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Mathematical Modelling of Slag Phase Composition during the EAF Process in Stainless Steelmaking

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Contemporary stainless steelmaking is based predominantly on the duplex route, consisting of an electric arc furnace (EAF) followed by argon–oxygen decarburisation (AOD), or on the triplex route, in which EAF and AOD processing is followed by vacuum–oxygen decarburisation (VOD). Raw materials strongly influence slag chemistry in the EAF, and therefore understanding the properties and evolution of EAF slag during processing is essential both for optimizing slag practice and for enabling downstream utilization of the slag. Recently, an EAF process model developed at the University of Oulu was extended with a metal–slag reaction module that describes mass-transfer-limited metal–slag reactions in stainless steelmaking, i.e., under conditions without foamy slag. The metal–slag kinetics are based on the effective equilibrium constant approach, which extends boundary-layer theory to systems involving several competing oxidation and reduction reactions. However, this approach can predict only the chemical composition of the slag and not the formation of potential solid phases. This paper presents a one-way coupling of the process model with computational thermodynamic software and demonstrates its application for calculating the evolution of slag phase composition throughout the EAF process in stainless steelmaking. The resulting phase-structure predictions provide valuable insights for slag practice in stainless steelmaking.

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