

Unconventional Techniques for Defect Free Casting – Inevitability

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Abstract - the world's biggest suppliers to automobile industry are the alloy steel sand casting industry. Due to rejection of component, there should be chance of loose the customer satisfaction and increase the financial burden on alloy steel sand casting industry. Aimed of this research is comparing and analyzing the simulation result with some suitable experimentation and validate the result. Casting simulation software is chosen for simulation due to its intrinsic potential to reveal the time-dependent changes in temperature and heat transfer during the solidification process of a casting and explore its capability for reducing the defects, and improving the casting quality. The effective implementation of the proposed methodology in the alloy steel casting industry would save the time and money of industry and add to the manufacturer's status in respect of quality.

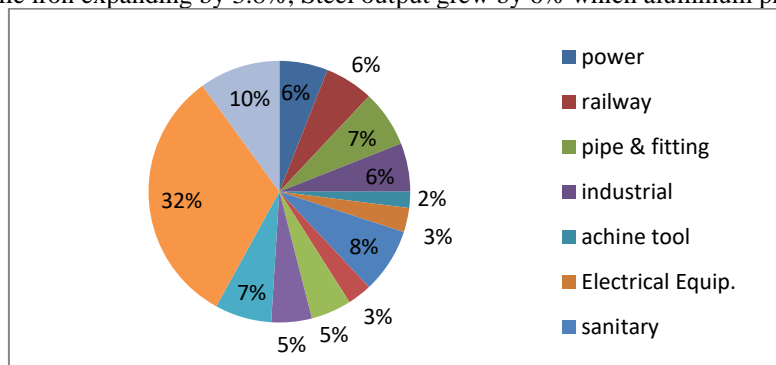
keywords - Casting Defect, Simulation Techniques, Comparison of techniques.

I. INTRODUCTION

The Indian foundry industry manufacturers metal cast components for applications in Auto, Tractor, Railways, Machine tools, Sanitary, Pipe Fittings, Defiance, Aerospace, Earth Moving, Textile, Cement, Electrical, Power machinery, Pumps / Valves, Wind turbine generators etc. Foundry Industry has a turnover of approx. USD 19 billion with exports approx. USD 3.06 billion[1]. There are approx 5000 units out of which 90% can be classified as MSMEs. Approx 1500 units are having International Quality Accreditation. Several large foundries are modern & globally competitive. Many foundries use cupolas using LAM Coke. However, these are gradually shifting to Induction Melting. There is growing awareness about environment & many foundries are switching over to induction furnaces & some units in Agra are changing over to coke less cupolas [1]. Govt. focusing on "MAKE IN INDIA", "EASE OF DOING BUSINESS", infrastructure & easing FDI norms to promote investments in manufacturing & new initiatives & co operations in skill development. Forecasts of growth by leading institutions:-India to become fastest growing economy >7.5% YoY as per forecasts of leading International Institutions.[1]

Major Foundry Clusters [1]: - Each cluster is known for its products. The major foundry clusters are located in Batala, Jalandhar, Ludhiana, Agra, Pune, Kolhapur, Sholapur, Rajkot, Mumbai, Ahmadabad, Belgaum, Coimbatore, Chennai, Hyderabad, Howrah, Kolkata, Indore, Chennai, Faridabad, Gurgaon etc. Typically, each foundry cluster is known for catering to some specific end-use markets. For example, the Coimbatore cluster is famous for pump-sets castings, the Kolhapur and the Belgaum clusters for automotive castings and the Rajkot cluster for diesel engine castings, Howrah cluster for sanitary castings etc.

Global Scenario [1]: As per 52nd World casting Census published by Modern Castings USA in December 2018, Global Casting Production increased to more than 109.8 million metric tons, an increase of 5.3% when compared to the previous year. China increased its total production by two million metric tons to a total of 49.4 million, meanwhile, the US was its tonnage increase by 4% and grey Iron heavy, India was an increase of 6.2% in compare to last year. Total production of Iron increased, with grey iron growing 6% and ductile iron expanding by 3.8%, Steel output grew by 6% which aluminum production jumped by 6.7%.



Sector wise major consumer of casting

II. LITERATURE REVIEW

Uday A. Dabade and Rahul C. Bhedasgaonkar had done research on Casting Defect Analysis using Design of Experiments (DoE) and Computer Aided Casting Simulation Technique. In this paper the DOE and FEM based casting simulation Package Magma soft is combined to analyze the sand related and methoding related defects in green sand casting. In first part of this paper Taguchi based L18 orthogonal array was used for the experimental purpose and analysis was carried out using Minitab software for ANOVA and AOM plot. [2]

Sunil Chaudhari, Hemant Thakkar had represented a research article on Review on Analysis of Foundry Defects for Quality Improvement of Sand Casting. 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. They have successfully reduced the casting defects considerably up to 6% by proper selecting sand parameters. It was concluded that the sand process parameters should be decided experimentally depending on quality of sand. [3]

