**Determination of the effectiveness of turbulent deposition of aerosols on the contact element of the device intensification**

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***Keywords****: turbulent migration, aerosols, gas separators, the separation efficiency.*

We consider the migration of fine turbulent phase in the gases and deposition of particles on the walls of the channels with the elements of the intensification and chaotic surface nozzle. Expressions Mednikova VP to calculate the turbulent particle migration rate to the wall, with associated dynamic rate. On the basis of applying cell model the flow pattern in the channel expressions are obtained for the calculation of the profile of the particle concentration and separation efficiency. Formulas for determining the model parameters - diffusion Peclet number and the number of complete mixing of cells. The results of calculations of the efficiency of deposition of particles in the channels with smooth and rough walls, a liquid film with a strong interaction with the axial movement and flow with a twist ribbon screw and nozzle and chaotic. The conclusions of the most effective designs of contact devices gas cleaning devices.

**References**

1. Mednikov E. P. Turbulent transport and deposition of aerosols. M.: Nauka, 1980. 176p. (in Russ).

2. Sugak E. V., Voynov N. A., Nikolaev N. A. Purification of gas emissions in apparatuses with intensive regimes gidrodinamicheskii. Kazan: RIC « Shkola », 1999. 224p. (in Russ).

3. Ramm V. M. Absorption of gases. M.: Chimia, 1976. 655 p. (in Russ).

4. Laptev A. G., Lapteva A. E. Opredelenie coefficients turbulent mixing v two-phase media by Taylor model. // Fundamental issledovaniya, 2015, no. 2, pp. 2810- 2814. (in Russ).

5. Laptev A. G., Nikolaev N.A., Basharov M. M. Metody intensifikacii i modelirovaniya teplomassoobmennyh processov. M.: «Teplotekhnik», 2011. (in Russ).

6. Nikolaev N.A. Effektivnost processov v mnogostupenchatyh apparatah s pryamotochno-vihrevymi kontaktnymi ustrojstvami. Kazan: «Otechestvo», 2011. (in Russ).

7. Kagan A. M., Laptev A. G., Pushnov A. S., Farakhov M. I. Contact packings of industrial heat and mass exchange devices. Kazan: Otechestvo, 2013. 454p. (in Russ).

8. Laptev A. G., Farakhov T.M., Lapteva A. E. Modeli yavlenij perenosa v neuporyadochennyh nasadochnyh i zernistyh sloyah. // Teoreticheskie osnovy himicheskoj tekhnologii [Theoretical Foundations of Chemical Engineering]. 2015, no. 4, pp. 407 - 414. (in Russ).

9. Farakhov M.I., Laptev A. G., Basharov M. M. Importozameshchenie po apparatam ochistki gazov ot dispersnoj fazy v neftegazohimicheskom komplekse // Himicheskoe i neftegazovoe mashinostroenie [Chemical and Petroleum Engineering]. 2016, no 5, pp. 14-16. (in Russ).

**Developing the mathematical model of zeolite-catalyzed benzene alkylation with ethylene**

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***Keywords:*** *ethylbenzene, mathematical model, alkylation reactor.*

Ethylbenzene and the following styrene production is a basic direction of benzene consumption. Nowadays the market of styrene polymers is decreasing in Russia, therefore, it seems currently essential to upgrade resource efficiency of raw materials and energy consumption for plants in a chain of styrene production. The following article describes a heterogeneous catalytic reactors mathematical models developing approach for benzene alkylation with ethylene. The process of mathematical model developing includes various stages: analysis of operational and experimental data of an industrial reactor, creating reaction network of alkylation process, calculation of thermodynamic parameters for targets and adverse reactions, creation of kinetic scheme and determination its parameters, verification the model in HYSYS comparing the calculated and experimental data. Developed model might be used for optimality research for upgrading raw materials efficiency and energy consumption during industrial processes.

**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. Himicheskaja promyshlennost' segodnja [Chemical industry today], 2012, no.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. Himicheskaja promyshlennost' segodnja [Chemical industry today], 2014, no. 8, pp. 46-56 (in Russ.).

3. Ingham J., Dunn J.I. Chemical Engineering Dynamics: An Introduction to Modeling and Computer Simulation. Wiley-VCH, 2007. 643 p.

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

5. 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.).

6. Tsyshevsky R.V., Garifzyanova G.G., Khrapkovskiy G.M. Quantum chemical calculations of chemical reactions mechanisms. K.: KNRTU, 2012. 86 p. (in Russ.).

