Reference Object Identifier – ROI: jbc-01/18-56-11-99
The Digital Object Identifier – DOI: 10.37952/ROI-jbc-01/18-56-11-99
Submitted on October 14, 2018.

Kinetics of the interaction of aluminum oxide with NaCl–H_2SO_4–H_2O solutions

© **Igor N. Tanutrov**,* **Simon O. Potapov**, and **Marina N. Sviridova**[+]
Institute of Metallurgy of Ural Branch of Russian Academy of Sciences. Amundsen St., 101. Ekaterinburg, 620016. Russia. Phone: +7 (904) 380-56-57. E-mail: intan38@live.ru

*Supervising author; [+]Corresponding author

Keywords: aluminum oxide, aqueous solution, sodium chloride, sulfuric acid, interaction, kinetics, thermography.

Abstract

The kinetics of the interaction of alumina powder with NaCl–H_2SO_4–H_2O solutions has been studied using a thermographic method modified by us in relation to the problem. A device was used that provides a record of the temperature in the reactor with an accuracy of 0.1 ^oC with a frequency of 5 s and a record of the signal to the computer in the form of a graph in the coordinates "temperature–time", as well as in a table form. The composition of the solutions was changed in the range of total (NaCl + H_2SO_4) concentrations from 0.1 to 2.0 mol/l and changing the H_2SO_4 concentration from 0 to 2 mol/l within the interval. Of the two possible reactions, the reaction with the formation of aluminum sulfate is thermodynamically more preferable than the formation of aluminum chloride.

At the initial volume of 100 ml, the amount of aluminum oxide responded to the reaction with the formation of sulfate, and the amount of oxide was administered with an excess of 20 mol %. The experiments were carried out at initial solution temperatures in the reactor, equal to 23.8, 32.3, 43.1 and 48.6 ^oC. Subsequent analyses of the solution composition and measurement data were used to compile material and thermal balances. Based on the thermal balance, the kinetic equation is determined by analyzing the temperature–time curves. It is found that the increasing part of the curve in the region from the initial to the maximum temperature is approximated by a polynomial of 3 degrees, and the falling part of the curve of the graph is linear. By mathematical processing of both parts of the graph, the dependences on the composition of the solution and temperature are obtained. It is also determined that the type of speed dependence on the degree of transformation does not meet the known kinetic models of heterogeneous processes. It is found that due to the exothermicity of the process its kinetics is controlled by convective heat exchange. On the basis of the studies, the kinetic parameters are established: the velocity constant equal to 15.91mol/s, the order of H_2SO_4 concentration in the solution equal to 0.336, the activation energy equal to 6.835 kJ/mol and the dependence of the velocity on the degree of transformation in the form of a graph determining the deviation from the kinetic model of the compressing nucleus.

References

[1] I.N. Tanutrov, S.O. Potapov, and M.N. Sviridova. Kinetics of interaction of magnesium oxide with NaCl–H_2SO_4–H_2O solutions. *Butlerov Communications.* **2018**. Vol.55. No.9. P.138-145. DOI: 10.37952/ROI-jbc-01/18-55-9-138
[2] V.M. Andreev, A.S. Kuznetsov, G.I. Petrov, L.N. Sigina. Production of germanium. *Moscow: Metallurgy.* **1969**. 96p. (russian)
[3] V.F. Borbat, Yu.L. Mikhailov, L.N. Adeeva, O.A. Golovanova, T.N. Filatova. Study of the possibility of enrichment of fly ash from CHP for rare and non-ferrous metals for their subsequent extraction. *Chemistry and chemical technology.* **1999**. Vol.42. Iss.5. P.86-90. (russian)
[4] S.O. Potapov, M.N. Sviridova, I.N. Tanutrov, D.A. Toloknov. Thephysics-chemical properties of fly-ash from the burning of Ekibastuz coals. *Butlerov Communications.* **2016**. Vol.45. No.3. P.36-39. DOI: 10.37952/ROI-jbc-01/16-45-3-36
[5] S.O. Potapov, M.N. Sviridova, I.N. Tanutrov. The behaviorof gallium and aluminum during sulfuric acid processing offly-ash from reftinskaya hydroelectric power plant. *Butlerov Communications.* **2016**. Vol.45. No.3. P.40-43. DOI: 10.37952/ROI-jbc-01/16-45-3-40
[6] I.N. Tanutrov, M.N. Sviridova. Thermodynamics of solutions NaCl–H_2SO_4–H_2O. *Butlerov Communications.* **2017**. Vol.51. No.7. P.25-30. DOI: 10.37952/ROI-jbc-01/17-51-7-25

[7] N.G. Ageev, S.S. Naboychenko. Metallurgical calculations using the hscchemistry: studies application package benefit. *Yekaterinburg: Ural publishing House. UNTA*. **2016**. 124p. (russian)
[8] A.N. Dyachenko, V.V. Shagalov. Chemical kinetics of heterogeneous processes. *Tomsk: publishing House of Tomsk Polytechnic University*. **2014.** 102p. (russian)
[9] A.R. Akhmedgoraeva, A.A. Biryukov, L.Yu. Zakirova, M.E. Zakirov, and A.R. Efimova. Study of the technological additive influence on the thermal properties of dynamic thermoplastic elastomer by differential scanning calorimetry and thermal gravimetric analysis. *Butlerov Communications.* **2017**. Vol.50. No.4. P.85-89. DOI: 10.37952/ROI-jbc-01/17-50-4-85
[10] Tsyganova I.V., Balykin V.P. Thermogravimetric analysis of ammonium – iron (II) sulfate. *Butlerov Communications*. **2018.** Vol.55. No.8. P.102-108. DOI: 10.37952/ROI-jbc-01/18-55-8-102
[11] K.V. Bryankin, N.P. Utrobin, V.S. Orekhov, T.P. Dyachkova. General chemical technology. *Tambov: Publishing house Tamb. state tech. UNTA.* **2006.** Part 2. 172p. (russian)
[12] F.F. Tsvetkov, B.A. Grigoriev. Heat and mass transfer: a textbook for universities. 2nd ed. *Moscow: Publishing house MEI.* **2005.** 550p. (russian)