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Thermodynamic modeling of cerium reduction from slags of the $CaO-SiO_2-Ce_2O_3-15\%Al_2O_3-8\%MgO$ system by dissolved aluminum in the metal

© **Anatoly A. Babenco**,* **Leonid A. Smirnov**,
Alena G. Upolovnikova,[+] and **Olga V. Nechvoglod**
Laboratory of pyrometallurgy of non-ferrous metals. FSBIS Institute of Metallurgy of the UB of the RAS.
Amundsen St., 101. Yekaterinburg, 620016. Sverdlovsk region. Russia.
Phone: +7 (343) 232-91-62. E-mail: upol.ru@mail.ru

*Supervising author; [+]Corresponding author
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Abstract

Thermodynamic modeling of cerium reduction from slags of the $CaO – SiO_2 – Ce_2O_3$ system containing 15% Al_2O_3 and 8% MgO by dissolved aluminum in the metal at temperatures of 1550 and 1650 °C was performed using the HSC 6.1 Chemistry software package (Outokumpu), based on minimizing Gibbs energy and variational principles of thermodynamics using the method of simplex planning lattices (mass% is indicated in this expression and hereinafter). When constructing the planning matrix, the following restrictions were imposed on the variable components of the $CaO-SiO_2-Ce_2O_3-Al_2O_3-MgO$ system: CaO/SiO_2 = 2-5; 15% Al_2O_3; 8% MgO and 1-7% Ce_2O_3. As a result of imposing restrictions on the change of components in the system, the studied region is represented by a local simplex in the form of two concentration triangles whose vertices are the pseudo-components Y1, Y2, Y3 and Y4. It was found that depending on the temperature of the metal, the basicity of the slag and the cerium oxide content in the steel, containing 0.06% carbon, 0.25% silicon and 0.05% aluminum, goes from 0.055 to 16 ppm cerium. The positive influence of the temperature factor, slag basicity and cerium oxide content in the studied range of chemical composition on the cerium reduction process is explained from the standpoint of the phase composition of the formed slags and the thermodynamics of cerium reduction reactions. When the metal is kept under slag with a basicity of 2.0, containing 1.0% cerium oxide, it passes into the metal at a temperature of 1550 °C to 0.055 ppm cerium. An increase in the temperature of the system to 1650 °C is accompanied by a slight increase in the concentration of cerium, reaching no more than 0.085 ppm. The most noticeable increase in the cerium content in the metal is observed with an increase in the slag basicity. It is noted that the shift of slags containing 7.0% cerium oxide to the region increased to 5.0 basicity provides, in the temperature range 1550-1650 °C, the equilibrium cerium content in the metal at the level of 12-16 ppm.

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