ABSTRACT AND REFERENCES

APPLIED PHYSICS

DOI: 10.15587/1729-4061.2017.108460

SIMULATION OF NANOMODIFIED POLYMERS TESTING BY THE ELECTRIC CAPACITIVE METHOD (p. 4-9)

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At present, the issue of the electric capacitive method application for non-destructive testing of nanomodified polymer composite materials (NMPCM) is relevant. The paper gives a mathematical model based on Maxwell-Ampere, Faraday and Gauss's equations and satisfying the Dirichlet boundary condition. This paper proposes a computer simulation of the nanomodified polymers testing by the electric capacitive method. The simulation was carried out in a two-dimensional planar formulation and a minimum required density of the calculated grid was determined (37,300 elements) to obtain a qualitative result of the calculation. A number of numerical studies were conducted with different contents of CNT in NMPCM in the range of 0 wt % up to 10 wt %, different defect depths in the material and distances from the sensor to the surface. The homogeneity of the dispersion is estimated using the Cochran statistical criterion. The value of the Cochren criterion did not exceed the critical one for all conducted experiments. Approximation relations of the maximum defect depth and distance from the sensor to the surface were obtained depending on the content of CNT in NMPCM. The results of the studies allowed determining the limits of the method application in the testing of NMPCM. The maximum defect depth was 5H (H is the relative value of the defect) at the CNT concentration of 1 wt % and with increasing the CNT concentration, the maximum defect depth decreases to 2H. The maximum distance between the sensor and the surface was 0.33H at the CNT concentration of more than 5 wt %. The obtained data can be used in the design of technological equipment for the polymeric nanocomposites production.

Keywords: electric capacitive method, capacitive nondestructive testing, nanomodified polymers, carbon nanotubes.

References

1. Mikhaylin, Yu. A. (2008). Konstruktsionnyye polimernyye kompozitsionnyye materialy. SPb.: Nauchnyye osnovy i tekhnologii, 822.
2. Guadagno, L., Vertuccio, L., Sorrentino, A., Raimondo, M., Naddeo, C., Vittoria, V. et. al. (2009). Mechanical and barrier properties of epoxy resin filled with multi-walled carbon nanotubes. Carbon, 47 (10), 2419–2430. doi: 10.1016/j.carbon.2009.04.035
3. Gorrasi, G., Di Lieto, R., Patimo, G., De Pasquale, S., Sorrentino, A. (2011). Structure-property relationships on uniaxially oriented carbon nanotube/polyethylene composites. Polymer, 52 (4), 1124–1132. doi: 10.1016/j.polymer.2011.01.008
4. Sakharov, A. S., Gondlyakh, A. V., Strizhalo, A. V. (1997). On features of numerical integration for the equations of motion of laminated shell systems in the iterative analytic theory. International Applied Mechanics, 33 (9), 713–718. doi: 10.1007/bf02700668
5. Nanocs. Carbon Nanotubes (2017). Available at: http://www.nanocs.com/nanotube.htm
6. Klyuyev, V. V. (1995). Nerazrushayushchiy kontrol i diagnostika: Spravochnik. Moscow: Mashinostroyeniye, 656.
7. Kolosov, A. E., Sivetskii, V. I., Kolosova, E. P., Lugovskaya, E. A. (2013). Procedure for analysis of ultrasonic cavitator with radiative plate. Chemical and Petroleum Engineering, 48 (11-12), 662–672. doi: 10.1007/s10556-013-9677-9
8. Kolosov, A. E., Sakharov, A. S., Sivetskii, V. I., Sidorov, D. E., Sokolskii, A. L. (2012). Method of selecting efficient design and operating parameters for equipment used for the ultrasonic modification of liquid-polymer composites and fibrous fillers. Chemical and Petroleum Engineering, 48 (7-8), 459–466. doi: 10.1007/s10556-012-9640-1
9. Sakharov, A. S., Kolosov, A. E., Sivetskii, V. I., Sokolskii, A. L. (2013). Modeling of Polymer Melting Processes in Screw Extruder Channels. Chemical and Petroleum Engineering, 49 (5-6), 357–363. doi: 10.1007/s10556-013-9755-z
10. Protasov, A. (2009). Application of FEMLAB software for simulation of the thermal method for nondestructive testing. American Society for Engineering Education Annual Conference and Exposition, Conference Proceedings, 182, 14.219.1–14.219.9.
11. Ivitskiy, I. I. (2014). Polymer wall slip modelling. Technology Audit and Production Reserves, 5 (3 (19)), 8–11. doi: 10.15587/2312-8372.2014.27927
12. Sakharov, A. S., Sivetskii, V. I., Sokolskii, A. L. (2011). Extrusion molding of polymers with allowance for near-wall slip. Chemical and Petroleum Engineering, 47 (3-4), 231–237. doi: 10.1007/s10556-011-9451-9
13. Ivitskiy, I. I., Sokolskiy, A. L., Mikulionok, I. O. (2017). Influence of a Lubricant on the Flow Parameters of a Molten Polymeric Material in Channels of Forming Devices. Chemical and Petroleum Engineering, 53 (1-2), 84–88. doi: 10.1007/s10556-017-0299-5
14. Kovalenko, K. G., Kolosov, A. E., Sivetskii, V. I., Sokol'skii, A. L. (2014). Modeling Polymer Melt Flow at the Outlet from an Extruder Molding Tool. Chemical and Petroleum Engineering, 49 (11-12), 792–797. doi: 10.1007/s10556-014-9837-6
15. Kolosov, A. E. (1988). Impregnation of fibrous fillers with polymer binders. 1. Kinetic equations of longitudinal and transverse impregnation. Mechanics of Composite Materials, 23 (5), 625–633. doi: 10.1007/bf00605688
16. Diamond, G. G., Hutchins, D. A. (2006). A New Capacitive Imaging Technique for NDT. Eur. Conf. NDT, Berlin, Germany, Poster 229. Available at: http://www.ndt.net/article/ecndt2006/doc/P229.pdf
17. Diamond, G. G., Hutchins, D. A., Leong, K. K., Gan, T. H. (2007). Electrostatic-capacitive imaging: a new NDE technique. AIP Conference Proceedings, 894, 689–694. doi: 10.1063/1.2718037

