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Process modeling of the nickel and iron reduction from oxide melts by converted natural gas

© **Alexander S. Vusikhis**,[1+] **Leopold I. Leontiyev**,[1]*
Victor P. Chentsov,[1] and **Evgeny N. Selivanov**[1]
Institute of Metallurgy. Ural Branch of the RAS. Amundsen St., 101. Yekaterinburg, 620016. Russia.
Phone: +7 (343) 232-91-01. E-mail: pcmlab@mail.ru

*Supervising author; [+]Corresponding author

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Abstract

The converted natural gas using possibility to reduce iron and nickel from oxide melts in bubbled layer has been considered. The thermodynamic modeling technique has been applied to describe the kinetic features of the multicomponent oxide melts interaction processes with various compositions reducing gases.

Various types of conversion is used to obtain it (oxygen, steam, carbon dioxide) are considered. Influence of the natural gas/oxidizer gas ratio and the temperatures at which the conversion is carried out to the converted gases compositions is estimated.

It is shown that temperature increase from 1725 to 2273 K has little effect to the converted gases compositions. The hydrogen concentration in the products of oxygen conversion at $CH_4/O_2 = 2$ is 66.5%; steam ($CH_4/H_2O = 1$) is 75.0%; carbon dioxide ($CH_4/CO_2 = 1$) is 49.9% (the rest is CO), respectively. Oxidant addition leads to CO_2 and water vapor appearance in the mixture.

Bubbling kinetics is described by means of thermodynamic calculation. Reducing gas content and quantity (injected in oxide melt) affect to it properties is considered. The melt content changing, elements reduction degree, oxide and metal phases mass ratio, equilibrium contents of exhaust gases, etc are analyzed on this base. As was obtained, Nickel oxide residual content in the final melt have been decreasing to 0.03% and Nickel share in the ferronickel (formed in reducing process) is 70% in the case of oxidant absent. Residual NiO content in the oxide melt is higher, and degree of reduction is less in the presence of CO_2 and H_2O. The results obtained allow us to predict the metals reduction process parameters in the oxide systems melt babbling treatment. It has been found that the most efficient gas is steam reformed.

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