibola et al. [11] in relation to the permeability of the moulding sand and the pouring temperatures. Pore size, hardness, and strength were investigated as a function of moulding sand permeabilities made from a mixture of coarse and fine particles in four different proportions and subjected to varying purging temperatures. The optimal mix of moulding sand for casting Al alloy was investigated by SumaiyaShahria et al. [12]. The goal is to minimise aluminium casting flaws by maximising the ratio of water to bentonite when applied to a mould made of reclaimed sand. Research by G. Mahesh et al. [13] examined the riser design optimisation and assessment in the sand casting process using modelling. With the help of ANSYS software, we examined all of the possible riser geometries and arrived at the optimal one. Hyung-Yoon Seo and colleagues [14] Designed a gate system and optimised the riser for the turbine housing; conducted experiments and simulations to determine the best way to cast stone. Using a

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heater as a heat source, this research aims to minimise the size of the riser and create the optimal gating system for producing turbine housing.Researchers C. Narayanaswam et al. [15] Analysed casting faults, identified corrective procedures, and mapped out the supply chain in a foundry process for cast iron. Presented findings. In their study, R. Dojka et al. [16] examined the best gating system for steel casting and reported the outcomes of a method for testing the performance of filling systems that aim to fill up to capacity while removing as much air as possible. This will minimise or eliminate surface turbulence and bubble entrainment. The optimisation method was examined by Tharoon T et al. [17] as a means to reduce casting faults. Using a variety of optimisation approaches, the casting products are made better with no faults. The impact of mechanical mould vibration on the characteristics of sand cast aluminium (A-1100) alloy was addressed by Premvrat Kumar et al. [18]. Researchers looked at how sand casting alloy characteristics change when mechanical mould vibration is applied. Researchers John O. OJI et al. [19] looked examined how different temperatures for the mould and pouring affected the final tensile strength of sand castings made of aluminium alloy. This work proposes using the analysis of variance (ANOVA) approach to study the impact of the sand casting process on the ultimate tensile strength of an aluminium alloy sand casting. In their study, Victor ANJO et al. [20] examined the design of a gating system that could manufacture thin aluminium cast alloy plates of varying thicknesses and sizes utilising the green sand moulding process and non-pressurized gating. "Nandagopal et al. [21]" Analyse the sand casting gating mechanism. A gating system's essential components, including the many kinds of gates and risers, are detailed. The root causes and potential solutions to casting problems were investigated by Rahul T. Patil et al. [22]. An assortment of die casting flaws in aluminium alloys, along with solutions and explanations of their origins, are detailed here. Heating duration, melting point, percentage of surplus air, flame temperature, and furnace rotating speed were among the furnace characteristics studied by Jain [23]. In order to generate the best model for future research, an artificial neural network was used to analyse the modelling, optimisation, and simulation processes. Bottom blowing metal for acid converters and providing consistent argon pressure in furnace ladle units were both developed by Kraev et al. [24]. To cut down on the forty minutes required for melt processing, it is necessary to examine the argon and nitrogen pipes in metal FLU and FLU every day. Then, the joints in the steel casting are replaced. After extensive testing in industrial settings, the optimal method for processing metals with argon in FLU was determined to have the most stable operating indices. Shishimirov [25] used a variety of furnace-tested techniques, including de-oxidation, alloying, inert gas blowing, and degassing, to make steel more stable at a reduced cost. The chemical combustion of several metal samples was determined using an OBLF spectrometer. Methods for making stable steel were uncovered via studies of semi-product and average density. Slag segregation in casting and transport ladles was addressed by Filatov et al. [26]. The coating's composition—which leads to hot metal contamination—was determined by the coating's carbon content and the temperature at which its specific sampling equipment took coating samples. Multiplying the apparent density by the volume yields the coating mass. In order to reduce the coating thickness or slag segregation, the concentration of Si and other components is decreased. One value chain system that Tim Heinemann [27] examined was that of aluminium die casting. Several Al die casting value chains were modelled. In order to generate a general flow of energy and materials, sample analysis was performed. Because it is difficult to estimate the parameters to eliminate inclusions for distinct processes, controlling non-metallic inclusions in Al melts is a tiresome procedure, according to Martin et al. [28]. By combining mathematical models with actual focused data, we were able to get a better understanding of the physical processes involved in settling. According to Zhe Xu et al. [29], the usual voltage makes it difficult to achieve the billet temperature of steel when using the electro magnetic induction heat process for the continuous casting of billets for the hot rolling line. The purpose of this study is to develop the ARX model, a method for enhancing the output voltage. The tuning enhanced the regulation of the casting billet's temperature range.

According to Narasimha Murthy et al. [30], foundry industries are opting to employ granulated blast furnace slag as mould material instead of sand. Using different sodium silicate-CO2 compositions, silica slag has been the subject of some inquiry. A mixture of three different kinds of sand slag was made. Results show that slag models provide an excellent surface finish with no surface flaws, as shown by both laboratory and industry testing. Methods for reducing energy consumption and waste during the casting process were covered by Mahrabi et al. [31]. Several steps in the casting process were examined in this article. The efficiency was enhanced and the input parameters were optimised. Jerald Brevick et al. [32] examined the energy and cost-effectiveness of die casting as part of the high-tech production process. Despite its benefits, die casting results in increased carbon dioxide emissions due to internal design and operational decisions. An operational choice and model subparts are two examples of how the Markov chain model improves upon the traditional die casting method.During direct chill casting of aluminium alloys, Eskin et al. [33]

conducted experimental investigations on the effects of melting point and casting flow on structure. An analysis was conducted on the sump temperature and melt flow distribution of the cast billets. The quantity of non-equilibrium eutectic in the billet's centre and the melting temperature were both affected by the porosity to a little degree. The main drawback of twin-roll, according to Christian Schmidt et al. [34], is that it lags behind the whole solidification process. This is why, at the melting furnace, a heat loss analysis was being calculated simultaneously with the chain process. Various phases of the solidification process are examined for heat losses.

2. ResearchGap

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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