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Viscivity of the B_2O_3-CaO-NiO (FeO) systems melts

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Abstract

Structure of the B_2O_3 melt was analyzed as well as CaO modifier additives (25, 34, and 45 mass %) effect to it. As was proved, non-ring groups of associated rings proper to pure B_2O_3 are transformed into BO_2O – metaborate triangles. The released oxide ions increase the coordination number of modifying ions, which occupy cationic vacancies place in the most disordered part of the melt greed.

The B_2O_3–CaO–NiO and B_2O_3–CaO–FeO melts viscosity were measured by the method of vibration viscometry. Ratio of Boron to Calcium oxide mass fractions was taken as 3/1 and content of Nickel and Iron oxides in the range up to 5 and 20 % mass respectively. The experiments had been carried out using vibration viscometer operating in the mode of forced oscillations. The melt temperature was measured by Platinum – Platinum – Rhodium thermocouple. The measurements were carried out in cooling mode of the melt from 1800 K at 7-10 K/min speed. The viscosity temperature dependencies as well as its dependence on Nickel and Iron oxides were determined. Data processing was performed using the Table curve application software. Viscosity experimental data of the B_2O_3-CaO-NiO system melts for 1373, 1423, 1473, 1523, 1573 K temperatures have been described by the equation: $\eta = a + b \cdot \exp(-cx)$, and for B_2O_3 – CaO – FeO melts by equation: $\eta = a + b \cdot x^2 + c \cdot \exp(x) + d \cdot \exp(-x)$. Experimental data and calculations results show good convergence.

The results are supposed to be used for describing the kinetics of metal reduction in bubbling processes, accompanied by the concentrations change of the oxides under reduction. The obtained information is useful for correction the slag melts properties in non-ferrous metal production.

References

[1] R.S. Bubnova, S.K. Filatov. High-temperature crystal chemistry of borates and borosilicates. *St.Petersburg: Science.* **2008**. 760p. (russian)
[2] A.A. Osipov, L.M. Osipova, V.M. Bykov. Spectroscopy and structure of alkaline borate glasses and melts. *Ekaterinburg-Miass: Ural Branch of the Russian Academy of Sciences.* **2009**. 174p. (russian)
[3] B.M. Lepinsky, A.A. Belousov, S.G. Bakhvalov, et all. Edited by N.A.Vatolin. Transport properties of metal and slag melts. Directory. *Moscow: Metallurgy.* **1996**. 649p. (russian)
[4] V.M. Denisov, N.V. Belousova, S.A. Istomin et all. The structure and properties of molten oxides. *Ekaterinburg: Ural Branch of RAS.* **1999**. 498p. (russian)
[5] S.A. Istomin, A.V. Ivanov, V.V. Ryabov, A.A. Khokhryakov. The effect of mechanical activation of REE oxides on the specific conductivity of borate melts. *News of universities. Non-ferrous metallurgy.* **2013**. No.5. P.35-41. (russian)
[6] S.A. Istomin, A.A. Khokhryakov, A.V. Ivanov, V.P. Chentsov, V.V. Ryabov. Effect of lanthanide group REM oxides activated mechanically on the surface tension of borate melts. *Russian metallurgy (Metally).* **2015**. Vol.2015. No.2. P.85-90.
[7] A.V. Ivanov, S.A. Istomin, A.A. Khokhryakov, V.P. Chentsov, V.V. Ryabov. Effect of the mechanical activation of Ln_2O_3 oxides (with Ln = Gd, Dy, Ho, and Lu) on the surface tension and density of borate melts. *Russian metallurgy (Metally).* **2012**. Vol.2012. No.8. P.730-735.
[8] L. Shartsis, W. Capps. Surface tension of molten alkali borates. *J. American Ceramic Society.* **1952**. Vol.35. No.7. P.169-172.
[9] A.S. Vusikhis, E.N. Selivanov, A.N. Dmitriev, V. P. Chentsov, V.V. Ryabov. Study of Structural-sensitive Properties of Melts System B2O3–CaO. Abstract book of the 15th international conference on diffusion in solids and liquids – DSL-2019, 24-28 June, 2019. *Athens, Greece.* **2019**. P.129.
[10] Slag Atlas. German trans. *Moscow: Metallurgy.* **1985**. 208p. (russian)

[11] V.N. Gladky. Viscosimetry of metallurgical melts. *Moscow: Metallurgy.* **1989**. 96p. (russian)
[12] E.N. Selivanov, S.N. Tyushnyakov. The effect of Iron oxidation on the viscosity of FeO x - CaO melts. *Metals.* **2013**. No.5. P.18-23. (russian)