18. Suh Nam, P., Tse, M.-K. (1983). An electrostatic charge decay technique for nondestructive evaluation of nonmetallic materials. Int. Adv. Nondestruct. Test., 9, 192–226.
19. Shibata, T., Hashizume, H., Kitajima, S., Ogura, K. (2005). Experimental study on NDT method using electromagnetic waves. Journal of Materials Processing Technology, 161 (1-2), 348–352. doi: 10.1016/j.jmatprotec.2004.07.049
20. Wen, J., Xia, Z., Choy, F. (2011). Damage detection of carbon fiber reinforced polymer composites via electrical resistance measurement. Composites Part B: Engineering, 42 (1), 77–86. doi: 10.1016/j.compositesb.2010.08.005
21. Protasov, A. G., Gordienko, Y. G., Zasimchuk, E. E. (2006). Multilayer thin film sensors for damage diagnostics. AIP Conference Proceedings, 820 (1), 930–937. doi: 10.1063/1.2184625
22. Bazhenov, V. G., Ivitska, D. K., Gruzin, S. V. (2013). Udoskonalenyy elektrostatychnyy metod neruynivnoho kontrolyu. Metody ta prylady kontrolyu yakosti, 2, 26–28.
23. Bazhenov, V. G., Ivitska, D. K., Ovcharuk, S. A., Gruzin, S. V. (2015). Patent 112917 Ukraine: G 01 B 7/00, G 01 B 7/287, G 01 N 27/22. Elektrostatychnyy odnokanal'niy amplitudno-fazovyy sposib neruynivnoho kontrolyu, No. a201502540, 10.11.16, Bul. 21, 5.
24. Ivitskiy, I., Sivetskiy, V., Bazhenov, V., Ivitska, D. (2017). Modeling the electrostatic control over depth of the introduction of intelligent sensors into a polymer composite material. Eastern-European Journal of Enterprise Technologies, 1 (5 (85)), 4–9. doi: 10.15587/1729-4061.2017.91659
25. Grinberg, G. A. (1948). Izbrannyye voprosy matematicheskoy teorii elektricheskikh i magnitnykh yavleniy. Moscow: Izd. AN SSSR, 727.
26. Sabet, M., Soleimani, H. (2014). Mechanical and electrical properties of low density polyethylene filled with carbon nanotubes. IOP Conference Series: Materials Science and Engineering, 64, 012001. doi: 10.1088/1757-899x/64/1/012001
27. Ivitskiy, I. I., Sokolskiy, O. L., Kurilenko V. M. (2016). Simulation of intelligent sensors dipping into the melting polymer composite. Technology Audit and Production Reserves, 5 (3 (31)), 22–26. doi: 10.15587/2312-8372.2016.81236

DOI: 10.15587/1729-4061.2017.108834

IMPROVEMENT OF THE MODEL OF TEMPERATURE DISTRIBUTION AND REGISTRATION OF NATIVE RADIATION OF BIOLOGICAL OBJECTS (p. 10-16)

