Air Entrapment Analysis of Casting (Turbine Housing) for Shell Moulding Process using Simulation Technique

Mr. Prasad P Lagad[1]

1 M.E (Mechanical-Design) Student, Department of Mechanical Engineering, Deogiri Institute of Engineering and Management Studies, Aurangabad, Maharashtra, India.

Mail: - Prasad.lagad8@gmail.com

ABSTRACT

Casting simulation plays a very important role in predicting defect before going to actual trials in shell moulding process. Air entrapment analysis, fluid flow analysis & solidification analysis generally performed in shell moulding. Fluid flow analysis to be done to see Temperature distribution for molten metal during pouring, Air entrapment, Flow related defects cold shut, misrun. Solidification/Thermal analysis to be done to simulate progressive solidification, Predict the solidification defects (porosity), Degree of soundness of casting.

This paper describes the benefits of casting simulation for air entrapment analysis to understand the possibility of area where air might be entrapped during solidification & give us solution to provide the flow off to avoid air entrapment related defect such as blow holes in the foundries.

Key Words: Air entrapment, Blow Hole, Casting simulation, Flow off, Fluid flow, Shell moulding, Solidification.

1. INTRODUCTION

Shell molding is the process in which resin coated sand is allowed to come in contact with the heated pattern (cope &drag) so that shell of mould is formed around the pattern & removed it with the help of ejector pins then both shell kept in a flask with necessary back up material & then molten metal is poured. Some of the advantages of shell moulding process is close degree of tolerance can be achieved intricate shaped casting can be easily manufactured. Some of the application of shell moulding is turbocharger parts such as turbine housing,center housing, water cooled bearing housing can easily manufactured from shell moulding process.

Casting simulation is a process of designing a model of real system & performs number of experiment (Iterations) with this model for the purpose of either understanding the behaviour of the system and/or evaluating various strategies for the operation of the system. casting simulation is necessary for quality improvement by finding & minimising internal defects or external defects in the casting. Casting simulation in shell moulding process play an very important role in reducing casting defects, optimize gating system & finalizing casting design, casting simulation performs solidification analysis, air entrapment analysis, temperature distribution analysis, fluid flow analysis etc. casting design simulation plays an important role in predicting output of the design.

1.1. Benefits of casting simulation:

1. Increased productivity by reducing number of actual foundry trials.
2. Improved product quality by minimising casting defects related to fluid flow & solidification.
3. Less remelting and refinishing.
4. Shortened lead time & increased production.
5. First Time Right (casting free from defects).
6. Predicting Metallurgy.
7. Yield improvement by performing number of iteration in simulation.

