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"A LITERATURE REVIEW ON MINIMIZATION OF DEFECTS IN CASTING THROUGH PROCESS IMPROVEMENT"

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Abstract:-

Nowadays manufacturing sector has entered a new era. Conventional and manual manufacturing system is replaced by modern manufacturing technology. The productivity in this sector has increased to a very high level. Modern technology has minimized the use of resources and also minimizes the defects. Foundry technology is not an exception to it. For quality casting manufacturing there is a need of proper design of gating and rising system which can minimize defects in casting product.Castings are very important part of manufacturing industries. In modern days, foundry industries also use modern technology with various software's to improve the quality of product comparing with others industries. Computer simulation of casting processes has advanced significantly within the last few years. The demand for precisely designed, cheap and perfectly made casts is constantly growing. This paper shows a brief review of a casting Simulation Techniques presented by a different researchers.

Keywords: - Casting defects, Casting Simulation, Process.

Introduction:-

Moreover, the competition in the market is rising every day. If the component's manufacturers want to keep their position on the market, they need to learn how to make use of modern simulation programs. Therefore, computer programs have been invented to enable designers to take control over liquid metal behavior and help to eliminate defective part, especially shrinkage porosity defects inside the casts.

Various simulation software's having Finite Element Method (FEM) or the Finite Difference Method (FDM) such as Inspire CAST, AUTO CAST, SOLID CAST, Pro CAST, Magma CAST etc. are used today. The Industry is following continuous improvement policy and efforts are being taken to improve the process and process parameters of various certified components. Ductile Iron casting is one of such components which need improvement in its process to achieve required quality and economy of operations. It has been found that process is incapable of producing quality castings due to improper gating, solidification and mold design. Present study analyses the current process and suggests improvements based on computer simulation and testing.

The Purpose of this review is:-

1. To gain some insight about which domain is relevant in order to position the research.
2. To identify the existing work to form a theoretical base for understanding the concerned area.
3. To review current work in the selected area to understand of the progression of that work in future.

The properties of casting determine the quality of the final product. In particular shrinkage or porosity and cold shut are undesirable. It appears that one half to three quarters of scrap castings are lost because of these defects.

Sunanda & Raju (2021) Casting is the method by which different kinds of metal products are manufactured. Sand casting is one of the commonly utilized metal casting processes because of its inherent benefit of the production, low cost, and high production rate. The critical issue with the sand casting process is casting defects and unstable casting quality. The pulley's quality characteristics have been affected by casting defects, which leads to a large number of shop floor trails, a high rejection rate, and poor casting performance. Knowledge of casting defects and causes is essential for quality control. Various

researchers have stated that 90% of casting defects are accumulated only because of the deficient design of the gating and feeding systems. In this work, creo software was used to create the Solid model of a pulley and the gating system. Using Procast Simulation software, mold filling, and solidification analysis was performed. Medium carbon steel was chosen for its wide variety of automotive applications. The Sand mold was chosen as a mold material, and prediction analysis has been implemented using computer-aided simulation software. [1]

Mohan & et al. (2020) In this current scenario of globalization, foundries play a key role for manufacturing industries as they are the major source of castings. Casting has various processes like Pre casting Processes, pattern making, core making, moulding and mould assembly making, Casting Processes, furnace charging, melting, holding and pouring, and Post casting Processes, shakeout, inspection and dispatch etc. In India there are many foundry have followed conventional and manual operations.Today's competitive environment has, lower manufacturing cost, more productivity in less time, high quality product, defect free operation are required to follow to every foundry man. Mould shifting, Crushing, Lower Surface finish, Shrinkage, Porosity, Cold shut and Extra material are common casting defects due to these manual operations. These defects directly affect on productivity, profitability and quality level of organization. [2]

Kamble & et al. (2019) Review provided about non-destructive testing (NDT) method that is ultrasonic technique for the characterization of casting material. The review considers the capabilities of Ultrasonic Testing (UT) with respect to advantages and disadvantages of this method. Then, method categorized based on their intrinsic characteristics and their applications. The aim of this study was investigation of the capability of ultrasonic technique in assessment of the structure and properties of nodular cast iron and to provide additional data concerning the particulars of the use ultrasonic velocity and attenuation measurements for quality control of different grades of ductile iron either in the as-cast condition or after heat treatment. In the measurements, first the directional dependence of velocity and apparent attenuation was investigated. Ultrasonic velocity and apparent attenuation measurements was carried out at various testing frequencies to observe the effect of the probe frequency. The nodularity status can be examined by metallographic investigations and hardness tests were performed. Finally, the results of ultrasonic velocity measurements, metallographic investigations and mechanical tests were compared. Thus; Ultrasonic Technique is effective quality control tool which can be used for characterization of casting materials. [3]

