International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 02 - Issue 07 || July 2017 || PP. 58-61

Comparative Study of Casting Simulation packages used in Foundries

Jyotiprakash Bhol [1], Madhava Selvan [2], Arun T [3]
(Associate Professor, Department of Mechanical Engineering, PACE Institute of Technology & Sciences, Ongole–523272, India)
(Associate Professor, Department of Mechanical Engineering, PACE Institute of Technology & Sciences, Ongole–523272, India)
(Assistant Professor, Department of Mechanical Engineering, PACE Institute of Technology & Sciences, Ongole–523272, India)

Abstract: To visualize mold filling, predict the internal defects like inclusions and cold shuts casting simulation has found its place. Now a day lots of casting simulations has come up and some are being developed to access way to real casting processes. Those include the melt flow analysis, heat transfer analysis for solidification calculation, mechanical property predictions and microstructure predictions. When this software is simulated with the real situations it gives a clear picture of position and intensity of the internal defects. By correcting these parameters a sound casting can be made. It however, requires a 3D CAD model with all the accessories like cores chills gating system, risers etc. After setting the end conditions like material and pouring and melting temperatures, mold material etc the virtual trial is made and known as simulation which gives different results by which it is possible to rectify the bottlenecks in the casting process. Due to these unforeseen bottlenecks lots of loss is detected in foundries may be small and large. By using AutoCAST software the design simulation is integrated and at the same time it gives an optimized result for the casting design including the feeders, runners and risers layout. This software is also user friendly and easy to use. As the casting is simulated virtually and rectifies the problems of future without any real casting it saves lots of time and money. ConiferRob ® - A pattern less casting technique, originally conceived at VTT Technical Research Centre of Finland and developed at its spin-off company, Simtech Systems, offers considerable saving in processing and product development time. Flow cast developed by VTT and Simtech can find out surface defects in casting and gas entrapment which is a major reason for that by simulation and this can be rectified by optimizing the design. This paper focuses and tries to mix the use of these softwares for a sound casting and emphasize the need new hybrid software to do this job.

Keywords: AutoCast, Casting, ConiferRob, Casting Simulation, Optimization

I. INTRODUCTION

Imitation of real phenomenon using mathematical algorithms by computer is known as simulation. Metal casting is a complex phenomenon generally being compared to lava of volcano and tide of sea.
The important factors of the casting process are to be decided as follows. These are to be optimized for a sound casting.

i. Shape & Dimension of the Casting including complexity of part surfaces, thickness at junctions, cores and bosses which control the molten metal flow and solidification.
ii. The mold layout i.e the sprue design, gate, ingate and runner dimensions and placement, risers and feeder placement which supplies the molten metal and allows the gasses to escape.
iii. Properties of the Casting material like its density, specific heat, thermal conductivity, latent heat, volumetric contraction during solidification, coefficient of linear expansion, viscosity and surface tension
iv. Properties of mold material, external chills thermal conductivity, coefficient of linear expansion, refractoriness and heat transfer coefficient
v. Casting practices and aids like chills, and padding, which are used in complex and intricate casting to help and increase thermal gradient for heat transfer.
vi. Type of flow inside the mold cavity through runners causing mold erosion or not.
vii. Percentage of mode of heat transfer from mold like conduction, convection radiation or mixer of any of the mode and phenomenon of solid state cooling to minimize residual stresses and reduce grain growth.

These problems are verified by the software like AutoCAST, MAGMASoft, ProCAST, and SOLIDCast when simulated and optimized.

II. DESIGN BY AUTOCAST

AutoCAST is used mostly and was developed by Advanced Reasoning Technologies, Mumbai in collaboration with I.I.T. Bombay. Solid modeling of the part mold layout optimization of the features and simulation are included in this software. The cost of the casting produces are also compared and minimized through the said software's Release 10. (Fig.1).

