Application of local RBF collocation method to prediction of mechanics-related casting defects during DC casting of aluminium alloys

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ABSTRACT

Direct chill casting is widespread technology for casting of aluminium billets and slabs, which are further used for extrusion. Achieving high quality of the product is difficult since the thermomechanical phenomena that occur during DC casting of aluminium billets can have a significant impact on the quality of the ingot mainly because of hot tearing and cracking which can occur under specific stress conditions [1].

A meshless local collocation method using radial basis functions has been developed to model the thermomechanical phenomena [2], [3]. The model uses elastic-viscoplastic model to describe the inhomogeneous material below the coherency isotherm. The model is coupled with the results of the fluid flow model [4]. Its results are used to determine the computational domain, calculate the thermal strain, and in the formulation of hot-tearing criteria.

Two criteria are used to predict hot tearing: the Lahaie -Bouchard criterion [5], which determines the force to separate two grains bound by liquid film, and the Suyitno-Kool-Katgerman criterion [6], which determines the rate of void growth and uses Griffith theory of brittle fracture to predict the initiation of tears.

In this contribution, we present the model and its implementation along with a sensitivity study of hot-tearing criteria on process parameters. The presented model is the first application of local radial basis function collocation method to describe such a complicated multi-physics problem in viscoplasticity.

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