Thematic Section: Research into New Technologies. **Full Paper**
Subsection: Technology of Electrochemical Processes. *The Reference Object Identifier* – ROI: jbc-01/19-60-12-125
The Digital Object Identifier – DOI: 10.37952/ROI-jbc-01/19-60-12-125
Submitted on Desember 27, 2019.

Analytical description of sodium halogenides melts specific electric conductivity and its calculation for sodium astatide melt

© **Ivan K. Garkushin**,*+ **Olga V. Lavrenteva**, **Karina R. Gilmanova**, and **Yana A. Andreeva**
Department of General and Inorganic Chemistry. Samara State Technical University.
Molodogvardeyskaya St., 244. Samara, 443100. Samara Region. Russia.
Phone: +7 (846) 278-44-77. E-mail: gik49@yandex.ru

*Supervising author; +Corresponding author

Keywords: analytical description, forecast, salt melts, sodium haloganides, electrical conductivity, serial number, ion radius, ion potential, electronegativity, temperature.

Abstract

The paper presents analytical and graphical dependences of the individual haloganides melts specific electrical conductivity æ of the sodium NaHal series (Hal – F, Cl, Br, I) on the halogen order number Z, ionic radius r of haloganide-ion Hal^-, halogen ionic potential $1/r$, reduced ionic radius r/Z, difference of electronegativity ($\Delta\chi = \chi(Hal) - \chi(Na)$): æ = $f(Z)$; æ = $f(r)$; æ = $f(1/r)$; æ = $f(r/Z)$; æ = $f(\Delta\chi)$ for the temperature higher melting temperatures on 5, 10, 50, 75, 100, 150 и 200°. M.Kh. Karapetyans comparative methods were applied for the description. The minimum standard deviation and maximum correlation coefficient corresponds to the equation $æ^{-1} = a + b\exp^{1/r}$, according to which the numerical values of æ(NaAt) are calculated for real temperatures. The temperature dependence æ of the NaAt melt is described by the equation æ = 0.0508+0.0023T. A comparative analysis of the relationship between the specific electrical conductivity of NaHal melts at a temperature of $T_m + n$ (n = 10 ... 200° higher the melting temperature) and æ at (T_m + 5°). A comparative analysis is represented by straightforward dependencies. It was shown that the specific electrical conductivity of the NaAt melt is related to the electrical conductivity of LiAt by the direct equation æ(NaAt) = 0.035+0.607æ(LiAt). The straight line equationalso relates æ of the NaHal melt (Hal – F, Br, I, At) to the specific conductivity of the NaCl melt. Between the numerical values of the specific electrical conductivity of the sodium astatide (NaAt) melt calculated by different methods, consistent data were obtained.

References

[1] M.Kh. Karapet'yants. Methods of comparative calculation of physical and chemical properties. *Moscow:* Chemistry. **1965**. 403p. (russian)
[2] M.M. Viktorov. Methods for calculating physico-chemical quantities and applied calculations. *Leningrad: Chemistry.* **1977**. 360p. (russian)
[3] I.K. Garkushin, O.V. Lavrenteva, M.A. Istomova, A.N. Trunova, S.N. Parfenova, A.I. Garkushin, A.V. Kolyado. Methods for calculating the properties of elements, simple substances, compounds and mixes. Samara: *SamGTU*. **2017**. 467p. ISBN 978-5-7964-2060-7. (russian)
[4] G.I. Zamaldinova, S.N. Parfenova, A.I. Garkushin, I.K. Garkushin, V.V. Slepushkin. Properties of s^1-elements, simple substances, halogenides and their mixes: analytical description, calculation and interrelation: monograph. Samara: *SamGTU*. **2010**. 202p. (russian)
[5] I.K. Garkushin, O.V. Lavrenteva, Ya.A. Andreeva, and K.R. Gilmanova. Analytical description of the specific electric conductivity of halogenides KHal melts and its calculation for the KAt melt. *Butlerov Communications.* **2019**. Vol.58. No.6. P.138-145. DOI: 10.37952/ROI-jbc-01/19-58-6-138
[6] I.K. Garkushin, O.V. Lavrenteva, Ya.A. Andreeva et al. Modeling of the specific conductivity of melts of the haloganides series MHal (M – Li, Na, K, Rb, Cs, Fr; Hal – F, Cl, Br, I, At). *In Proceedings of the Eleventh All-Russian Scientific Conference with International Participation "Mathematical Modeling and Boundary Value Problems" (May, 27-30, 2019, Samara, Russian Federation), Vol. 1, Samara State Technical Univ. Samara*. **2019**. P.233-237. (russian)
[7] I.K. Garkushin, O.V. Lavrentyeva, and Ya.A. Andreeva. Analytical description of critical properties of alkaline metals in the Li…Cs group and calculation of critical properties for francium. *Butlerov Communications.* **2017**. Vol.52. No.12. P.129-133. DOI: 10.37952/ROI-jbc-01/17-52-12-129
[8] I.K. Garkushin, O.V. Lavrenteva, Ya.A. Andreeva, and V.M. Yakovlev. Analytical description of

