**Regularities of performic acid formation from hydrogen peroxide and formic acid aqueous solutions**

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***Keywords****: performic acid, hydrogen peroxide, formic acid, kinetics, reaction mechanism, peracids, decomposition of active oxygen, epoxidation.*

The routes of decomposition of the active oxygen in the process of synthesis of performic acid from formic acid and hydrogen peroxide standard solutions were investigated by using the analysis of correlation between the concentrations of initial reactants and reaction products. It was shown that peracid undergoes decomposition to molecular oxygen, carbon dioxide and water. The kinetic model of the process of peracid formation was proposed, it describes the experimental data adequately. The kinetic rate constants and activation energies of the reactions were calculated and they are in good agreement with the data of other researchers. The kinetic model obtained can be used to get a mathematical model on the process of epoxidation of unsaturated compounds by performic acid.

**References**

1. Bunton C.A., Lewis T.A., Llewellyn D.R. Tracer studies inthe formation and reactions of organic per**-**acids. Journal of the Chemical Society, 1956, pp.1226–1230.

2. Liew Kin Hong, Rahimi M.Y., Salih N., Salimon J. Optimization of the *in situ* epoxidation of linoleic acid of *jatropha curcas* oil with performic acid. The Malaysian Journal of Analytical Sciences, 2015, vol. 19, no 1, pp.144–154.

3. Rubio M., Ramirez-Galicia G., Lopez-Nava J.. Mechanism formation of peracids. Journal of Molecular Structure: THEOCHEM, 2005, vol. 726, pp.261–269.

4. Leveneur S., Thцnes M., Hebert J-P. From kinetic study to thermal safety assessment: application to peroxyformic acid synthesis. Industrial & Engineering Chemistry Research, 2012, vol. 51, pp.13999−14007.

5. Shapilov O.D., Kostyukovskiy J.L. Reaction kinetics of hydrogen peroxide with formic acid in aqueous solutions. Kinetika i Kataliz [Kinetics and Catalysis], 1974, vol. 15, no. 4, pp.1065–1067 (in Russ.).

6. Mosovsky V., Cvengrosova Z., Kaszonyi A., Kralik M., Hronec M. [Collection of Czechoslovak Chemical Communications](http://cccc.uochb.cas.cz/), 1996, vol. 61, pp.1457–1463.

7. Ebrahimi F., Kolehmainen E., Oinas P. Production of unstable percarboxylic acids in a microstructured reactor. Chemical Engineering Journal, 2011, vol.167, pp.713–717.

8. Swern D. Differential analysis of hydrogen peroxide, peroxy acid and diacyl peroxide on a single sample. Organic Peroxides, 1970, vol. 1, pp.501.

9. Sun X., Zhao X., Du W., Liu D. Kinetics of formic acid-autocatalyzed preparation of performic acid in aqueous phase. Chinese Journal of Chemical Engineering, 2011, vol. 19, no. 6, pp.964–971.

10. Filippis P. de, Scarsella M., Verdone N. Peroxyformic acid formation: a kinetic study. Industrial & Engineering Chemistry Research, 2009, vol. 48, pp.1372–1375.

11. Voronov M.S., Aleksandrova J.V., Konyaeva I.A., Bolshakov A.P. Analytical determination of performic acid in the presence of hydrogen peroxide and formic acid. Uspehi v himii I himicheskoi tehnologii, 2013, vol. XXVII, no. 4, pp. 43–46. (in Russ.).

12. Dudley Sully B., Williams P. L. The Analysis of Solutions of Per-acids and Hydrogen Peroxide. Analyst, 1962, vol. 87, pp.653–657.

13. Formaliev V.S., Reviznikov D.L. Chislennye metody (Numerical Methods). // M.: Fizmatlit, 2004. 400 p. (in Russ.).

14. Min`ko A.A. Statistical Analysis in MS Excel. // M.: Vil`yams, 2004. 448 p. (in Russ.).

15. Prokhorov Yu.M. Encyclopedia of Mathematics. M.: Bol`shaya Rossiiskaya Entsiklopediya-Drofa, 2003. 75 p. (in Russ.).

16. Kim M.H., Kim C.S., Lee H.W., Kim K. Temperature Dependence of Dissociation Constants for Formic Acid and 2,6-Dinitrophenol in Aqueous Solutions up to 175 °C. Journal of the Chemical Society, Faraday Transactions, 1996, vol. 92, pp.4951–4956.