Fig-1 Solid Modeling of the part by AutoCAST

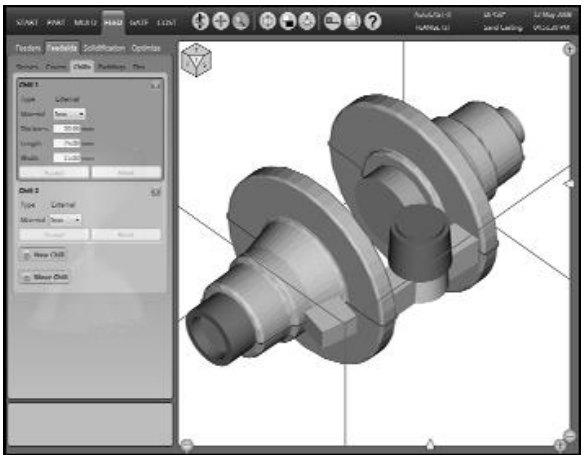

Fig-2 Automatic modeling and Design

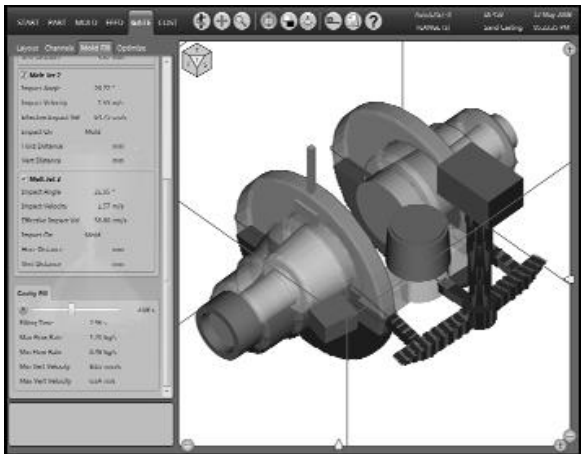

Fig-3 Virtual mold filling through runners

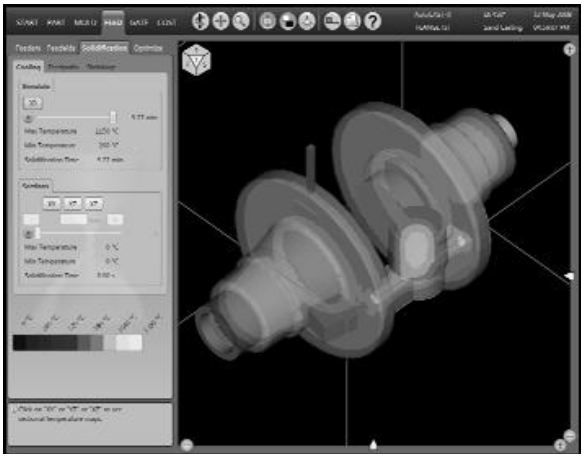

Fig-4 Simulation of Solidification

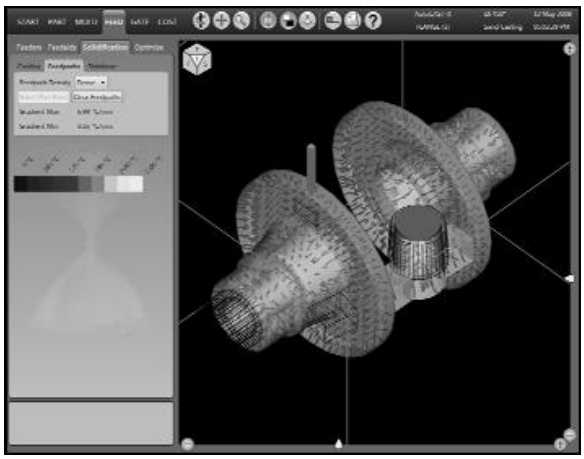

Fig-5 Solidification simulation mesh

Fig-6 Economic Analysis

3D CAD model is made in the software without any allowances or tolerances of cast part (Fig.2) like any drawing software. To ease the design and drawing the software also provide different options like pan, zoom, rotate. Like ANSYS the software has a database of materials of cast metals from where the user is to select. Where the melting point, thermal and physical properties are taken as default according to the material pouring temperature, the junctions of feeders and risers are computed using the modulus principle. The placement of casting aids like chills are pads are the placement of the hottest zone. The standard shape of the feeders like cylindrical, spherical are available to choose from and any new shape can be designed and added in the software.

