عنوان مقاله:

Numerical Modeling of Macrosegregation in Direct-Chill Casting of Al-Cu Billets

محل انتشار:

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خلاصه مقاله:

Macrosegregation has been in focus of the solidification modelling studies, more specifically in direct-chill casting of Al-Cu billets. Nonetheless, it is not straightforward yet to discuss or predict how alloying elements will distribute in a casting billet. Mathematically, an important challenge is how to keep temperature and composition fields linked together as thermodynamics suggest, while temperature and composition are separately defined through heat and solute mass transport equations. In the current work, a two-phase mathematical model of mass, momentum, energy andspecies transport was formulated for the mixture of liquid and solid in an axisymmetric solidifying billet in a practical scale DC caster. The fluid dynamics of the problem involved thermosolutal convections, shrinkage flow through mushy solid and floating dendrites in slurry liquid in the mathematical model to contribute to the evolution of macrosegregation in results. An already proposed model called SIMTLE was employed for three-phase eutectic Al-Cu alloy, and then implemented to link the temperature and composition fields for calculation of mass fractions and compositions of the phases. The solution methodology was based on a standard CFD routine plus the proposed algorithm of SIMTLE.Measurements were performed on an industrial scale caster and obtained experimental data were used to verify calculated macrosegregation patterns. Results have been illustrated as distributions of temperature and composition, flow patterns, relative movement of liquid/solid and macrosegregation profiles. With reasonable agreements in validations, the results have been discussed giving an insight into solidification dynamics and macrosegregation mechanisms.

کلمات کلیدی:

Macrosegregation, Modelling, Solidification, Direct Chill Casting, Aluminium Alloys, Phase diagram