17. Ramos V.D.; Derouet D., Visconte L.L.Y. Epoxidation of 4-Methyloct-4-ene: Identification of Reaction Products and Kinetic Study. Polymer Testing, 2003, vol. *22*, pp.889–897.

**Synthesis and properties of anion exchangers based on acrylonitrile**

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***Keywords:*** *anion exchangers, ion exchange resins, ion exchange in water treatment.*

Synthesis and properties of anion exchangers based on acrylonitrile for use in the processes of water treatment was studied. To obtain the polymer matrix of the anion exchanger composition of the dispersion medium from modified carboxymethylcellulose and an aqueous solution of ammonium chloride was selected. As the blowing agent used isooctane and PB-3. In the synthesis of the copolymer the curing mixture on the basis of acrylonitrile, divinylbenzene and methacrylic acid methyl ester of different composition was used.The conditions of copolymerization reaction, which provide high air conditioning copolymer were found. By aminolysis of nitrile groups in the synthesized copolymers the samples of the anion exchangers with high capacity characteristics and high osmotic stability were obtained.

**References**

1. Leykin Yu.A. Physico-chemical base of synthesis polymer sorbents. // M.: Binom. 2013. 413 p. (in Russ.)

2. Ion exchange resins market. // M.: API, 2014. 64 p. (in Russ.)

3. Frog B.N., Levchenko A.P. Water treatment. // M.: MGU, 2003. 680 p. (in Russ.)

4. Kokotov Yu.A. Ionites and ion exchenge. // L.: Chimia, 1980. 246 p. (in Russ.)

5. STO VTI 37.002-2005. // Chelyabinsk: VTI Ltd., 2005. 27 p. (in Russ.)

6. Balanovsky N.V., Zorina A.I., Ilyinsky A.A. Patent RU № 2387673. The method of preparation of pores anionites. 2010. (in Russ.)

7. Dok А.Е., Ledovskih G.I., Balanovsky N.V. Patent RU № 2323944. The method of preparation of anionites. 2008. (in Russ.)

**Cleaning the fluorine-containing waste water production of sodium fluorosilicate**

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***Keywords:*** *fluorosilicic acid, fluorosilicate sodium, sewage treatment.*

It was presented the method of cleaning fluorine-containing reagent waste water. The process of wastewater purification sodium fluorosilicate lime milk ( 10% solution of calcium hydroxide Ca(OH)2 ) by has bun investigated . It is shown that the presence of Na2SiF6 wastewater sodium fluorosilicate production leads to a drastic decrease in the degree of purification of this waste by fluorine impurity is the cause of high fluorine content in the purified water industrial treatment plants. For a wastewater purification fluorosilicate sodium milk of lime in the presence of calcium reagents was used .This treatment reduces the residual fluorine content in the treated water up to 50 times, and also to reduce the consumption of milk of lime on 15-30%. The optimal dose of calcium reagents and process conditions to ensure the required standards of the fluorine content in the treated water. Consumption rates of reagents for processing a unit volume of wastewater purification for production of sodium fluorosilicate, are presented.

**References**

1. Zaitsev V.A., Novikov A.A., Rodin V.I. *Proizvodstvo ftoristykh soedinenij pri pererabotke fosfatnogo syrya* [Production of fluoride in the processing of phosphate raw materials]. Moscow, Chemistry, 1982, 244 p (in Russ.).

2. Ryss I.G. *Khimiya ftora i ego neorganichikh soedinenij* [Chemistry fluorine and its inorganic compounds], Moscow, GSTCL Publ., 1956, рp. 401-403 (718 p.) (in Russ.).

