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Modeling of the gas reduction of metals process from multi-component oxide melt in the bubbled layer

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Abstract

A technique is proposed for the kinetics of oxide melt bubbling by various reducing gases description. The theory uses thermodynamic modeling termes.

The following assumptions are used in the theory: one-cycle calculation is performed for "melt - single gas bubble" system; at the " floation up " of a single bubble in the "melt-gas" system, equilibrium is reached; during interaction with a next portion of gas the equilibrium content of oxides extends over the entire melt volume, the amount of metal redused in the current cycle is output from the system and is not taken into account in the next cycle.

The method is tested for the NiO-FeO-Al_2O_3-SiO_2-CaO-Mg-CO-CO_2 system. Influence of gas quantity in a single bubble to the calculation results was analyzed preliminary. The B_2O_3-CaO-NiO-CO system was used for this purpose, with the of nickel oxide amount in the system equal to one mole and the CO contents in the single bubble is equal to0.001, 0.01, 0.1 and 1.0 mole respectively. It was shown that an increase of the gas quantity in the bubble has little effect to the results accuracy, but reduces the calculation cycles number.

Comparative analysis of such calculated and experimental indicators as the oxide melt composition, elements reduction degree, the mass ratio of the oxide and metallic phases, the equilibrium composition of the gas, etc., depending on the amount of gas introduced, showed that the proposed technique can be used for a qualitative analysis of the interaction processes for multicomponent oxide melts with different reducing gases compositions. A slight difference between calculated and experimental data can be caused, among other things, by choosing the gas quantity in one bubble.

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