8. Less development time.

1.2. General process flow of shell moulding process

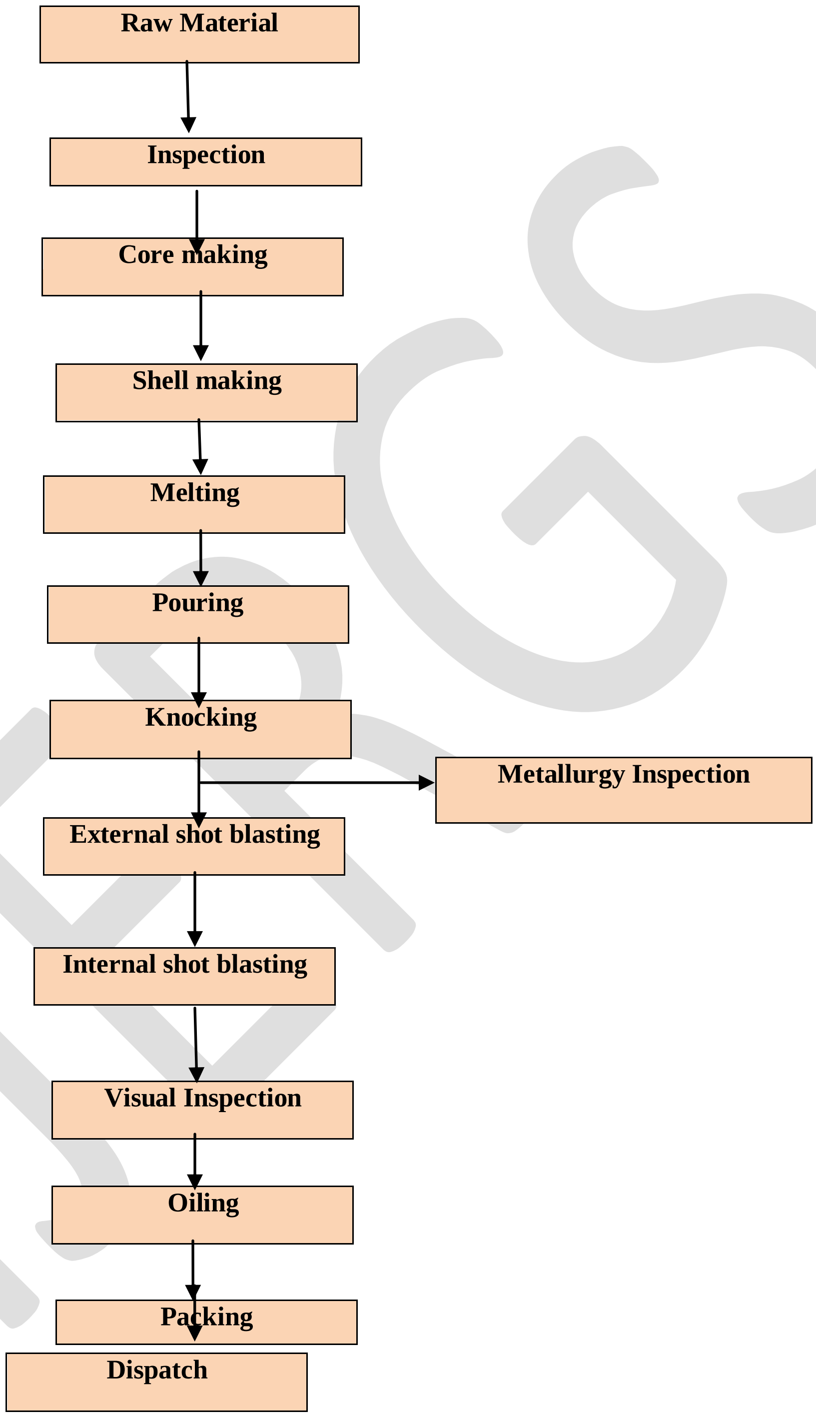
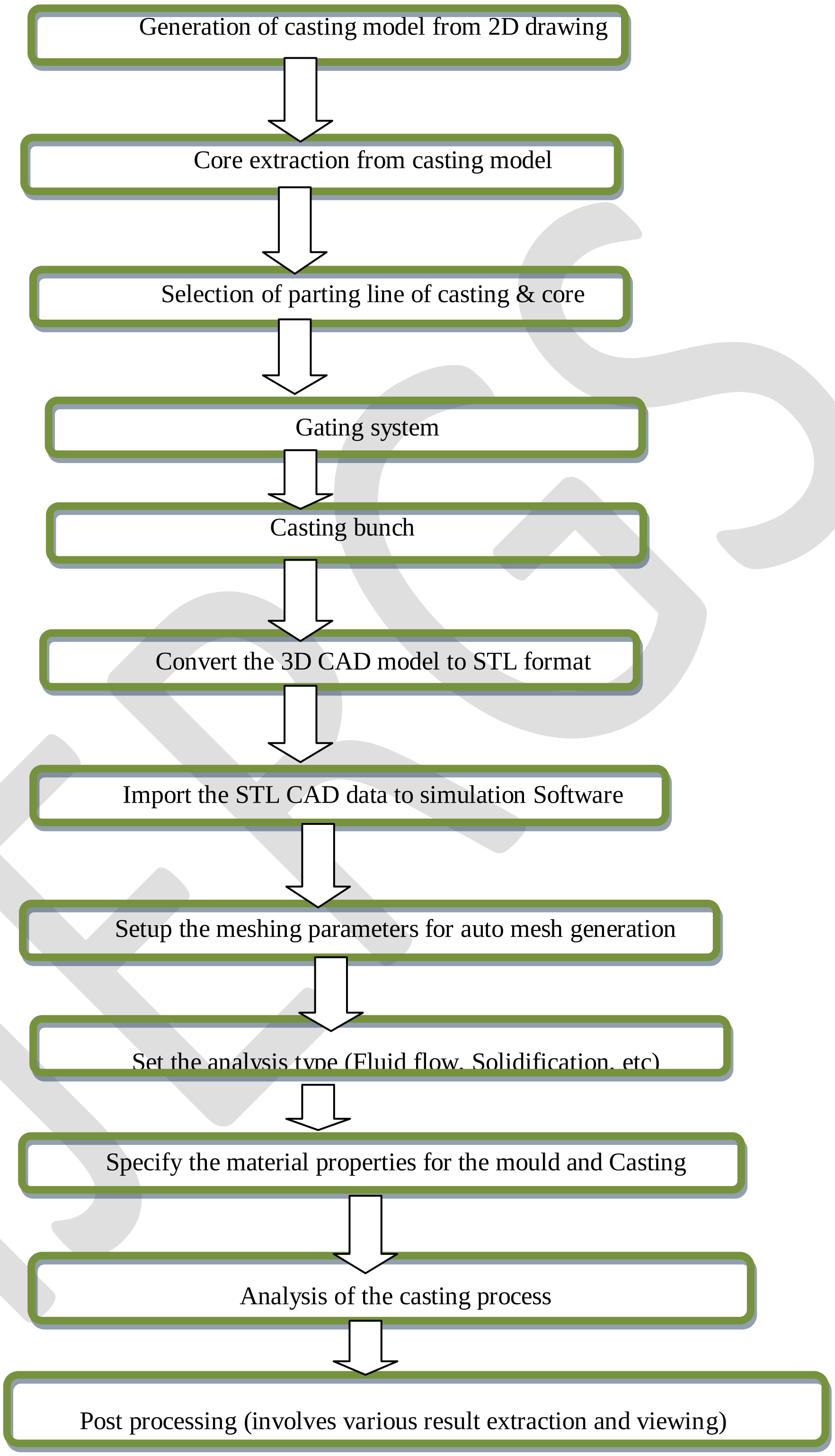