7. Dolganova I.O., Belinskaya N.S. , Ivashkina E.N. , Martemyanova E.Y., Tkachev V.V. Improving the ethylbenzene manufacturing technology using the mathematical modeling method. Fundamental'nye issledovanija [Fundamental Research], 2013, no.8, pp. 595-600 (in Russ.).

8. Constantinos C.P., Min. O. Process modelling tools and their application to particulate processes. Powder Technology, 1996, no. 87, pp. 13-20.

9. Khlebnikov E.S., Ivashkina E.N., Pappel K.C. Optimization of the process of mixing the reactants in the technology of ethylbenzene using a hydrodynamic model. Mir Nefteproduktov. Vestnik neftjanyh kompanij [World of Oil Products. The Oil Companies’ Bulletin], 2016, no. 9, pp. 30-35 (in Russ.).

**Methods of manufacturing a cathode for lithium-ion batteries and the influence of the components of the composite cathode based on LiFePO4 active material on the electrochemical performance LIB**

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***Keywords:*** *chemical current source, an electrode, a cathode material, current collector, optimization, application of the composite, an active material, a binder, a conductive additive, lithium iron phosphate.*

The electrochemical performance of lithium power sources directly depend on the type of cathode material, but the methods of forming the composite electrode, the coating methods and the subsequent operations for the manufacture of the electrode can significantly affect the performance of the electrode. The article deals with various industrial and laboratory methods for the production of cathode for lithium-ion batteries. There is the scheme of cathode fabrication for lithium ion battery which discussed in detail and each stage is analyzed. Also discussed the influence of qualitative and quantitative composition of the components of the electrode mixture (an active material, a binder and a conductive additive) on the electrochemical performance of lithium-ion batteries on example of LiFePO4 cathode material.

**References**

1. Kim K.M., Jeon W.S, Chung I.J Chang., S.H. Effect of Mixing Sequences on the Electrode Characteristics of Lithium-Ion Rechargeable Batteries // Journal of Power Sources. – 1999. – Vol. 83. –P . 108-113.

2. Lee G.-W., Ryu J.H., Han W., Ahn K.H., Oh S.M. Effect ofslurry preparation process on electrochemical performances of LiCoO2composite electrode // Journal of Power Sources. – 2010. -Vol. 195.- P. 6049-6054.

3. Cho K.Y., Kwon Y.I., Youn J.R., Song Y.S. Interaction analysis between binder and particles in multiphase slurries // Materials Research Bulletin. – 2013. -Vol. 48.- Р. 2922-2926.

4. Li C.-C., Lin Y.-S. Electrochemical properties of ceria-based intermediate temperature solid oxide fuel cell using microwave heat-treated La0.1Sr0.9Co0.8Fe0.2O3−δ as a cathode // Journal of Power Sources. – 2012. -Vol. 220.- Р. 413-421

5. Bauer W., Nötzel D. Rheological properties and stability of NMP based cathode slurries for lithium ion batteries // Ceramics International – 2014.- Р. 4591-4598

6. Hodges A. M., Chambers G. Multilayer Dielectric substrate overcoated with electroconductive layer // US Patent 6,946,067. Accessed 20 Sept 2005

7. Chu WB, Yang JW, Wang YC, Liu TJ, Tiu C, Guo J. The effect of inorganic particles on slot die coating of poly(vinyl alcohol) solutions // J Colloid Interface Sci. -2006. – Vol. 297. -P. 215–225.

8. Lee KY, Liu LD, Ta-Jo L Minimum wet thickness in extrusion slot coating // Chem Eng Sci. -1992.- Vol. 47.-P. 1703–1713.

9. Tymecki L, Zwierkowska E, Koncki R Screen-printed reference electrodes for potentiometric measurements // Anal Chim Acta. – 2004.- Vol. 526,- P. 3–11.

10. T. Syrový and others Cathode Material for Lithium Ion Accumulators Prepared by Screen Printing for Smart Textile Applications // Journal of Power Sources. - 2016. - Vol. 309.- P. 192–201.

11. Oh S.W., Myung S.-T., Oh S.-M., Yoon C.S., Amine K., Sun Y.-K. Polyvinylpyrrolidone-assisted synthesis of microscale C-LiFePO4 with high tap density as positive electrode materials for lithium batteries // Electrochimica Acta. -2010. -Vol. 55- Р. 1193-1199.

