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Abstract

"Evolution of the chemical composition and model of growth non-metallic inclusions in liquid steel with yttrium content"

This paper is devoted to the issue of generation and growth of nonmetallic inclusions under the influence of yttrium alloy additive to steel. When dosing yttrium one may expect low yttrium losses being a consequence of the precipitation processes taking place in the presence of sulphur and oxygen. Accordingly, these components and the order in which they are introduced decide about the final yttrium content in steel in dissolved and in bounded form in the precipitation phase. For the sake of determining the amount of the forming nonmetallic phase in liquid steel there was used a FactSage computer program. The kinetics of deoxidization and desulphurization was analyzed with the aid of a non-commercial program based on the worked out models. The process was analyzed in view of the order in which the additives: Y, Al, Ca were introduced to preliminarily deoxidized steel. The analysis of obtained chemical compositions of nonmetallic phase reveals that complex bi - component nuclei can be formed, i.e. oxide/oxide and oxide/sulfide. The growth of the nuclei was stimulated with the use of own computer program based on the proposed mathematical model. When aluminum is introduced to the liquid metallic bath before yttrium, then nonmetallic oxidic inclusions are generated. In both cases they have a strong tendency to agglomerate. The agglomeration effect was analyzed for various mixing conditions in the liquid metallic bath with the PSG method and population balance equation. The deoxidization and modification processes were experimentally analyzed in strictly controlled conditions. The samples collected during the steel refining process exhibited varying morphology and evolution of the shape of generated inclusions being a consequence of amount of oxygen and magnitude of oversaturation. There were identified complex aluminum oxide inclusions in the form of clusters. Then calcium was introduced, i.e. a typical modifier used in steel metallurgical processes. The tests were repeated for yttrium as an additive – a laboratory casting process was realized. Yttrium played the role of an alloy additive and also modifier of sulphur nonmetallic inclusions.