Figure 1. Entire general Process flow of shell moulding process

1.3. Steps involve in casting simulation for shell moulding:



1.4. Gating system & its element for shell moulding process:

Gating system to be designed in a way that there should not be any turbulence in casting cavity while metal entering from gating passage to the casting cavities. The main objective of gating system is too feed the material ensuring uniform, smooth &complete filling.

The importance element of gating system are down sprue, sprue well, runner bar, riser & ingate.

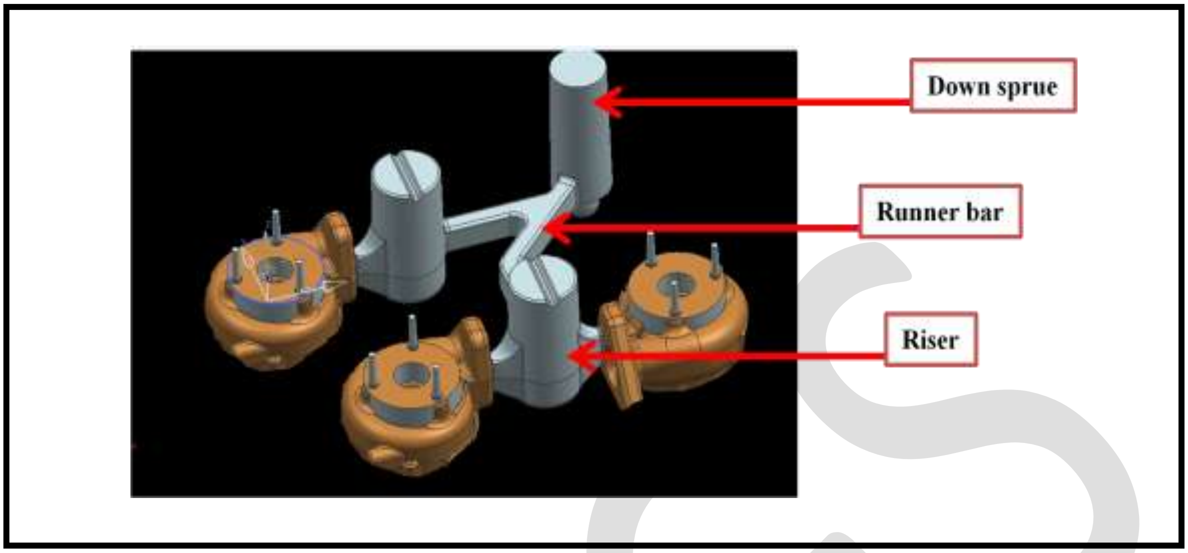


Figure 2. Major elements of gating system

i) Down Sprue - It is a circular cross-section minimizing turbulence and heat loss and its area is quantified from choke area and gating ratio. Ideally it should be large at top and small at bottom.
ii) Sprue well: It is designed to restrict the free fall of molten metal by directing it in a right angle towards the runner. It aids in reducing turbulence and air aspiration. Ideally it should be shaped cylindrically having diameter twice as that of sprue exit and depth twice of runner.
iii) Runner - Mainly slows down the molten metal that speeds during the free fall from sprue to the ingate. The cross section are of a runner should be greater than the sprue exit. It should also be able to fill completely before allowing the metal to enter the ingates. In systems where more than one ingate is present, it is recommended that the runner cross section area must be lowered after each ingate connection to ensure smooth flow.
iv) Ingate: It directs the molten metal from the gating system to the mold cavity. It is recommended that ingate should be designed to reduce the metal velocity; they must be easy to fettle, must not lead to a hot spot and the flow of molten metal from the ingate should be proportional to the volume of casting region.

