Preliminary Investigation of Mathematical Modeling of Stainless Steelmaking in an AOD Converter: Mathematical Model of the Process

Steel Research Int., 78 (2007) No. 4, 305-310, DOI: 10.2374/SRI06SP134-78-2007-305

Zhu, H., Wei, J.-H., Shi, G., Shu, J., Jiang, Q., Chi, H.

Department of Metallic Materials, College of Materials Science and Engineering, Shanghai University, Shanghai, 200072, P. R. China

Mathematical modeling of stainless steelmaking in an AOD (argon-oxygen decarburisation) converter with the side and top combined blowing has been preliminarily investigated. The actual situations of the side and top combined blowing AOD process were analysed. A mathematical model for the whole refining process of stainless steel has been proposed and developed. The model is based on the assumption that one part of the oxygen blown through a top lance reacts with CO escaping from the bath, another part of the oxygen oxidizes the elements in the molten steel droplets splashed by the oxygen jet, and the remaining oxygen penetrates and dissolves into the molten steel through the pit stroked by the jet. All the oxygen entering into the bath oxidizes C, Cr, Si, and Mn dissolved in the steel and also the Fe of the steel melt, but the FeO generated is also an oxidant of C, Cr, Si, and Mn in the steel. During the process, all the possible oxidation-reduction reactions occur simultaneously and reach their equilibria, respectively their combined equilibrium, in competition at the liquid/bubble and liquid/slag interfaces. In the simple side blowing after the top blowing operation is finished, the possible reactions take place simultaneously and reach a combined equilibrium in competition at the liquid/bubble interfaces. The overall decarburization rate in the refining process is the sum of the contributions of both the top and side blowing processes. It is also assumed that at high carbon concentrations, the oxidation rates of elements are mainly dependent upon the supplied oxygen rate, and at low carbon contents, the rate of decarburisation is primarily related to the mass transfer of carbon from the molten steel bulk to the interface. It is further assumed that the non-reacting oxygen blown into the bath does not accumulate in the steel and will escape from the bath and react with CO in the atmosphere above the bath. The study presents calculations of the refining rate and the mass and heat balances of the system for the whole process. Additionally, the influences of the operating factors, including addition of slag materials, scrap, and alloy agents, the non-isothermal conditions, the changes in the amounts of metal and slag during the whole refining process, and others have all been considered.

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