II. I Automatic optimization of AutoCAST

The main criteria of the casting i.e the mold cavity layout, position and shape of the feeders, number of gates and type of gate are automatically optimized based on quality requirements and other constraints given by the user. The program tries out various combinations of mold sizes and number of cavities to find the combination that is closest to the desired value of metal to mold ratio. The optimization for gating is decided by the pouring time, choke area and minimum wall thickness of the part. Pouring time is important in casting as it may lead to turbulence and thus some defects like mold erosion inclusion will be developed. Slow filling may cause defects related to premature solidification like cold shuts and misruns. To optimize the gating design, mold filling is simulated and total fill time is computed (Fig.4). This is decided by a slicing technology algorithm where instantaneous velocity through the gates and the local cross section of the mold cavity is taken into account. This gives a fairly accurate estimation of filling time.. The user has to indicate a target quality which automatically changes the feeder dimensions, creates its solid model, carries out solidification simulation (Fig.5), and estimates the casting quality. The solidification simulation employs the Vector Element Method, which computes temperature gradients (feed metal paths) inside the casting, and follows them in reverse to identify the location and extent of shrinkage porosity (Fig.6).

III. FLOW- 3D CAST SOFTWARE FOR FOUNDRIES

FLOW-3D Cast ® uses latest 3D CFD (Computational Fluid Dynamics) technique. The fundamental laws of conservation of energy, conservation of momentum heat transfer laws of mass are utilized to control the computation of the software. FLOW-3D Cast ® is divided into different solver modules with increasing capabilities according to the process. It also offers accessory modules for e.g. materials data and designing.

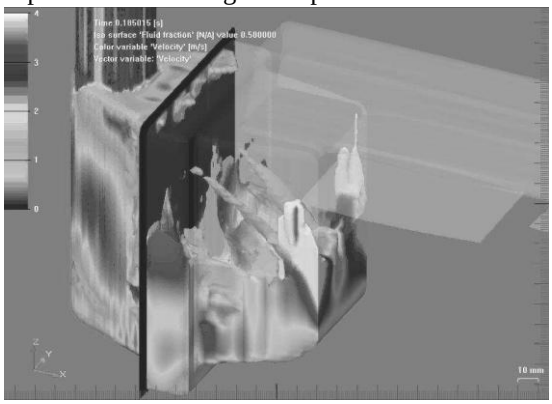

Fig-7 Sheet metal cut

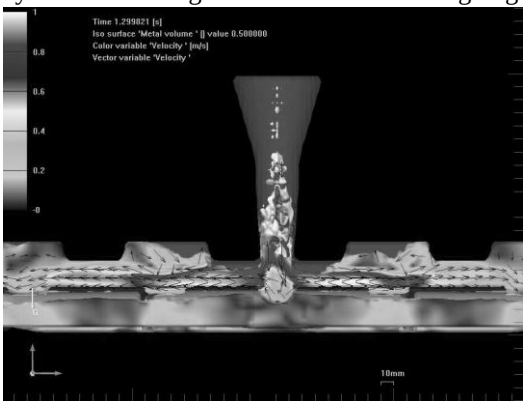

Fig-8 Velocity vectors and air entrainment in the channels

Study of fluid flow through simulation is quite difficult in practice because of its dynamics condition. Due to very high velocity of the molten metal in the casting geometry the calculation are done in meshing structure. These nodes velocity may be converged to have practical solution. This needs foundry knowledge to have simulation. For these reasons, many foundries tend to trust to their empirical knowledge.

Inertia effects may cause splashing, jetting or undesirable filling of the metal flow into mould cavity. When considering complex parts, the accurate prediction of mould filling behavior using only empirical knowledge is virtually impossible.