Desai & et al. (2019) This paper describes the "Use of Casting Simulation for Yield Improvement." This is a need to increase the yield of casting without any casting defect. The main purpose of the casting simulation was to increase the yield and to increase the productivity and also to reduce the shop floor trials. Casting simulations techniques are widely used now days in foundries and metal casting industries. Casting simulations simulates real casting phenomenon and gives virtual casting process as molten metal flow in mould cavity with respect to time and direction. It shows virtual process like mould filling, solidification and cooling and also predicts the location of internal defects like blow holes, shrinkage porosity etc. Casting simulation was used in the production of reliable, economical and high accuracy cast component. Although casting simulation becomes important tool, simulation cannot correct itself existing casting process or design. So for the application of casting simulation experienced and knowledge person is required.Reliability of casting component can be improved with the help of casting simulation software. In this review paper, the casting simulation, its importance, types of casting simulation software, application and case study of yield improvement is described. [4]

Kabnure & et al. (2019) Foundries contribute to production of major automotive parts. These foundries now a days suffering from poor quality and productivity due to different parameters of the casting process. Casting quality depends on the solidification process after pouring. Computerized casting modeling and solidification simulation is being extensively used by foundries to design the casting process for manufacturing of castings before castings are prepared or before equipment is constructed or improved. The basic objective of using computerized casting modeling and solidification simulation is to increase the quality of the casting manufactured, both in the existing produced casting and first ever castings made and to reduce cost expenses. The shop floor trials can be reduced effectively by casting solidification simulation and defect free castings can be assured. The casting simulation approaches are based on finite element method (FEM), finite difference method (FDM), finite volume method (FVM). In this paper an attempt has been made to use finite difference method (FDM) and finite volume method (FVM) for casting solidification simulation and optimization of casting gating system to assure maximal yield. Modeling and simulation of Flange is analyzed in this study. The material for the flange is ductile iron and produced using shell molding process. [5]

Khan & Sheikh (2018) This paper presents a new approach to analyze the quality of ductile iron castings through simulations and experiments. Standard tensile test specimens are considered as simple cast products for which a multi-cavity mold is designed, simulated, and optimized to minimize porosity using MAGMASoft. X-ray imaging, hardness measurement, and tensile testing are done for selected specimens produced using optimized mold design. Finite element simulation of tensile testing until fracture was done in ABAQUS using elastic-plastic material model and porous metal plasticity model. Simulation results for sound specimen are found to be in good agreement with the experimental results. Since mold design optimization is solely based on porosity minimization, no porosity is observed in the final mold design. However, if multi-criteria optimization of mold is done, the specimens may show some porosity which can be integrated in the developed finite element model of tensile testing. The concluded remark that simulation-based mold design optimization can produce nearly defect-free castings and at the same time exhibit the similar mechanical properties as their sound counterparts produced with other manufacturing processes. [6]

Kavad & et al. (2018) The final casting parts are the greatly influenced life of cast parts and mechanical performance by the presence of porosity. The progress way to predict the presence of porosity is the reduced or eliminate in shop floor with help of the computer simulation program. The main aim of experiments performed to verify possibilities of the simulation software how much meshing results in simulation and experimental to predict presence of the porosity of casting process, shrinkage porosity it's very difficult and challenge to eliminate porosity but is the transfer to unimportant area can't be affects mechanical performance. So there are requirements of shrinkage porosity prediction with help of the simulation software namely click2cast software is made Altair Software Company. The porosity prediction before the production start of foundry its advantage of the industry I was performed for simulation and experimental work was be done Spheroidal Graphite Iron material solidification module in click2cast simulation software. Temperature and time calculation takes into basic phenomena

at the origin of the micro and macro porosity .for the experiments purposes have used a pattern made of the maximum T shape cover at pattern its take into mold with a shape and size of mold. [7]