12. Fey G.T.-K., Huang K.-P., Kao H.-M., Li W.-H. Particle size effects of carbon sources on electrochemical properties of LiFePO4/C composites // Journal of Power Sources. – 2011. -Vol.196- Р. 2810-2818.

13. Beninati S., Damen L., Mastragostino M. A Three-dimensional carbon-coated LiFePO4 electrode for high-power applications// Journal of Power Sources. - 2009. -Vol. 194.- Р. 1094-1098.

14. Xu J., Chen G., Teng Y.-J., Zhang B. Flow-controlled vertical deposition method for the fabrication of photonic crystals // Solid State Communications. - 2008. -Vol. 147.- Р. 414-418.

15. Mi C.H., Zhang X.G., Zhao X.B., Li H.L. Effect of sintering time on the physical and electrochemical properties of LiFePO4/C composite cathodes// Journal of Alloys and Compounds. -2006. -Vol. 424.- Р. 327-333.

16. Wang K., Cai R., Yuan T., Yu X., Ran R., Shao Z. Preparation and performance study of LiFePO4 and xLiFePO4·yLi3V2(PO4)3 // Electrochimica Acta. – 2009.- Vol. 54.- Р. 2861-2868.

17. H. Zheng, L. Tan, G. Liu, X. Song, V.S. Battaglia Investigation of degradation mechanisms of a high-temperature polymer-electrolyte-membrane fuel cell stack by electrochemical impedance spectroscopy // Journal of Power Sources. – 2012. - Vol. 208.- Р. 52-57.

18. Shim J., Striebel K.A. Effect of electrode density on cycle performance and irreversible capacity loss for natural graphite anode in lithium-ion batteries // Journal of Power Sources. - 2003.- Vol. 119.- Р. 934-937.

19. Liu Z., Zhang X., Hong L. Preparation and electrochemical properties of spherical LiFePO4 and LiFe0.9Mg0.1PO4 cathode materials for lithium rechargeable batteries // J Appl Electrochem. - 2009.- Vol. 39.-Р. 2433-2438.

20. Örnek A., Bulut E., Can M., Özacar M. Characteristics of nanosized LiNixFe1−xPO4/C (x  =  0.00-0.20) composite material prepared via sol-gel-assisted carbothermal reduction method // J Solid State Electrochem. - 2013.- Vol. 17.- Р. 3101-3107.

21. Goren A., Costa C.M., Silva M.M., Lanceros-Mendez S. State of the art and open questions on cathode preparation based on carbon coated lithium iron phosphate // Compos Part B Eng. – 2015.- Vol. 83.- P. 333–345.

22. Marks T., Trussler S., Smith A.J., Xiong D., Dahn J.R Study of electrolyte additives using electrochemical impedance spectroscopy on symmetric cells// Journal of The Electrochemical Society. – 2011.-Vol. 158- Р. 51-57.

23. Shi Z., Huang M., Huai Y., Lin Z., Yang K., Hu X., Deng Z. Superconductivity Modulated by Binary Doping in Nd1-xBaxFeAsO1-2xF2x// Electrochimica Acta. – 2011. -Vol. 56.- Р.4263-4267.

24. Huang Y., Zheng F., Zhang X., Li Y., Yin J., Li Q. Functional electrospun nanofibrous scaffolds for biomedical applications// Solid State Ionics. - 2013.- Vol. 249–250.- Р. 158-164.

25. Zhang H., Liu D., Qian X., Zhao C., Xu Y. Neat ionic liquid electrolytes based on functionalized 1,3-dialkylimidazolium cation and bis(fluorosulfonyl)imide anion were investigated in MCMB/LiFePO4 // Journal of Power Sources. -2014. -Vol. 249.- Р. 431-434.

26. Chou S.-L., Pan Y., Wang J.-Z., Liu H.-K., Dou S.-X. Small things make a big difference: binder effects on the performance of Li and Na batteries // Physical Chemistry Chemical Physics. – 2014. -Vol. 16.- Р. 20347-20359.

27. Myung S.T., Komaba S., Hirosaki N., Yashiro H., Kumagai N. Emulsion drying synthesis of olivine LiFePO4/C composite and its electrochemical properties as lithium intercalation material // Electrochem. Acta. -2004. - Vol. 49.- P. 4213-4222.