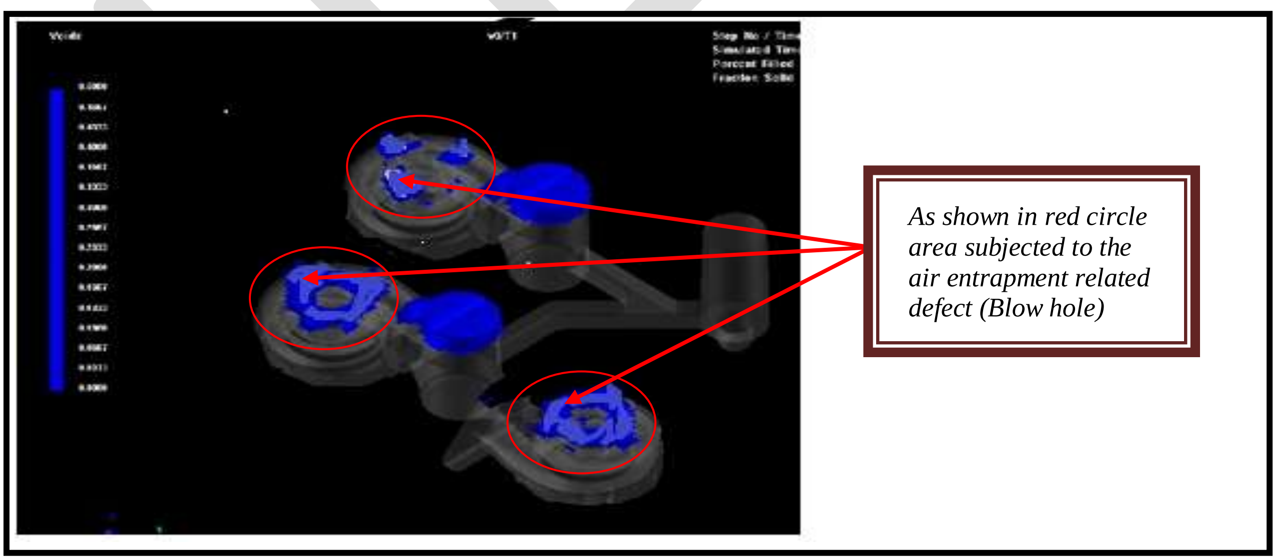


Figure 3. Final stage of air entrapment analysis

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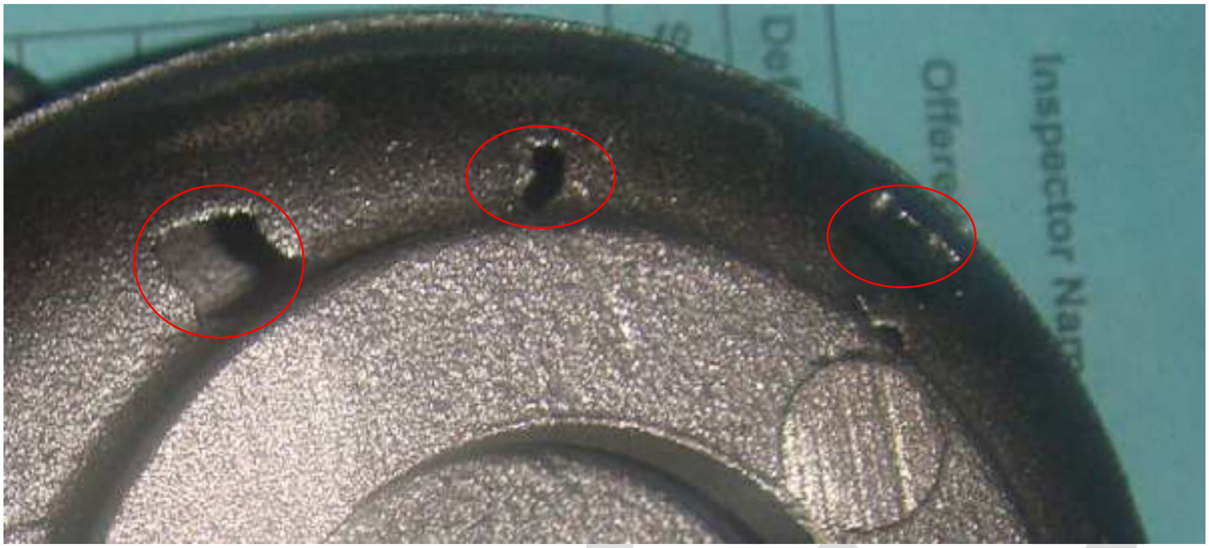

