Solidification Simulation Approaches and Their Application for Shrinkage Porosity Prediction

Prof. Durgesh Joshi

Durgesh Joshi[1], Mayur Sutaria[2], Vasudev Shinde[3]

[1] SGS Institute of Technology & Science, Indore

[2] Charotar Institute of Technology, Changa, Gujarat

[3] DKTE's Textile & Engg. Institute, Icharkaranji

Email : djoshi@sgsits.ac.it

Abstract

Casting solidification simulation assists in identifying potential locations of shrinkage porosity defects. This is useful for optimizing the feeding system design considering quality and yield. In this paper, two different solidification simulation approaches: Finite Difference Method (FDM), and Vector Element Method (VEM) are described and compared. Simulation using FDM involves computation of temperature history driven by Interfacial Heat Transfer Coefficient. On the other hand, VEM is based on determining the convergence of thermal gradients, given by the vector sum of flux vectors in all directions. The results of both methods are compared and validated by an experimental benchmark casting in cast steel (0.2% C). It was found that both methods could predict the location and extent of shrinkage defect. The VEM, however, required fewer inputs, and took less than 10 % of the time taken by FDM, making it more suitable for implementation in the industry.

Excerpts from the Paper

A benchmark casting as shown in Fig. 1, consisting of two similar parts with different wall thicknesses (overall size 120 mm x 90 mm x 60 mm), but without a feeder (to predict shrinkage location by simulation) was produced in cast steel using conventional sand casting process. Simulation study on this casting was also carried out by two different methods – SOLIDCast, an FDM based programme; and AutoCAST, a VEM-based programme. Details about these and the simulation results using different mesh sizes are given in the paper.

The authors have concluded that : In terms of accuracy of prediction, user inputs and time taken, the two methods SOLIDCast and AutoCAST were compared.

- Both methods were found to be able to predict the shrinkage defect fairly accurately.
- The FDM required more user inputs, as well as more time for computing the results, compared to VEM, for similar mesh size.
- For mesh size of 5 mm VEM required less than one tenth of the time as compared to FDM.
- For smaller mesh size, VEM performs even better than FDM.

The FDM can be extended to mould filling phenomenon, important in casting processes involving rapid solidification, such as thin walled investment casting, and pressure die casting. The VEM is more suitable for gravity casting processes, and is more user-friendly.

The investigators are at present based in three different institutions located at three different centres, Indore (M.P.), Changa (Gujarat) and Ichalkaranji (Maharashtra).

This hints that slowly, but steadily, the knowledge and insight in this field is percolating in foundries in different parts of India.

Catalytic actions are now needed to accelerate this growth, and at the same time improve understanding of simulation technology among foundrymen.