Casting Simulation Software – Applications and Benefits

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Abstract:

Casting simulation helps visualize mold filling and casting solidification. It predicts related defects like shrinkage, porosity and hard spots and optimize the casting design to achieve the desired quality with high yield. Flow and solidification of molten metals is very complex difficult to simulate correctly by conventional techniques. For industrial application, we need an alternate approach that is fast, reliable and user-friendly. In this paper emphasis is given on the casting tools which help the foundry engineers to decide the better simulation software.

Keywords:

Casting, Simulation, optimization, mold filling, casting softwares

Introduction:

Simulation is the process of imitating areal phenomenon using a set of mathematical equations implemented in a computer program. A complete and physically accurate simulation of metal casting process is very difficult. The important to develop a practically useful simulation program is to determine the most important factor. Some of the well-known casting simulation programs currently discussed [1].

The main inputs for the casting simulation process are:
 (a) The geometry of the mould cavity (3D model of the casting, feeders, and gating channels).
 (b) Thermo-physical properties (density, specific heat, and thermal conductivity of the cast metal as well as the mould material, as a function of temperature).
 (c) Boundary conditions (i.e. the metal mould heat transfer coefficient, for normal mould as well as feed aids including chills, insulation and exothermic materials).
 (d) Process parameters (such as pouring rate, time and temperature).

Methodology:

Figure1 shows a flowchart, in which 3D CAD and simulation tools are utilized to improve the system design of the casting[2].
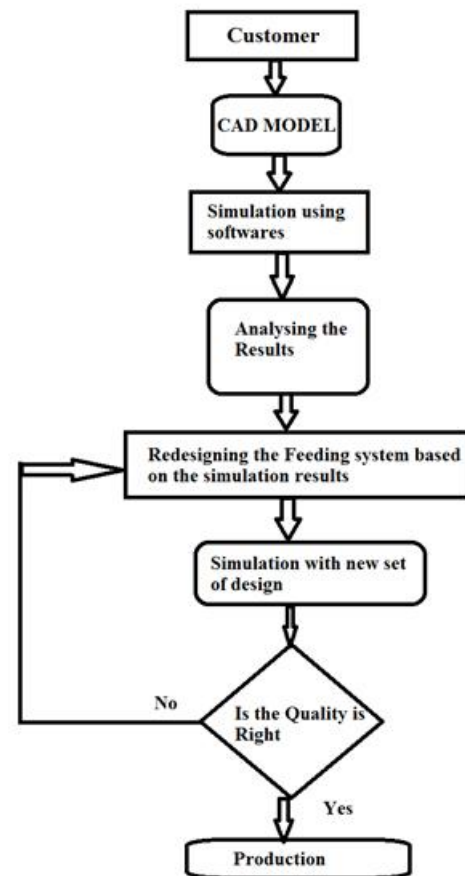

Figure 1: Shows a flowchart of a design process, in which 3D CAD and simulation are used by the foundry.

From table 1, it introduce us the casting simulation software which are used in foundry. It helps us in many ways especially the mold filling time and solidification time[3].

Table 1: List of casting simulation software's:

Sl. No	Name of casting software
1	SUTCAST
2	ProCAST&QuikCAST
3	FLOW-3D
4	MAGMASOFT

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A Monthly Peer Reviewed Open Access International e-Journal www.ijmetmr.com

Page 346

5	SOLIDCast
6	OPTICast
7	FLOWCast

Casting simulation software's:

In this section, the details of the casting simulation software's are explained thoroughly. So that it may help the foundry engineers to choose the right software for right applications [4-6].

(i) SUTCAST:

It is one of the most powerful and user friendly tools for visualizing, modeling, analyzing, and optimizing every foundry process. The software simulates the molten metal of any casting alloy into sand or permanent molds. The software developed to accurately simulate the entire casting process and provide quick and reliable solutions to casting problems for any casting process and material needs. It provides mainly the Solidification Simulation and Mold Filling Simulation.

(ii) ProCAST & QuikCAST:

It is a complete solution allowing predictive evaluation of the entire casting process including filling and solidification defects, mechanical properties and complex part distortion. It enables rapid visualization of design changes and allows for correct decision-making at an early stage of the manufacturing process. Using this software we can model the casting defects which are shown in table 2.

Table 2: Shows the casting defects which can be simulated using ProCAST and QuikCAST

(iii) FLOW-3D:

It consists of a full flow and thermal solution for both the cast alloy and the die or mold, providing detailed insights into the flow characteristics of a simulated casting. It can also enable modelers to save unnecessary development costs when deploying new casting processes or alloys.