Naik & Patil (2017) In India many foundries have followed conventional and manual operations. Foundry industries suffer from poor quality and productivity due to large number of process parameters combined with lower penetration of automation and shortage of skilled worker. Mould shifting, sand inclusions, poor surface finish, shrinkage, porosity, cold shut and flash are common casting defects in casting. Since casting process involves complex interaction among various parameters and operations related to metal composition, method designs, melting, pouring, shake-out, fettling and machining and hence need to improve. This Paper describes comprehensive review of work pertaining to process improvement techniques used for defect minimization in casting. [8]

Gaware & Mahalle (2017) Aim of this paper is to investigate casting defects, provide remedies and simulation of casting process by using casting simulation software.Casting defect occurs where mistake happens in the process of casting. Most defects occur due to improper feeding system. Simulation is helpful in minimizing the casting defects. Various simulation softwares like AutoCAST-X, ProCast&SOLIDCast can be used. Defects like shrinkage, blowhole, pinhole, sand inclusion and sand burning can be identified and simulated. Separate design software is needed to design the product which needs to be simulated. Simulation helps to manufacture defect free casting without consuming too much time. In India, casting simulation technology is increasing rapidly. Besides improving the existing casting, this technology can also be used for rapid development of new products. [9]

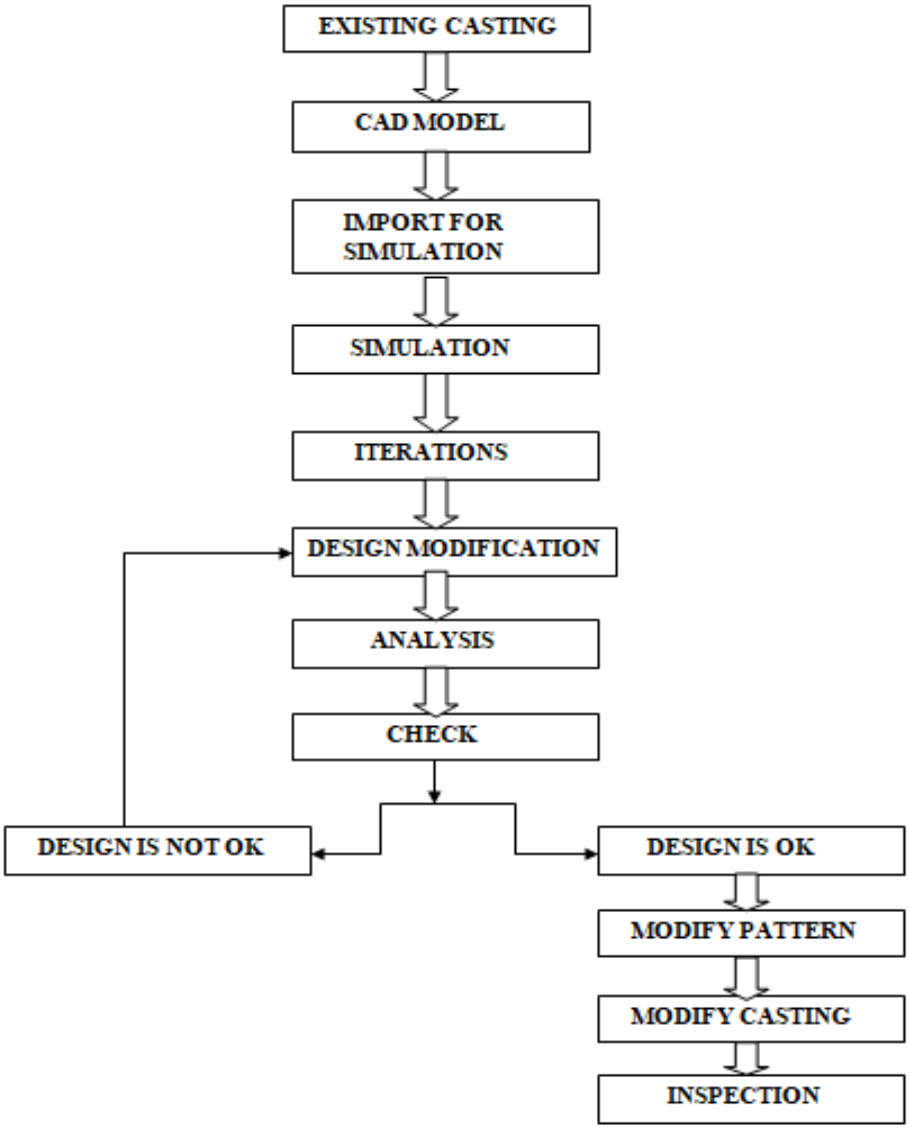
Kadam & Kamble (2016) The ability of a molten metal to get the shape of the mould is a casting process. Casting is a defect prone manufacturing process. A variety of defects measuring from 3- 6% of the total casting produced are commonly in the acceptable level. Metal casting industries are continuously exposed to ever increasing demands regarding their competitiveness, sound quality products as well as in developing their specific casting process. The casting development process for a new product was in the past determined within the foundry using "personal experience" as well as "shop floor trial and error". In order to achieve continuous improvements, controlled processes and close customer-vender relationships, foundries have introduced QMS which in turns enable implementation of quality requirements using CAE tools like FEA and simulation of casting techniques which are effective and reliable tools in order to achieve reliable and calculable product development and production processes. Simulation based approach has helped in the improvement of the feedability index which represents yield of riser and quality of casting. The methods layout of a casting is an important activity in tooling development. It involves critical decisions regarding part orientation in mold, parting line, cores, cavity layout, feeder's size and its location, feedaids and gating system dimensions. An improper layout leads to either poor quality or low yield, affecting manufacturing costs and productivity. Here an attempt is made to virtually simulate feeding system design in order to obtain optimum risering solution by using AutoCAST simulation software. [10]