3. Istomin S.P., Plekhanov I.G., Zaruba A.A. Patent RU 2042626. A method for removing fluorine from the fluorine-containing solutions. Patent RU 2042626. 1995. (in Russ).

4. Proncheva L.E., Tikhanovskaya G.A., Chudnovskij S.M.. Defluorination method of groundwater. Patent RU 2274608. 2006. (in Russ).

5. Pilat B.V. The method of deep cleaning drinking and waste water from fluorine. Patent RU 2225365. 2004. (in Russ.).

6. Vershinina V.V., Rogovetz I.E., Ponomareva T.A. A method for purifying wastewater from fluoride. Patent SU 550346. 1977. (in Russ).

7. Valkov A.V., Loginov A.S., Romanenko V.I. A method for recovering fluorine ions from waste water.. Patent SU 539845. 1976. (in Russ).

8. Vershinina V.V., Rogovetz I.E., Gagarina E.V. A method for purifying wastewater from fluoride. Patent SU 742390..1980. (in Russ.).

9. Kovalchuk L.I., Andrianov A.M., Poladyan V. E. A method for purifying wastewater from fluoride. Patent SU 1393802.1988. (in Russ).

10. Sokhan V.F., Orlova O.V., Enikeeva F. Kh.. A method for purifying wastewater from fluoride. Patent SU 1682321. 1991. (in Russ).

11. Lokshin E.P., Belikov M.L. A method of deep cleaning of wastewater from fluoride. Patent RU 2228911. 2004. (in Russ.).

12. Sharipov T.V., Mustafin A.G.. Method for producing sodium fluorosilicate. Patent RU 2411183. 2011. (in Russ).

13. Sharipov T.V., Mustafin A.G. Disposal of fluorinated waste water production of sodium fluorosilicate. Vestnik Bashkirskogo yniversiteta [Bulletin of Bashkir University], 2010, V. 15, no. 1, pp. 38-41 (in Russ.).

**Еlectrochemical reduction of salicylaldoxime on solid electrodes**

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***Keywords:*** *electrosynthesis, salicylaldoxim, salicylamin.*

Preparative electrochemical reduction of salicylaldoxime to salicylamin in water-ethanol solution on metals with high and medium hydrogen overvoltage was studied. Most effective reduction process of salicylaldoxime proceeds on lead, cadmium, zinc and amalgamated lead. Current efficiency of salicylaldoxime is increasing at higher current density and higher concentration of salicylaldoxime. Temperature of the reaction mixture produces significant impact on current efficiency of salicylaldoxime and the yield of salicylamin. Maximum current efficiency and yield of salicylamin were obtained at temperature of 30° С, and are equal to 20-32 % and 90-100 %, respectively. At higher temperature current efficiency of salicylamin is reducing due to the contribution of side reactions – hydrolysis of salicylaldoxime and hydrogen evoluation.

**Reference**

1. Interferon–2011. Proceeding // Pod red. F.I. Ershova, A.N. Narovlianskogo. M. : Moscow, 2012, pp. 80–106 (in Russ.).

2. Raiford L. Chas., Clark E.P. Diacyl derivatives of ortho-hydroxybenzylamine .J. Am. Chem. Soc., 1923, v. 45, pp. 1738−1741.

3. Kitaev IU.P., Troepolskaia Т.V. Progress of electrochemistry of organic compounds, / Pod red. S. G. Maiiranovskogo. M.: Nauka [Science], 1969, v. 1, pp. 41−75 (in Russ.).

4. Lund H. Reduction of compounds containing the azomethine group. Acta chem. Scand, 1959, v. 13, no. 2, pp. 249 −267.

5. Lund H. On the electrolytic reduction of oximes and semicarbazones. Tetrahedron Lett, 1968, v. 9, no. 38, pp. 3651−3654.

6. Lund H. Reduction of compounds containing the azomethine group. Acta chem. Scand, 1964, v. 18, no. 2, pp. 563−565.

7. Damle M.V., Kaushal R, Tiwari M., Malshe P.T. Polarography of aldoximes in buffer solutions. Bull. Soc. Chim. Belg, 1980, v. 89, no. 11, pp. 969−976.