28. Wang K., Cai R., Yuan T., Yu X., Ran R., Shao Z. Process investigation, electrochemical characterization and optimization of LiFePO4/C composite from mechanical activation using sucrose as carbon source // Electrochem. Acta. -2009.- Vol. 54.- P. 2861-2868.

29. Doeff M.M., Wilcox J.D., Kostecki R., Lau G. Optimization of carbon coatings on LiFePO4 Multi-resonator System for Contactless Measurement of Relative Distances// J. Power Sources. -2006. - Vol. 163.- P. 180-184.

30. Liu Y., Cao C. Enhanced electrochemical performance of nano-sized LiFePO4/C synthesized by an ultrasonic-assisted co-precipitation method // Electrochimica Acta. – 2010. - Vol. 55.- Р. 4694-4699.

31. Cheng F., Wan W., Tan Z., Huang Y., Zhou H., Chen J., Zhang X. High power performance of nano-LiFePO4/C cathode material synthesized via lauric acid-assisted solid-state reaction // Electrochimica Acta. – 2011. - Vol. 56.- Р. 2999-3005.

32. Jugović D., Mitrić M., Cvjetićanin N., Jančar B., Mentus S., Uskoković D. Synthesis and characterization of LiFePO4/C composite obtained by sonochemical method // Solid State Ionics. – 2008. - Vol. 179.- Р. 415-419.

33. Liu H., Tang D. The low cost synthesis of nanoparticles LiFePO4/C composite for lithium rechargeable batteries // Solid State Ionics. – 2008. - Vol. 179.- Р. 1897-1901.

34. Liu H.-p., Wang Z.-x., Li X.-h., Guo H.-j., Peng W.-j., Zhang Y.-h., Hu Q.-y. Synthesis and electrochemical properties of olivine LiFePO4 prepared by a carbothermal reduction method // Journal of Power Sources. – 2008. - Vol. 184.- Р. 469-472.

35. Kavan L., Exnar I., Cech J., Graetzel M. Enhancement of Electrochemical Activity of LiFePO4 (olivine) by Amphiphilic Ru-bipyridine Complex Anchored to a Carbon Nanotube // Chem. Mater. – 2007. - Vol. 19.- Р. 4716-4721.

36. Li X., Kang F., Bai X., Shen W. A novel network composite cathode of LiFePO4/multiwalled carbon nanotubes with high rate capability for lithium ion batteries // Electrochem. Commun. – 2007. - Vol. 9.- Р. 663-666.

37. Georgakilas V., Otyepka M., Bourlinos A.B., Chandra V., Kim N., Kemp K.C., Hobza P., Zboril R., Kim K.S. Functionalization of Graphene: Covalent and Non-Covalent Approaches, Derivatives and Applications // Chem. Rev. – 2012. - Vol. 112. - Р. 6156-6214.

38. Kucinskis G., Bajars G., Kleperis J. Graphene in lithium ion battery cathode materials: A review // J. Power Sources. – 2013. - Vol. 240.- Р. 66-79.

39. Su F.Y., You C., He Y.B., Lv W., Cui W., Jin F., Li B., Yang Q.H., Kang F. Flexible and planar graphene conductive additives for lithium-ion batteries // J. Mater. Chem. – 2010. - Vol. 20.- Р. 9644-9650.

40. Wei W., Lv W., Wu M.B., Su F.Y., He Y.B., Li B., Kang F., Yang Q.H. The effect of graphene wrapping on the performance of LiFePO4 for a lithium ion battery// Carbon. – 2013. - Vol. 57.- Р. 530-536.

41. Kim W.K., Ryu W.H., Han D.W., Lim S.J., Eom J.Y., Kwon H.S. Fabrication of Graphene Embedded LiFePO4 Using a Catalyst Assisted Self Assembly Method as a Cathode Material for High Power Lithium-Ion Batteries // ACS Appl. Mater. Interfaces. – 2014. - Vol. 6.- Р. 4731-4736.

42. Guo X., Fan Q., Yu L., Liang J., Ji W., Peng L., Guo X., Ding W., Chen Y. Sandwich-like LiFePO4/graphene hybrid nanosheets: In situ catalytic graphitization and their high-rate performance for lithium ion batteries // J. Mater. Chem. – 2013. - Vol. A 1.- Р. 11534-11538.

43. Ma Z., Fan Y., Shao G., Wang G., Song J., Liu T. In Situ Catalytic Synthesis of High-Graphitized Carbon-Coated LiFePO4 Nanoplates for Superior Li-Ion Battery Cathodes // ACS Appl. Mater. Interfaces. – 2015. - Vol. 7.- Р. 2937-2943.