IV. CONIFERROB-PRECISION CONTROL

Simtech Systems' ConiferRob® precision software fills the process gap between machining path generation systems and generates tool path like STL files from CAD systems. This tool path is fed to a Robot or

a mechanical manipulator to cut out the mold according to the part. This software executes the mold making precisely and quickly saving the manufacturing time.

In addition to optimum accuracy, the positioning of work pieces can also be easily designed and reviewed with the help of ConiferRob .

Manual corrections required if any can be done in the software animation and simulation. The feeders riser are added manually with help of design data and the correctness is checked before execution.

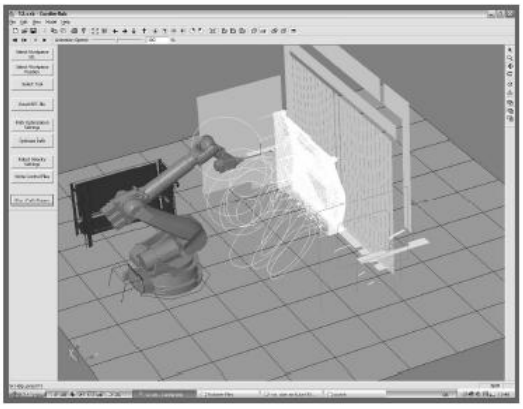

Fig-9 ConiferRob ® programme is used to do robotized machining automatically with high accuracy

Fig-10 Robotic machining of mold of cars tooling frames in Audi

V. CONCLUSION

In AutoCAST software the model is simulated in the software drawing itself. The thermal analysis is been done and optimized results are found regarding dimension of the feeder, riser and the distance from the mold wall. It may be different according to the mold material and process like sand casting die casting etc. The geometries also differ depending upon the part material and pouring temperature. But the software is silent about the accuracy and precision of making a mold from those data which is a real challenge to a foundry engineer. This has been taken care by ConiferRob which finds the cutting path from the solid model and creates a file according to tool path which is utilized to move the Robot to make a mold. This mold is quite accurate to cast the material and also helpful for a sound casting.

In using FLOW 3D CAST the sources of controlling the dimensions are different but it also gives detail report regarding the optimized geometry of the mold and also economical consideration too. This can be used as input data to ConiferRob to find out the tool path and thus machining may be done. These will produce a accurate casting without internal defects. Thus in near future, we will be able to get the castings right first time, every time, in real time.

REFERENCES

[1]. Advanced Reasoning Technologies, AutoCAST Software User Manual and Case Studies, http://www.autocast.co.in, 2009

[2]. B. Ravi (2008) " Casting Simulation and Optimization: Benefits, Bottlenecks, and Best Practices," Technical Paper for Indian Foundry Journal January 2008 Special Issue, 54 (1)

[3]. B. Ravi (1999) "Computer-Aided Casting- Past, Present and Future," Indian Foundry Journal, 45(1), 65-74

[4]. B. Ravi (2007) Metal Casting: Computer-aided Design and Analysis, Prentice-Hall India, ISBN-81-203-2726-8, 4th print.

[5]. B. Ravi and Durgesh Joshi (2007) "Feedability Analysis and Optimization Driven by Casting Simulation," Indian Foundry Journal, 53(6), 71-78.

[6]. Sirviö, M. and Martikainen, H (1995) "Simultaneous engineering between workshops and foundries" Int. Conf. on Best Practices in the Production, Processing and Thermal Treatment of Castings. Singapore.

[7]. Sirviö, M . and Louvo, A (1994) "Use of simulated porosity for avoidance of casting defects". International GIFA Congress Metal Casting '94 (GIFA '94). Dusseldorf, 15 - 18 June 1994. German Foundrymen's Association.

[8]. Sirviö, M . and Louvo,(1994) "Casting directly from a computer model by using advanced simulation software FLOW-3D Cast" archives of foundry engineering ISSN (1897-3310) Volume Issue 79 – 82