PHOSPHIDE CAPACITIES OF FERROMANGANESE SMELTING SLAGS

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DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

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(Signature of candidate)

____________________ day of ________________________ 2007

ABSTRACT

Factors influencing the equilibrium phosphorous distribution, Lp, and phosphide capacity, C_P^{3-}, of ferromanganese smelting slags in highly reducing atmospheres were studied in this research work at 1500°C (1773°K). The research work seeks to extend the concept of slag capacities to submerged electric arc furnace operations used in the production of ferromanganese alloys. The concept of slag capacities has been used fairly widely in the steelmaking industry particularly in ladle technology processes to control various impurities including sulphur and phosphorous.

Equilibrium experimental runs were conducted in graphite crucibles under two different atmospheres, CO and Ar/CO mixture at 1500°C. The resultant partial pressure of oxygen in the two atmospheres was 1.223×10^{-16}atm. and 7.826×10^{-19} atm. respectively at 1500°C. The compositions of the slag samples were determined using the extreme vertices design method for mixture experiments. The composition of ferromanganese slag samples was in the following range, MnO 5-10 wt. %, SiO_2 36-54 wt. %, CaO 18-36 wt. %, P_2O_5 1-4 wt. %, and Al_2O_3 and MgO were fixed at 5 wt. % and 10 wt. % respectively. Three types of alloy samples were made and their composition was in the following range Mn 70-85 wt. %, Fe 6-18 wt. %, Si 1.5-4.5 wt. % and C was fixed at 7.5 wt. %.

The analytical results of the final equilibrium slag and metal samples were used to calculate the equilibrium phosphorous distribution ratios, Lp, and these were used in turn to calculate the slag C_P^{3-}. The results for Lp, and C_P^{3-}, were further used to derive empirical models to predict Lp and C_P^{3-} as functions of slag composition using statistical modeling. Graphs were compiled to determine the effect of varying the slag composition on Lp and C_P^{3-} parameters. Increasing the SiO_2 content in the slag reduced slag basicity which led to a decrease of the slag Lp and C_P^{3-} parameters. Increasing the slag basicity under both atmospheres led to an increase of both Lp and C_P^{3-}. Increasing slag CaO content, a basic oxide, led to an increase in both Lp and

C_P^{3-} parameters of the slag. The ferromanganese slag Lp and C_P^{3-} parameters decreased with a reduction of Po_2 in the controlling atmosphere. Therefore an overall increase in slag basicity resulted in an increase of Lp and Cp^{3-} under both atmospheres. An overall decrease in slag basicity resulted in a decrease of Lp and Cp^{3-}.

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