Figure .4 Blow Holes in cast component

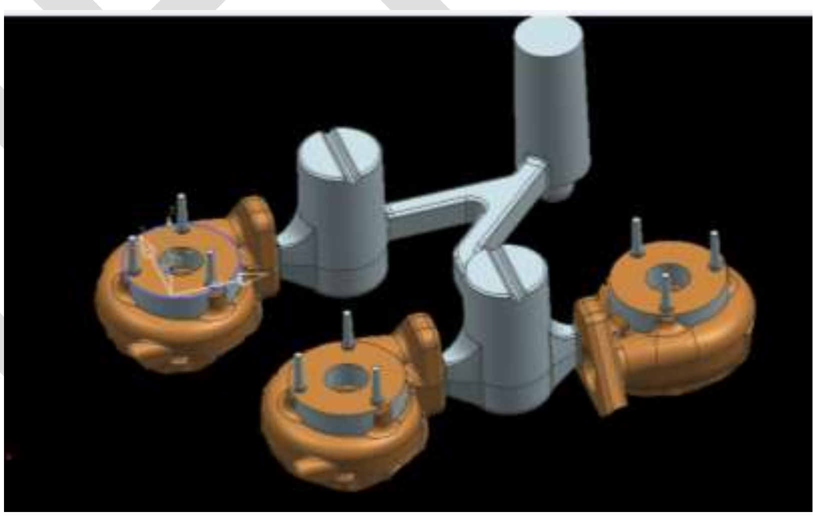

Figure 5. Gating system for 2nd run simulation (Casting, Runner bar, Riser &Down sprue)

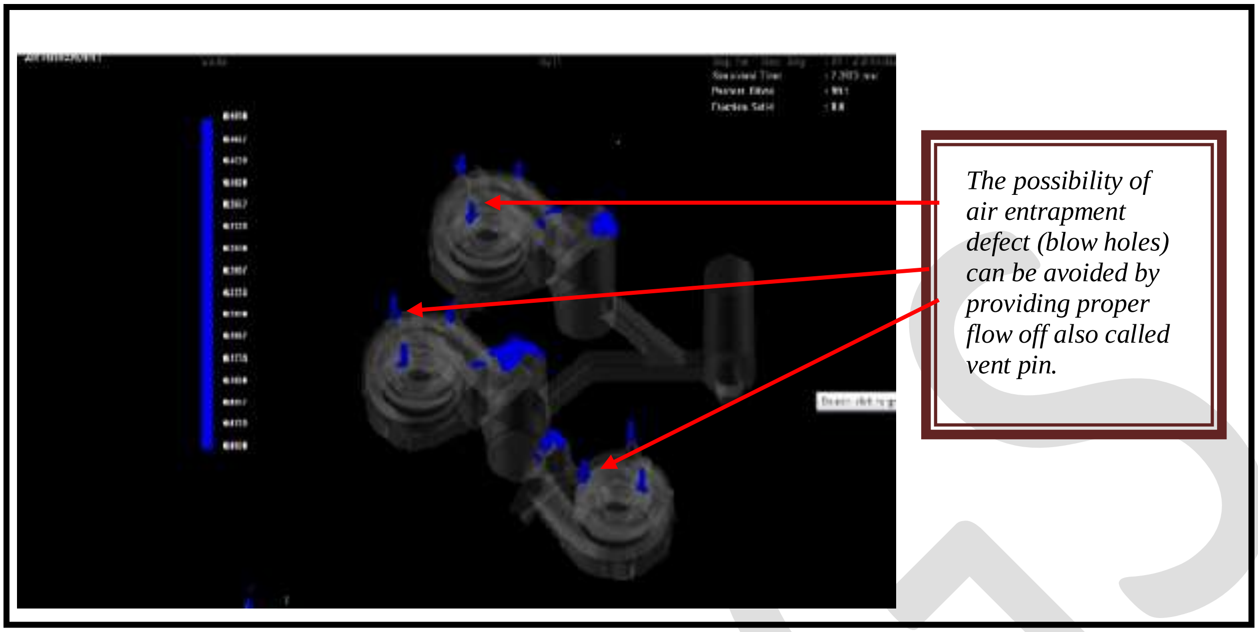

Figure 6. Final stage of Air Entrapment analysis (simulation) after flow off addition.

2. CONCLUSION:

Upper part of the product parts is more likely to have air bubble entrapment defects (Blow hole) because it is filled last, this predictable defect can be avoided by providing proper vents also called flow off. Casting Simulation tool permits foundry development engineers to fill gap between design & manufacturing, improve quality, increase productivity by minimizing number of foundry trials and also analyse prediction of defects & experimenting different gating arrangements. Casting simulation helpful for rapid design & development of castings by significant reduction in development time which is a need of today's foundry industry.

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