Multiphysics CAE Simulations of Casting Process for First Time Right Product Development

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Abstract

Casting is a very old and common manufacturing processes used to produce complex components with lower costs. USA and India are among the top and largest casting producer. Casting of ferrous, non ferrous, Aluminum Alloy, graded cast iron, ductile iron and Steel materials are used for automobiles, railways, aerospace and industrial applications. In a casting process, liquid material is usually poured into a mould of the desired shape, and then allowed to solidify. Casting product performance depends on the, material, flow, Process Temperature, Solidification, Shrinkage and residual stress. In a casting process, not all available resources are utilized effectively which results in low quality of casting, defects and metal wastage. Physics based modeling is increasingly used to optimize product performance, improve quality and reduce defects of casting products.

In this paper, phase change solidification process of alloy wheel is investigated for process performance and optimization.
Figure 1 shows the solid model of the alloy wheel. During casting process, liquid melt is poured into the mould. The flow process is fast, however, the solidification process is complex. Hence, a simplified, 2D axisymmetric model is considered for this investigation of liquid metal solidification due to process parameters. Heat Transfer Module of COMSOL Multiphysics software with Phase change physics is used. In the casting process of alloy wheel, a significant amount of latent heat is released during the phase transition process. The location of the transition front between the molten and solid state is a strong function of the casting flow and the cooling rate in the mould. A transient simulation was performed to study solidification process over time. Figure 2 and 3 shows, typical contour plots of liquid solid transition phase and temperature profile at 15 and 60 seconds, respectively. These investigations will be further used to predict the properties profile of the casted parts. A correlation between process parameters and final part property will be established. Coupled flow, heat transfer and phase change solidification process modeling of casting process will enable first time right casting product development.

Reference

1.Rajkolhe R and Khan J G, Defects Causes and Their Remedies in Casting Process: A Review, International Journal of Research in Advent Technology, Vol.2, No.3, March 2014

Figures used in the abstract

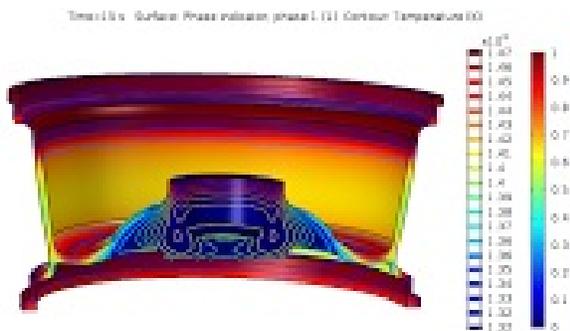**Figure 1**: 3D model of the casted aluminium alloy wheel.

Figure 2: Transient Contour plot of liquid solid transition phase and temperature profile at 15 s.
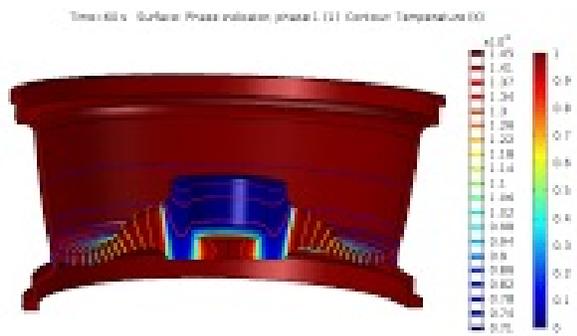
Figure 3: Transient Contour plot of liquid solid transition phase and temperature profile at 60 s.