44. Hu L.H., Wu F.Y., Lin C.T., Khlobystov A.N., Li L.J. Graphen-modified LiFePO4 cathode for lithium ion battery beyond theoretical capacity // Nat. Commun. – 2013. - Vol. 4.- Р. 1687-1693.

45. Gui X., Zeng Z., Zhu Y., Li H., Lin Z., Gan Q., Xiang R., Cao A., Tang Z. Three-Dimensional Carbon Nanotube SpongeArray Architectures with High Energy Dissipation // Adv. Mater. – 2014. - Vol. 26.- Р. 1248-1253.

46. Xu Y., Sheng K., Li C., Shi G. Self-Assembled Graphene Hydrogel via a One-Step Hydrothermal Process // ACS Nano. – 2010. - Vol. 4.- Р. 4324-4330.

47. Xing W., Qiao S.Z., Ding R.G., Li F., Lu G.Q., Yan Z.F., Cheng H.M. Superior electric double layer capacitors using ordered mesoporous carbons // Carbon. – 2006. - Vol. 44. - Р. 216-224.

48. Chang H.H., Wu H.C., Wu N.L. Enhanced high-temperature cycle performance of LiFePO4/carbon batteries by an ion-sieving metal coating on negative electrode // Electrochem. Commun. -2008.- Vol. 10.- P. 1823-1826.

**Effect of humidity and structure of complex phosphate fertilizer granules on their physico-mechanical properties**

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***Keywords****: complex mineral fertilizers, humidity of granules, strength of granules, non-destructive methods of analysis, X-ray microtomography, scanning electron microscopy.*

Being one of the most important characteristics of physical and mechanical properties of mineral fertilizers, the strength of the granules determines product preservation during storage and transportation. In this research, the dependence of the granules strength on their structure, moisture content and settings of the granulation and drying processes was investigated for complex NP-, NPS- and NPK- fertilizers. The structure of the fertilizer granules was studied using modern non-destructive methods of analysis - X-ray microtomography and scanning electron microscopy. When the moisture content of the product rises, the static strength of the granules decreases significantly, which is probably due to dissolution of a part of the solid-phase contacts between the crystals and replacement of them by weaker liquid-phase ones. It was shown that in the absence of large defects such as cracks and pores in granules, the strength of the granule is determined by the strength of its binding phosphate part.

**References**

1. Fertilizer manual. IFDC/UNIDO, Netherlands, 1998.

2. Kuvshinnikov I.M. Mineral fertilizers and salts. Properties and ways of their improvement. M.: Chimia, 1987, 256 p. (in Russ.).

3. Grishaev IG, Syrchenkov A.Ya., Tikhonovich Z.A. Modes of formation of "plastic" ammonium phosphate granules. Chimicheskaya promishlennost’ segodnya [The chemical industry today], 2004, №1 (in Russ.).

4. Gribkov A.B, Sokolov V.V, Andriyanova E.A, Petropavlovskiy I.A. Effect of the conditions of the granulation process on the physical properties of ammonium phosphates. Materialy nauchno-prakticheskogo seminara [Materials of the international scientific-practical conference] Moscow, 2015 (in Russ.).

5. Andrianova EA, Sokolov VV, Petropavlovskii IA, Pochitalkina IA Determination of the static strength of granules of mineral fertilizers. Mir sery i N P K [World of sulfur N P and K] 2012, No. 6 (in Russ.).

6. Kochetova I.M. Sokolov V.V. Mihaylichenko A.I. Methods of research of structure of mineral fertilizers granules. Materialy seminara «Rol' analiticheskih sluzhb v obespechenii kachestva mineral'nyh udobrenij i sernoj kisloty». [Seminar materials "Role of analytical services in quality assurance of mineral fertilizers and sulfuric acid"], Moscow, NIUIF, 2015, pp. 42-49 (in Russ.).