8. Peshkova V. M., Savostina V. M., Ivanova V. K. Oximes. (Series: "Reagents for analysis"). М.: Nauka [Science], 1977 pp. 236 (in Russ.).

**The study of electro-flotation extraction process of surface-active substances, ions of iron (II, III) and carbon nanomaterials from aqueous solutions**

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***Keywords:*** *electroflotation, iron hydroxides (II, III), surfactant, carbon nanomaterials (CNM), adsorption, isoelectric point, Zeta potential, hydrodynamic radius, the degree of extraction.*

The article is discussed electroflotation extraction process of dispersed phase hydroxides of iron (II) and hydroxides of iron (III), surface-active substances (surfactants) and carbon nanomaterials (CNM) from aqueous solutions. The description of carbon nanomaterials and surfactants used in the work is given. The methodology of the performed works is described. Studies show that the pH of the solution, the composition of the electrolyte, nature of surface-active substances, the nature of the carbon nanomaterials provide a significant impact on the efficiency of the process. Information about such important characteristics of interfacial phenomena as hydrodynamic radius, isoelectric point, Zeta potential is given. Adsorption abilities of carbon nanomaterials are also identified.

**References**

1. Kolesnikov A.V., Kapustin Y. I., Vorob`eva O.I. Extraction research hydrooxide heavy metals at presence emulsiia oils, diesel fuel and surface-active substance // Khimicheskaya technology [Chemical technology], 2009, no. 7, p. 31 (in Russ).
2. Brodsky V. A., Kolesnikov V. A., Il'in V. I. Influence of physicochemical characteristics of the dispersed phase of poorly soluble compounds non-ferrous metals on the efficiency of electro-flotation extraction from aqueous solutions. Teoreticheskie osnovy chimicheskoi tehnologiy [Theoretical foundations of chemical technology], 2015, vol. 49, no. 3, p. 253 (in Russ.).
3. Kolesnikov V. A., Il'in V. I., Kapustin Y. I, Electro-flotation technology of wastewater treatment of industrial enterprises. M.: Chimia, 2007. 303 p. (in Russ.)
4. Kolesnikov A.V., Kuznetsov V.V., Kolesnikov V.A., Kapustin Y. I. Role of surface-active substances in the electro-flotation process of extracting the hydroxides and phosphates of copper, nickel and zinc. Teoreticheskie osnovy chimicheskoi tehnologiy [Theoretical foundations of chemical technology], 2015, vol. 49, no. 1, p. 3 (in Russ.).
5. Chirkst D. E., Lobacheva O. L., Djevaga N.V. Ion flotation of lanthanum (III) and holmium(II) from nitrate and nitrate-chloride media. Gurnal prikladnoi chimii [J. appl. Chemistry], 2012, vol. 85, no. 1, p. 28 (in Russ.).
6. Vigdorovich V. I., Tsygankova L. E.,. Chelles N. V., Sturgeon A. J., etc. Carbon nanomaterials and composites on their basis. Vestnik TGU [Vestnik of Tomsk State University], 2013, vol. 18, no. 4, – pp. 1220-1229 (in Russ.).
7. Zaramenskikh K. S. Carbon nanotubes ceramic composites. Thesis abstract. M., 2011. (in Russ.)
8. Kokarev G. A., Kolesnikov V. A., Kapustin Yu. I, Interfacial phenomena at the interface oxide/solution. M: RHTU by D. I. Mendeleev, 2004. 72 p.(in Russ).

**Increase of efficiency of technological installation of gas low-temperature separation with application imitating dynamic model**

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***Keywords:*** *low-temperature separation, mathematical model, dynamic simulation.*

For increase on efficiency of technological installation of gas low-temperature separation devices it is offered to use the imitating dynamic model developed on the basis of mathematical models of separate devices of the plant (heat exchangers, separators, ejectors) and established connection between them. With application of developed model dependence of system key parameters change on main regulating influences commission is shown. Modeling of system transition process from one stationary mode to another at commission of indignation in system is executed. The simulation results can be used to analyze the stability of system in case of normal and abnormal situations, for calculation of time spent on transition mode and the size of possible negative economic due to receiving of sub-standard product.