thermodynamic properties of alkaline metals and calculation them for francium. *Butlerov Communications*. **2018**. Vol.54. No.4. P.34-39. DOI: 10.37952/ROI-jbc-01/18-54-4-34
[9] I.K. Garkushin, O.V. Lavrenteva, and Ya.A. Andreeva. Analytical description of the alkaline metals melts density and calculation of it for francium. *Butlerov Communications.* **2018**. Vol.55. No.8. P.92-101. DOI: 10.37952/ROI-jbc-01/18-55-8-92
[10] I.K. Garkushin, A.N. Trunova, A.I. Garkushin. Analytical description of the specific conductivity of lithium halogenides melts and its prediction for a LiAt melt. *J. Melts.* **2016**. Vol.1. P.26-34. (russian)
[11] A.G. Morachevsky. Handbook of molten salts. Vol.1. Ed. A.G. Morachevsky. *Leningrad: Chemistry.* **1971**. 168p. (russian)
[12] V.A. Rabinovich, Z.Ya. Havin. Brief Chemical Handbook. *Leningrad: Chemistry*. **1977**. 376p. (russian)
[13] M.V. Smirnov, Yu.A. Shumov, V.A. Khokhlov. The conductivity of molten alkali metal fluorides. *Works of the Electrochemistry Institute of the Ural Scientific Center of the USSR Academy of Sciences.* **1972**. Iss.18. P.3-9. (russian)
[14] Shot handbook of physico-chemical variables. Under. ed. K.P. Mishchenko, A.A. Ravdel. *Leningrad: Chemistry.* **1974**. 192p. (russian)
[15] A.I. Efimov, L.V. Belorukova, I.V. Vasilkova, V.P. Chechev. Properties of inorganic compounds. Handbook. *Leningrad: Chemistry*. **1983**. 392p. (russian)
[16] I.I. Kornilov, N.M. Matveeva, L.I. Pryakhina, R.Kh. Polyakova. Metallochemical properties of the the periodic system elements. *Moscow: Science*. **1966**. 352p. (russian)
[17] P.I. Bistrov, D.N. Kagan, G.A. Krechetova, E.E. Spielrain. Liquid metal heat carriers of heat pipes and power plants. *Moscow: Science*. **1988**. 263p. (russian)
[18] Emsli Dzh. Elements: translation from English. *Moscow: MIR*. **1993**. 256p. (russian)
[19] The chemical encyclopedia in 5 volumes. Under ed. I.L. Knunyans. Vol.2. *Moscow: Soviet encyclopedia*. **1990**. 671p. (russian)
[20] The chemical encyclopedia in 5 volumes. Under ed. I.L. Knunyans. Vol.3. Moscow: Scientific publishing house «BRE». **1992**. 639p. (russian)
[21] The chemical encyclopedia in 5 volumes. Under ed. N.S. Zefirova. Vol.4. Moscow: Scientific publishing house «BRE». **1995**. 641p. (russian)
[22] The chemical encyclopedia in 5 volumes. Under ed. N.S. Zefirova. Vol.5. Moscow: Scientific publishing house «BRE». **1998**. 783p. (russian)
[23] Physico-chemical properties of elements. Handbook ed. G.V. Samsonov. *Kiev: Naukova Dumka.* **1965**. 808p.
[24] K. Saito, S. Hayakova, F. Takei, X. Yamadera. Chemistry and the periodic table. Translation from Japanese. *Moscow: World*. **1982**. 320p. (russian)
[25] Janz G.J., R.P.T. Tomkins, C.B. Allen. Molten Salts**:** Vol.4. Part 4. Mixed Halide Melts. *J. Phys. Chem. Ref: Data* **1979.** Vol.8. No.1. P.125-283.
[26] G.J. Janz, R.P.T. Tomkins, C.B. Allen et al. Molten salts: Vol. 4. Part 2. Chlorides and mixtures, electrical conductance, density, viscosity, and surface tension data. *J. Phys. Chem. Ref.* **1975**. P.871-1178.
[27] G.J. Janz, R.P.T. Tomkins. Molten Salts**:** Vol.5. Part 2: Additional Multi-Component Salt Systems**.** *J. Phys. Chem. Ref: Data* **1983**. No.12**.** P.591.
[28] M.P. Slavinsky. Physico-chemical properties of elements. *Moscow: Metallurgizdat*. **1952**. 763p. (russian)
[29] Thermal constants of substances. Issue X. 4.1. Tables of accepted values: Li, Na. Under. ed. V.P. Glushko. *Moscow: All-Russian Institute of Scientific and Technical Information RAS USSR*. **1981**. 299p. (russian)
[30] A.K. Charykov. Mathematical processing of the results of chemical analysis. *Leningrad: Chemistry.* **1984**. 168p. (russian)
[31] A.N. Seidel. Errors of measurement of physical quantities. *Moscow: Science.* **1974**. 108p. (russian)
[32] Table Curve 2D. Automated Curve Fitting & Equation Discovery. *Version 5.01. SYSTAT Software Inc.* **2002**.