7. Shchukin E. D. Kinetics and catalysis. Moscow, 1965 (in Russ.).

**Study of microwave regeneration of active coal, saturated n-butanol**

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***Keywords:*** *gas purification; activated carbon; microwave irradiation; regeneration; desorption.*

The desorption n-butanol from active carbon in modified 800-Watt domestic microwave oven was investigated. The experiment was conducted in a quartz weighing bottle. A sample of saturated coal which was placed in one. For removing condensate in the desorption process, the lid has been provided with a nipple in the weighing bottle. By fitting silicone hose was attached. The one was passed through a microwave oven through a small drilled hole. Coal temperature in the weighing bottle was measured by a pyrometer with a narrow spectral range - it is possible to measure through the glass door of the microwave oven. The kinetic curves of the carbon condensate volume and temperature during the 15-minute experiment were obtained. It is shown that the main part butanol is desorbed from the active carbon in a microwave oven in the first 3 minutes of regeneration, which is not achievable for desorption by live steam.

**References**

1. Muhin V.M., Klushin V.N. Production and application of carbon adsorbents. – M.: RKhTU im. D.I. Mendeleeva, 2012. – 308 p. (in Russ.).

2. Research group "InfoMine". The review of the market of the activated coal in the CIS. (2014), (available at http//www.infomine.ru/files/catalog/169/file\_169.pdf.)

3. Roskill Information Services Ltd., The economics of activated carbon, Clapham Road, SW9 OJA, London, 1998, p. 17.

4. Keltcev N.V. Basics of adsorption technique. M .: Chimia, 1976. – 512 p. (in Russ.).

5. Regeneratciia sorbentov (2014), (available at http://engineeringsystems.ru/r/regeneracia-sorbentov.php).

6. Kuznetcov V.P. Technical and economic review of production and regeneration of activated coals (2012), (available at http://do.gendocs.ru/docs/index-322101.html#7438118)

7. Foo K.Y., Hameed B.H. A cost effective method for regeneration of durian shell and jackfruit peel activated carbons by microwave irradiation // J. Chemical Engineering, 2012, № 192, pp. 404-409.

8. Liu X, Yu G., Han W. Granular activated carbon adsorption and microwave regeneration for the treatment of 2,4,5-trichlorobiphenyl in simulated soil-washing solution // J. Hazard Mater, 2007, № 147 (3), pp. 746-751.

9. Peng W., Shan-Shan Z., Wei Z. Treatment of an industrial chemical waste-water using a granular activated carbon adsorption-microwave regeneration process // J. Chemical Technology and Biotechnology, 2012, V. 87, pp. 1004-1009.

10. Bradshaw S.M., van Wyk E.J., Swardt J.B. Microwave heating principles and the application to the regeneration of granular activated carbon // J. South African Inst. Mining Metall, 1998, № 4, pp. 201-212.

11. Coss P.M., Cha C.Y. Microwave Regeneration of Activated Carbon Used for Removal of Solvents from Vented Air // J. Air Waste Manage. Assoc., 2000, № 50, pp. 529-535.

12. Balba I.S., Oda S.J., Haque K.E., Kondos P.D., MacDonald R.J.C. Microwave reactivation of cip spent carbon // Ceramic transactions, Amer. Ceram. Soc., 1991, № 21, pp. 475-483.

13. Cha C.Y., Carlisle M.W. Microwave Process for Volatile Organic Compound Abatement // J. Air Waste Manage. Assoc., 2001, № 51, pp. 1628-1641.

14. Jones D.A., Lelyveld T.P., Mavrodis S.D., Kingman S.W., Miles N.J. Microwave heating applications in environmental engineering — a review // Resources, Conservation and Recycling 2002, № 34, pp. 75-90.

15. Ku H.S., Siores E., Taube A., Ball J.A.R. Productivity improvement through the use of industrial microwave technologies // Comput. Ind. Eng., 2002, № 42, pp. 281-290.

16. Semenishcheva E.L., Starostin K.G., Klushin V.N. To the analysis of the efficiency of desorption of butanol from active coal using microwave radiation // Collection of scientific papers «Uspekhi v khimii i khimicheskoi tekhnologii», M.: RKhTU im. D.I. Mendeleeva, 2014, vol. XXVIII, no 5, pp. 66-69. (in Russ.).

17. Semenishcheva E.L., Starostin K.G., Klushin V.N. Regeneration of granular active carbon saturated with butanol vapor, microwave radiation // Molodoi uchenyi, 2014, no 6 (65), pp. 235-239. (in Russ.).

