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Commentary

Challenge and progress of process technology and fundamental research for the promotion of lime dissolution into slag

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In order to improve the productivity and efficiency of steel refining process, the promotion of lime (CaO) dissolution is quite important issue, which retardation would be one of the rate-controlling steps of total converter process. Recent years, many innovative refining processes have been invented which enables rapid removal of impurity elements such as phosphorus, sulfur and oxygen[1].

On the other hand, we should well consider the dissolution mechanism even more to evaluate the dissolution time of lime into molten slag. During this dissolution, $2CaO \cdot SiO_2$ is considered to once form on the surface of lime lump and to dissolve into molten slag. The second step of this phenomena, dissolution of $2CaO \cdot SiO_2$, would be controlling the total dissolution rate; thus, this study is focused on the dissolution rate of $2CaO \cdot SiO_2$ into molten $CaO\text{-}FetO\text{-}SiO_2$ slag which has been investigated by the diffusion experiments between $2CaO \cdot SiO_2$ rod and molten $CaO\text{-}FetO\text{-}SiO_2$ slag .

The difficulty lay in the determination of diffusion coefficient of each oxide component. Since the cylindrical crucible has been employed as the container and cylindrical rod of $2CaO \cdot SiO_2$ has been immersed, un-steady state diffusion equation should be solved in the cylindrical coordinate; however, the simplification could be comprehensively made by the application of the equation in cardinal coordinate to enable effective determination of the diffusivities of oxide component assuming the pseudo-interdiffusivity between molten slag system and each oxide. The diffusivity of CaO obtained to have the range from 4.9 × 10-7 to 4.7 × 10-5 cm^2/s at temperatures from 1573 to 1673 K leads to the estimation of complete dissolution time of lime sphere having the diameter of 1 cm to be in the order of 104 s which will be significantly reduced by an increase in flowing velocity of slag and temperature, both of which are important parameter to decide the operation time of this converter refining.

Such kind of studies on the thermos-physical properties have been paid growing attention in viewpoint of significance as processing parameters in the practical operation of Lime Dissolution processes nowadays. Through many years, a great number of thermodynamic studies regarding chemical equilibration has been extensively made such as slag-metal reaction, deoxidation equilibria and phase diagrams. They have greatly contributed the productivity and property improvement of Lime Dissolution because liquid-liquid reaction has great expectancy to reach the equilibrium state under the strong stirring condition. However, mass, heat and momentum transfer also would play controlling roles in the sequence of real Lime Dissolution operation. This work has been done from this point of view that the diffusivity determines the mass transfer phenomena which would control the bottle neck process such as lime dissolution, which might be conjugated with heat transfer through the formed layer of $2CaO \cdot SiO_2$ to guarantee the heat supply necessary for the smooth progression of lime dissolution. Further work will be expected on how to substantially couple these thermo-chemical properties to totally evaluate the final state and processing time of lime product processes.

REFERNCES

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