K.Srinivasulu Reddy presented a paper on Casting Simulation of Cast Iron Rotor Disc using ProCAST. In this research, the study of solidification behavior of Cast Iron rotor disc and detection of hot spots in castings with the help of casting simulation software ProCast and analyze the defect and sort-out the defect by using ProCAST package and save time and money. They conclude that by using Pro Cast can reduce the defect by from 8.5% to 3.5%. [4]

Mr. Siddalingswami. S. Hiremath, Dr. S. R. Dulange had represented a research article on Advanced Techniques in Casting Defects and Rejection Analysis: A Study in an Industry. This project is about new devolvement for identification of defects for 4R cylinder block which is presently having a 40% or more percent rejection in Kirloskar ferrous industrial ltd, Solapur. This project also presents a methodology in rejection level percent by using scientific study on casting defects. Various casting quality improvement techniques such as; Product Process Search analysis (PPS) Inspection method, Design of Experiment (DOE), and by using a Casting simulation software and by finding out the cause-effect diagram.[5]

Parth Lakum, R.D.Gondaliya, H.N.Chauhan had represented a research article on Shrinkage Porosity & Temperature Distribution analysis of air cooled Cylinder liner block of Grey cast iron-ASTM class 35". Pro-Cast helps to understand heat flow of the casting. It helps predicting the amount and location of the porosity. It show that experimental result and simulation result almost nearer. Now conclude that parametric design analysis, we can reduce the defect and increase the acceptance ratio of product and satisfied the customer.[6]

Bhautik R. Pabani, Pratik R. Vyas, Mitesh D. Patel, Pratik A. Vataliya had represented a research article on Casting Defect Identification and Its Solution by Niyama Simulation. In this study, the experimental and virtual behavior for core casting process of coupling part called Coupling Cage is validated with FEA result carried out in PRO-CAST 2014 & CREO 2.0 software. By considering two different factors as gate size, sprue size optimization for core casting process is being generated. Shrinkage defect reduced the productivity at most and we target that parameter in our work and help the company for and give the new way of gating system in core casting of stainless steel material. Conclude that core casting process for any complex shaped part with less productivity rate could be improved by simulation approach without spending more time and money. [7]

Vipul Vasava had represented a paper on defect analysis of inlet tube casting by computer simulation. From the present work, it can be concluded that optimization in current gating system design could be done to increase the casting yield. In casting simulation software (PROCAST), by comparing that result with calculated data for same component and after validation, we can reduce residual stresses, fast cooling rate, improper design of gating system of the inlet tube of the casting. The software gives solidification time, defect location and gives a solution for defect removal. [8]

Shivtej Salokhe, Prof. U. M. Nimbalkar had represented a paper on Casting Simulation to Identify Shrinkage Zones in Flywheel Castings by Using ProCast. In this paper author first identified the location and types of defects. So now using PROCAST simulation software, simulate the flywheel and change the parameter which affect the quality of flywheel and reduced the defect virtually then validate experimentally. Now from simulation and experimental result, conclude that by using simulation we can reduce manufacturing cost, reduce development time and reduce trial cost, manufacture & optimized simulation of flywheel casting.[9]

Khan, M. A. A. & Sheikh, A. K. had represented a research article on a comparative study of simulation software for modeling metal casting processes. In this study the software are compared in term of casting process simulated, add-on packages, solution methods used, defect prediction and advance simulation capabilities. This study conclude that the need based selection of software leads to high production and reduced the defect and save time and money. [10]

Jukui GUO, Yongxin LI and Jia FU had represented a research article on Design and Improvement of the Investment Casting Process for the Ring-shaped Aluminum Alloy based on PROCAST software. The investment casting process of a ring-shaped ZL101 alloy is investigated based on PROCAST software. Based on the simulation analysis of solidification time map, shrinkage prediction map, solidification sequence diagram the shrinkage was forecast to be likely appeared on both sides and the bottom position of the piece, while the slag inclusion is easily enriched in the upper position and heat preservation are optimized and improved, and shrinkage and inclusion are avoided. [11]

Purvi Chauhan, Krupang Panchal, Vijay Baraiya and Ruchit Kasvala had represented a research article on Design of Gating and Feeding System for Drag Chain Link and Simulation for Yield Reclamation. According to calculation and suggestion of industry it is decided to place three risers, out of it one should be of large diameter riser and two should be of small diameter riser to achieve comparatively higher Yield, Favorable Temperature Gradient, and Suitable for industry's methodology and easy removal of Riser. [12]

Nazma Sultana, Md. Rafiquzzaman, Younosur Rahman and Apurba Das had represented a research article on Solidification and Filling Related Defects Analysis Using Casting Simulation Technique with Experimental Validation. Click2cast is used in this study to determine the optimal size and positioning of gating and feeding systems for minimizing the defects. Hence casting simulation enables to provide 'correct at the first time' through preventing potential problems related to flow of metals or during the time of freezing compatible with both product requirements and foundry capability. [13]

Yiqi Gao, Sijia Sun and Hui Jin had represented a research article on Casting simulation of cast steel joint based on Pro-CAST and conclude that the simulation with original data and experimental result is quite nearer or matched. So runner and riser are optimized for defect reduction. Casting simulation software can be used to guide the casting production. [14]