**References**

1. Dolganov I.M. , Ivanchina E.D. ,Kravtsov A.V., Kirgina M.V., Romanovsky R.V. , Francina E. V. System modeling process for preparing linear alkylbenzenes based on recycling materials. Himicheskaya promyishlennost segodnya. [ Chemical industry today], 2012, №1, pp. 33-42. (in Russ.).

2. Ivashkina E.N., Khlebnikova E.S., Becker A., Belinskaya N.S. Research of reagents mixing in benzene alkylation with ethylene technology with the use of computational dynamics methods. Himicheskaya promyishlennost segodnya. [Chemical industry today], 2014, № 8, pp.46-56. (in Russ.).

3. Ivanov S.S., Tarasov M.Y. Zobnin A.A. Selection of optimal modes of complex gas treatment plant. Gazovaya promyishlennost . [ Gas industry ]. 2014, №2, pp 100-103. (in Russ.).

4. Ingham J., Dunn J.I. Chemical Engineering Dynamics: An Introduction to Modeling and Computer Simulation. Wiley-VCH, 2007, 643 p. (in Russ.).

5. Lanchakov G.A, Stavitskiy V.A., Kabanov O.P. Gas Treatment Optimization of Valanginian deposits of the Urengoy gas condensate field . Gazovaya promyishlennost. [Gas industry], 2005, №3, pp. 48-50. (in Russ.).

6. Lanchakov G.A., Stavitskiy V.A. Kabanov O.P. Operation of Valanginian GPP Urengoy field in compressor period of development. Gazovaya promyishlennost. [Gas industry] 2006, №2, pp. 31-33. (in Russ.).

7. Lanchakov G.A., Kabanov O.P., Stavitskiy V.A. Effect of operating mode of GPP EH Yakhinskoye condensate field in the preparation. Gazovaya promyishlennost. [Gas industry], 2007, №3, pp. 71-73. (in Russ.).

8. Yunusov R.R., Kudrin A.A., Gritsishin D.N. Improving of commercial gas treatment technology at Yurkharovskoye condensate field. Gazovaya promyishlennost. [Gas industry], 2008, №3, pp. 29-33. (in Russ.).

9. Kasatkin A.G. The basic processes and apparatus of chemical engineering: a textbook for high schools. M: Alliance, 2009. 750 p. (in Russ.).

10. Siebert A.G., Siebert G.K. Improving separation equipment considering the phase state of gas-liquid mixture. Gazovaya promyishlennost. [Gas Industry], 2010, №4, pp. 49-52. (in Russ.).

11. Pisarev M.O., Dolganov I.M., Ivashkina E.N. Simulation modes of installation devices of gas and gas condensate in low-temperature separation technology. Neftegazovoe delo. [ Oil and Gas Business ], 2014, №3, pp. 187-206. (in Russ.).

12. Shirokov G.S., Yelistratov M.V. Aspects of liquid hydrocarbons production from the perspective of mandatory utilization of petroleum gas. Gazovaya promyishlennost. [Gas Industry], 2010, №4, pp. 57-62. (in Russ.).

13. Flow Equations for Sizing Control Valves, Standart, ISA-75.01.01-2007 (60534-2-1 Mod).

14. Skoblo A.I., Molokanov J.K. Processes and devices of refined and petrochemical products: Textbook for universities . M .: Russian State University of Oil and Gas named after IM Gubkin, 2012. 725 p. (in Russ.).

15. Bukin A.V., Panin V.V., Vlasov S.P. Development and operating experience of the main process equipment in preparation of gas for transportation at Achimov horizonts Gazovaya promyishlennost . [Gas Industry], 2011, №11, pp. 23-26. (in Russ.).

16. Bahadori A. Natural Gas Processing. Technology and Engineering Design. Elsevier Inc, Gulf Professional Publishing, 2014. 896 p.