Prajapati & et al. (2016) In the present casting arena, emphasis is laid on the precise and defect free casting, minimum production cost, develop the components on demand in short period of time accompanied by high yield of production for casting units & foundries. In order to achieve this level, Fish-bone diagrams and computer simulation technique are inevitably necessary. The paper studies on the shrinkage defect prevailing in the Hand wheel casting and its remedy with the help of casting simulation software ADSTEFAN. Due to the lack of standard acceptable theoretical procedures, the design processes are normally carried on a trial-and-error basis. Systematic studies & analyses are carried out to understand the reasons for occurrence of defects and suitable remedial measures are identified. Then, computer assisted casting simulation technique is used to analyze the casting defects. Shrinkage porosity analysis is performed using this technique by introduction of a new gating system design, followed by various iterations that include changing of the length of runner and introducing a riser. The results show a significant reduction in shrinkage porosity and improvement in yield. This can be of great economic value due to reduction in material consumption and less unit price for production. The proposed approach reduces the rejection due to casting defects. [11]

Olawale & et al. (2016) Ductile cast irons are materials having strength, impact toughness and ductility comparable to those of many grades of steel while exceeding by far those of standard gray irons. In addition, they have the same advantages of design flexibility and low cost casting procedures of cast irons. Their corrosion resistance is equal or superior to that of gray cast iron and cast steel in many corrosive environments. Its wear resistance is comparable to some of the best grades of steel and superior to gray iron under heavy load or in impact situations. They are considerably less expensive than cast steels to produce and only moderately more expensive than gray cast irons because the procedures are similar. The combination of good mechanical properties and casting abilities of ductile cast iron makes it economical choice for many applications. Practical examples are valves, pumps, cylinder liners, crankshafts, metal working rolls, dies, gears, process equipment and structural applications. This paper reviews the process techniques and applications of ductile cast irons. The understanding of processing techniques of ductile irons is a requisite requirement to successfully convert gray cast iron to ductile iron. While the metallurgical concepts of ductile iron is the key to understanding its potential use as an engineered metal and allows the design engineer to determine its suitability in specific applications and to intelligently select the best grade. [12]

Gondkar & Inamdar (2014) Introduced methodology for casting defects analysis .the need of optimization for casting process. It states the advantages of casting simulation and solidification to predict the defect and minimize rejection of casting. The casting simulation program which are used for analyzing mold filling, solidification, internal stresses and mechanical properties. These simulation programs are based on finite element analysis of 3D models of casting. IITB developed a casting software namely Autocast which include many features like various dimension, wall thickness suitable position of parting lines, location of feeders and gates. This paper has also included experimental work in which all related data is given and simulation process of that experimental is carried out. Further, optimization of modification design was obtained. [13].

process for modeling and simulation for analysis and prediction of defects is as follows:



Conclusion:-

Casting simulation is used for the production of reliable, cost-effective and high accuracy cast component. Also it is secondhand to increase the casting yield and diminish the shop floor experimental time. With the help of casting simulation techniques, casting system and design optimization is easily possible. Casting simulation supports to predict the defects and their locations in an exact manner. With use of a casting simulation technique, the Feed ability of casting process can be analysis and optimized.

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