Phase Relations in Stainless Steel Slags

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ABSTRACT

Computational thermochemistry is an important research tool for high-temperature materials processing. In stainless steel-making, it proves to be a useful tool both for process improvement and slag reutilisation. Thermodynamic databases allow to calculate phase diagrams, complex phase equilibria, solidification sequences and much more. Although they can provide good approximations from a limited amount of data, the databases can only be as correct as the experimental data they are based on. Therefore, concurrently with model optimisation, it remains important to determine phase diagram data and thermodynamic data experimentally.

In this work the high temperature phase relations of stainless steel slags and their subsystems are studied. In a first part, the principles of both modelling and experimental determination of oxide phase diagrams are discussed. The available thermodynamic models for the multicomponent system CaO-CrOx-MgO-Al_2O_3-SiO_2, which contains the major oxides present in industrial slags, are reviewed and the experimental studies on the ternary subsystem CrOx-MgO-SiO_2 are summarised as well.

In the second part, new experimental and theoretical work is discussed. First, an experimental method to study liquidus-solidus relations in the system under investigation is proposed. Equilibration, sampling and microprobe analysis are the different steps to determine the equilibrium phase compositions.

Next, the experimental results in the CaO-CrOx-MgO-Al_2O_3-SiO_2 system are discussed. Systematic differences between FactSage calculations and experimental data are observed, which appear to be a result of incomplete ternary descriptions, especially in the CrOx-MgO-SiO_2 system.

Therefore, this system is studied experimentally for oxygen partial pressure levels ranging from air to Cr metal saturation. Finally, an improved description of the CrOx-MgO-SiO_2 system is proposed, based on literature data and new results. Although some disparities remain, the new description provides better results in the ternary system, and, moreover, in the higher order system.