(iv) MAGMASOFT:

It provides cutting-edge solutions that meet the needs of casting producers. Casting simulation is the standard accepted for designing the casting process before producing expensive moulds or patterns.

Use of this casting simulation will keep casting producers competitive & profitable. With this software the casting process from filling to solidification is simulated. Foundries relying on this simulation tool can have the advantage of the latest casting process design technology that calculates residual stresses, metallurgical prediction improves quality, reduces lead times and cost.

(v) SOLIDCast:

It is the world's most popular metal casting software & solidification modelling software. The casting simulation software offers accuracy, ease of use and power.

Benefits of this software are listed below:

- It can simulate thermal changes caused by heat transfer in the solidification process of casting
- Visualize the solidification of casting process of a particular cast using this casting design simulation program.
- It can detect defects that might occur during the casting process.

(vi) OPTICast:

It is a casting optimization module which simulates the casting design process, giving more accurate results in molding and solid casting. It works in integration with SOLIDCast and provides an automatic casting design solution to engineers. Itanalyzes the size and properties of riser and gating components.

(vii)   FLOWCast:

It is yet another exciting module which works with SOLIDCast to simulate the flow of molten metals when they are poured into the cast. This allows engineers to visualize how different processes like conduction, radiation and cavity filling work together to produce the final product. The software uses Computational Fluid Dynamics technology to simulate the flow of molten metal through cavities and casts to analyze how the metal will solidify. The mold filling simulation software can be used with any kind of casting, including investment casting, iron casting, copper castings, aluminum sand casting as well as steel sand casting. This software comes with two modules for modeling mold filling:

INTERNATIONAL JOURNAL & MAGAZINE OF ENGINEERING, TECHNOLOGY, MANAGEMENT AND RESEARCH   October 2014
A Monthly Peer Reviewed Open Access International e-Journal www.ijmetmr.com

Page 347

(a) Quick Simulation – This is a relatively fast process which can be used in the initial stages of a project, as it helps industry engineers to simplify assumptions and simulate the mold filling process in a short amount of time.

(b) Full Simulation – The fill simulation feature of FLOWCast uses Computational Fluid Dynamics to calculate the fluid flow in different casts. The final output can be viewed from any angle and is computed based on a number of factors, including progressive temperature, fluid velocity and fluid pressure.

Literature Review:

There were lot of research work had been done oncasting simulation by using different casting simulation software's. The literature review is mainly focusing on design and optimization technique based on casting related defects and their research and outcomes. Ravi and Joshi [7] orked on computer-aided casting design and simulation of feeder and gating design of castings using Auto-CAST software and they describe how it assists in designing, modeling, simulating, analyzing and improving cast products. Bhatt and Barot[8] suggested that the design optimization of feeding sys-tem and simulation reduced the casting defects of cast iron in foundries, which arose during solidification and mold filling. In casting processes most important is to change riser and gates dimensions and simulate with the help of Auto-CAST software. The simulation got shrinkage and reduces hot spots and cracks in gear box of automobile components.

Masoumi et al. [9] suggested the effect of gating design on mold filling for light metal casting processes. The validation results showed that the design and shape of the gate and the ratio of the gating system have a great influence on the pattern of mold filling. Hassan et al. [10] investigated the impeller shaped casting using MAGMASOFT Software. The effect of riser and gates on parameters, such as filling pattern, pressure and speed, cooling rate, solidification and related defects, was studied. Choudhari et al. [11] suggested that by optimization method cast-ing related defects can be improved. The proper location, size and design of gating and feeder system using simula-tion technology improved the shrinkage porosity and cracksin casting.

Sun and Su [12] suggested the numerical simulation technique, parameters of gating and riser for a magnesium alloy casting with multiple analysis characteristics in magnesium alloy base casting to analyse the effect of various gating system designs on cavity filling and casting quality using MAGMASOFT simulation software; satisfactory results were obtained with high yield and reduced shrinkage porosity. Sutaria [13] worked on a new idea where optimization of casting feeding is done with the help of feed-paths. The computation of feed-paths is done by the method known as vector element method (VEM).

Benefits of casting simulation:

The main uses for using different casting simulation software's are below:

- Energy savings
- Improved product quality
- Less remelting and refinishing
- Shortened lead time & increased production
- First Time Right
- Predicting Metallurgy

CONCLUSION:

Casting simulation technology become a powerful tool for casting defect troubleshoot in and method optimization. It will reduce the lead time for the sample casting; improved productivity and knowledge of software's can be maintained for future use and for training new engineers in foundry. By using casting simulation software's one can avoid conducting trials on computers.

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Page 348

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Page 349