Swapnil A. Ambekar observed that gating some also termed the gating systems as risers or runners systems, overflows, venting channels can be optimized using numerical simulation. Solidification related defects can also be predicted taking into account cooling channels and die cycling so as to accurately reproduce production conditions. Pro E readily addresses all these issues but also includes advanced features to better assess the casting quality. [15]

III. CONCLUSION

From the review of literature it is apparent that research has been carried out about various casting defects, their causes and remedies to be taken to resolve casting defect. Research has also been done for optimization of various casting defect minimization. Various casting simulation software are available to reduce casting defect at production level to minimize rejection of casting product but casting simulation software are still not utilized much in small and medium scale casting industries because of

- High cost of software.
- Trained operator is required which also increased the cost.
- No software should satisfy the all the requirement.

In addition, defects are still produced in casting due to numerous process parameters involved during production of casting and negligence in implementation of parameters required. Identification of such defects, finding causes and remedies depends upon expertise of an individual. Hence need of present industry is to minimize the dependency of human interaction by establishment of a support system to assist human at various stages of production.

IV. REFERENCES

- [1] http://foundryinfo-india.org/profile_of_indian.aspx
- [2] Uday A. Dabade , Rahul C. Bhedasgaonkar. " Casting Defect Analysis using Design of Experiments (DoE) and Computer Aided Casting Simulation Technique." Forty sixth CIRP conferences on manufacturing system 2013.
- [3] Sunil Chaudhari, Hemant Thakkar. " Review on Analysis of Foundry Defects for Quality Improvement of Sand Casting." Int. Journal of Engineering Research and Applications ISSN: 22489622 Vol. 4, Issue 3 (Version 1), March 2014.
- [4] K.Srinivasulu Reddy. "Casting Simulation of Cast Iron Rotor Disc using ProCAST." International Journal of Current Engineering and Technology, E-ISSN 2277 – 4106, P-ISSN 2347 – 5161, 2014.
- [5] Mr. Siddalingswami. S. Hiremath, Dr. S. R. Dulange. "Advanced Techniques In Casting Defects And Rejection Analysis: A Study In An Industry." International Journal Of Innovations In Engineering Research And Technology [Ijiert]. ISSN: 2394-3696 Volume 2, Issue 9, Sep.-2015.
- [6] Parth Lakum, R.D.Gondaliya, H.N.Chauhan. " Shrinkage Porosity & Temperature Distribution analysis of air cooled Cylinder liner block of Grey cast iron-ASTM class 35." IJARIII-ISSN 023954396 Vol-2 Issue-3 2016.
- [7] Bhautik R. Pabani, Pratik R. Vyas, Mitesh D. Patel and Pratik A. Vataliya. "Casting Defect Identification and Its Solution by Niyama Simulation." International Research Journal of Engineering and Technology. e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 04 Issue: 07, July-2017.
- [8] Vipul Vasava. "Defect Analysis Of Inlet Tube Casting By Computer Simulation." International Journal of Mechanical and Production Engineering Research and Development. ISSN (P): 2249-6890; ISSN (E): 2249-8001, Vol. 7, Issue 3, Jun 2017, 133-146.
- [9] Shivtej Salokhe, Prof. U. M. Nimbalkar. " Casting Simulation To Identify Shrinkage Zones In Flywheel Castings By Using Procast." International journal of advance research in science and engineering, Vol. No.- 7 ISSN No. 2319-8354, 2018.
- [10] Khan, M. A. A. & Sheikh, A. K. " A Comparative Study Of Simulation Software For Modelling Metal Casting Processes." Int j simul model 17, 197-209 ISSN 1726-4529, 2018.
- [11] Jukui GUO, Yongxin LI, Jia FU. "Design and Improvement of the Investment Casting Process for the Ring-shaped Aluminum Alloy based on PROCAST software." IOP Conference Series: Materials Science and Engineering. 382-042006 doi:10.1088/1757-899X/382/4/042006 (2018).
- [12] Purvi Chauhan, Krupang Panchal, Vijay Baraiya and Ruchit Kasvala. " Design of Gating and Feeding System for Drag Chain Link and Simulation for Yield Reclamation." Journal of Emerging Technologies and Innovative Research (JETIR), November 2018, Volume 5, Issue 11, (ISSN-2349-5162).
- [13] Nazma Sultana, Md. Rafiquzzaman, YounosurRahman, Apurba Das. " Solidification and Filling Related Defects Analysis Using Casting Simulation Technique with Experimental Validation." International Journal of Mechanical Engineering and Applications ISSN: 2330023X (Print); ISSN: 23300248 (Online) January 28, 2019.
- [14] Yiqi Gao, Sijia Sun and Hui Jin. " Casting simulation of cast steel joint based on Pro-CAST." IOP Conf. Series: Materials Science and Engineering 592 (2019) 012086.
- [15] Swapnil A. Ambekar, A review on optimization of gating system for reducing defect, ISSN 2091-2730 volume 2, Issue 1, January 2014.