Study of the chromium recovery process from the system CaO-SiO_2-Cr_2O_3-FeO-MgO-MnO-Al_2O_3 silicon ferrosilicon by thermodynamic modeling

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Abstract

The results of thermodynamic modeling to the elements recovery process from the oxide system of the following composition, % mass: 25 CaO; 25 SiO_2; 25 Cr_2O_3; 5 FeO; 14 MgO; 3 MnO; 3 Al_2O_3 silicon ferrosilicon FeSi45 (45% Si; 55% Fe) and FeSi65 (65% Si; 35% Fe) are given. The HSC Chemistry 6.12 software package developed by Outokumpu Research Oy (Finland) was used for the simulation. Thermodynamic modeling was carried out for 3 compositions of the oxide system, differing in the content of CaO (25-37.5%) and SiO_2 (12.5-25%), i.e. basicity. The calculations were performed using «the Equilibrium Compositions» module in the temperature range of 1500-1700 °C and the consumption of reducing agent 110% from the stoichiometrically necessary for the reduction of iron, manganese and chromium and the pressure of the gas phase 1 atm. The results of the calculations are presented in the form of graphical dependences of the change in the degree of chromium reduction (η_{Cr}) on temperature (t) and basicity (CaO)/(SiO_2). It established that increasing the process temperature from 1500 to 1700 °C reduced the degree of chromium reduction by 11.4% (from 77.2 to 68.4%) with slag basicity (CaO)/(SiO_2) equal to 1 and FeSi45 reducing agent, and using FeSi65 by 12.4% (from 80.5 up to 70.2%) with other things being equal. The effect of slag basicity on the degree of chromium reduction at a temperature of 1600 °C was studied. It is shown that an increase in slag basicity from 1 to 3 contributed to an increase in the degree of chromium reduction. The degree of chromium reduction increased by 14.2% (from 74.4 to 86.7%) when used as a reducing agent FeSi45, and when using FeSi65 by 12.5% (from 76.9 to 87.9%). It should be noted that a significant increase in chromium reduction by 10.1 and 12.5% occurred with an increase in the basicity of the slag from 1 to 2 and using FeSi45 and FeSi65 respectively. The results of thermodynamic modeling can be used to calculate the degree of chromium reduction from steelmaking converter slags by silicon of ferrosilicon of FeSi45 and FeSi65 grades during the recovery period for obtaining stainless steel grades.

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