18. Great Soviet Encyclopedia. (2017), (available at <http://bse.sci-lib.com/article056216.html>).

**Study of the effectiveness of electroflotation method for the extraction of highly dispersed carbon materials from wastewater and liquid industrial waste in the presence of surfactants**

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***Keywords****: electroflotation, surfactant, highly dispersed carbon materials (HDCM), carbon nanoflakes, activated carbon, Zeta potential, hydrodynamic radius, the degree of extraction.*

The process of electro-flotation extraction of highly dispersed carbon materials (carbon nanoflakes and activated coal OU-B) from aqueous solutions in the presence of different types of surfactants was studied experimentally. The influence of the important characteristics of interfacial phenomena, such as hydrodynamic radius, Zeta potential, on the efficiency of electro-flotation extraction of highly dispersed carbon materials was studied. Values of these parameters for carbon nanoflakes and activated coal OU-B were compared. The effect of solution pH on the process of electro-flotation of carbon nanoflakes was shown. The influence of flocculants of different nature on the efficiency of electro-flotation extraction of carbon nanoflakes was investigated.

**References**

1. Sashok J. S., Prokopchuk N. R. The use of carbon nanomaterials in polymeric compositions // Minsk: BSTU, 2014.( in Russ).

2. Rakov E. G. Carbon nanotubes in new materials // Uspekhi v khimii [Successes of chemistry]. 2013. V. 82. No. 1. P. 27-47. ( in Russ).

3. Milyutina D. A., Kolesnikov A. V. Efficient removal of La(III) and Nd(III) from aqueous solutions using carbon nanoparticles // Uspekhi v khimii b khimicheskoi tekhnologii [Successes in chemistry and chemical technology]. V. XXIX, No. 1. 2015. P.28-30. ( in Russ).

4. Kozenkov O. D., Ptashkina T. V., Kosilov A. T. The density and microhardness of composite coatings containing carbon nanomaterials // Vestnik VGTU. [The Bulletin of Voronezh State Technical University]. 2015. V. 11. No. 1. S. 56-60. (in Russ).

5. Kharlamova T. A., Kolesnikov A.V., Brodskii V. A., Kondratieva E. S. Promising electrochemical processes in wastewater treatment // Halvanotekcnika i obrabotka poverkcnosti. [Electroplating and surface treatment] 2013. No. 1. V. 21. P. 54. (in Russ).

6. Vu T.P. et al. Characteristics of an electrocoagulation–electroflotation process in separating powdered activated carbon from urban wastewater effluent // Separ. Purif. Tech. 2014. V. 134. P. 196.

7. Shulenina Z. M., Bagrov V. V., Desyatov A. V., et al. Technogenic water: issues, technology, resource value. Moscow: MGTU im. N. E. Bauman, 2015. ( in Russ).

8. Brodskiy V.A., Kolesnikov V.A., Il'in V.I. Effect of the physicochemical characteristics of the disperse phase of slightly soluble compounds of nonferrous metals on the efficiency of their electroflotation extraction from aqueous solutions // Teoreticheskie osnovy chimicheskih tehnologiy [Theoretical foundations of chemical technology] 2015. V. 49. № 2. P. 138. ( in Russ).

**A calculation method of gas mixtures membrane separation**

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***Keywords****: membrane separation, thermodynamics, vapor-liquid equilib-rium, continuous mixing, plug flow, cascade, membrane module.*

A calculation method for gas mixtures separation was suggested. Method uses analogy of thermodynamic vapor-liquid flash calculation. Program module is realized for continuous stir mixing in permeate and retantat zones. Analysis of mathematical equations solution was performed. For plug flow regime the cascade of arbitrary configuration from standard membrane modules is composed. The figures and tables of the results are presented. The method is checked and realized in engineering information system SATRAPiS. On the base of our mathematical model this system allows to solve direct and reverse tasks of membrane gas separation. A criterion from physical and chemical parameters is suggested to obtain the solution.

**Refererances**

1. Dytnersky Yu.I., Brykov V.P., Kagramanov G.G. , Gas membrane separation//

 M., Chemistry, 1991, 344 p.

2. Kovalenko N. F. PhD. thesis, M., MUCTR, 1991, 136 p.

3. Kiselev Yu. I., Mathematical simulation of complex mixtures separation PhD. thesis,

 M., MUCTR, 1985, 197 p

4. Baker R.W., Membrane technology and applications (second edition)//2004, 427 p.

5. Bernardo P., Drioli E., Colemme G., Membrane gas separation: A review/state of art//

 Ind. Eng. Chem.Res., 2009, 48, 4638-4663

6. Bank of computer program, data bases and integral microscheme technologies.

 Russian Agency for computer program and integral microscheme technologies