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Temperature is a reliable indicator of most physiological pathologies, since they are accompanied by disturbance of temperature balance. Non-invasive control of deep temperatures makes it possible to increase the efficiency of diagnosis. One of the promising methods of non-invasive measurement of deep temperatures is the method of radiothermometry, based on measuring the power of native radiation of the electromagnetic field on the surface of the human body. The model of the temperature distribution in the biological tissue has been improved in the case of a region of lower temperature taking into account the physiological processes of formation of thermal fields. During the analysis of the model, it has been established that at a depth of the temperature anomaly up to 2–3 cm, the temperature spots on the surface of the skin are distinguishable by the methods of infrared thermography. With this in mind, and also taking into account the penetrating power of electromagnetic waves, it is reasonable to choose the operating frequencies of the radiometer to 1.8 GHz. An improved model of temperature distribution makes it possible to estimate the integral temperature of a layer of biological tissue by electromagnetic radiation.

It has been shown that it is possible to determine the characteristics of the temperature anomaly region by numerical modeling of the formation of own electromagnetic radiation. The determination of two or more parameters of the temperature anomaly region is possible using a system of two or more equations, which is achieved by measuring the radiation power at different frequencies. A principle possibility of simultaneous determination of several parameters of the temperature anomaly, using a system of equations, has been considered very important. A working mathematical model has been created that makes it possible to solve the inverse problem of finding two parameters of the temperature anomaly with respect to the noise temperature measured at two frequencies. The next step is to study the multilayer model of biological tissue.

Keywords: temperature anomaly, thermal radiation, electromagnetic field, radiothermometry, multifrequency thermography.

References

1. Panteleev, I. A., Plekhov, O. A., Naymark, O. B. (2012). Mekhanobiologicheskoe issledovanie strukturnogo gomeostaza v opuholyah po dannym infrakrasnoy termografiy. Fiz. mezomekh., 15 (3), 105–113.
2. Potekhina, Yu. P., Golovanova, M. V. (2010). Prichiny izmeneniya lokal'noy temperatury tela. Medicinskiy al'manah, 2, 297–298.
3. Siores, E., Daskalakis, C. (2011). Non-Invasive Devices for Early Detection of Breast Tissue Oncological Abnormalities Using Microwave Radio Thermometry. Advances in Cancer Therapy. doi: 10.5772/23586
4. Kulish, S. N., Oleinik, V. P., Shulepov, V. Y., Sami, A. O. (2010). The radiothermometry of biological objects in the radio frequency range. 2010 20th International Crimean Conference "Microwave & Telecommunication Technology". doi: 10.1109/crmico.2010.5632726
5. Akki, R. S., Arunachalam, K. (2013). A study of factors influencing detectability of breast tumour in microwave radiometry. IEEE MTT-S International Microwave and RF Conference. doi: 10.1109/imarc.2013.6777730
6. Afyf, A., Bellarbi, L., Achour, A., Yaakoubi, N., Errachid, A., Sennouni, M. A. (2016). UWB thin film flexible antenna for microwave thermography for breast cancer detection. 2016 International Conference on Electrical and Information Technologies (ICEIT). doi: 10.1109/eitech.2016.7519635
7. Lulu Wang, Simpkin, R., Al-Jumaily, A. M. (2013). Open-ended waveguide antenna for microwave breast cancer detection. 2013 IEEE International Workshop on Electromagnetics, Applications and Student Innovation Competition. doi: 10.1109/iwem.2013.6888771
8. Caferova, S., Uysal, F., Balci, P., Saydam, S., Canda, T. (2014). Efficacy and safety of breast radiothermometry in the differential diagnosis of breast lesions. Wspolczesna Onkologia, 3, 197–203. doi: 10.5114/wo.2014.42721
9. Ojica, S., Iftemie, A. (2013). Noninvasive assessment of breast pathologies during pregnancy. 2013 E-Health and Bioengineering Conference (EHB). doi: 10.1109/ehb.2013.6707252
10. Karathanasis, K. T., Gouzouasis, I. A., Karanasiou, I. S., Uzunoglu, N. K. (2012). Experimental Study of a Hybrid Microwave Radiometry – Hyperthermia Apparatus With the Use of an Anatomical

Head Phantom. IEEE Transactions on Information Technology in Biomedicine, 16 (2), 241–247. doi: 10.1109/titb.2012.2187301
11. Avagyan, R., Vesnin, S., Gasparyan, L. V., Makela, A. M. (2008). Possible areas of application of radio-thermometry in laser medicine. Photodiagnosis and Photodynamic Therapy, 5, S40. doi: 10.1016/s1572-1000(08)70122-4
12. Vaysblat, A. V. (2003). Radiotermografiya kak metod diagnostiki v medicine. Moscow: NCZD RAMN, 80.
13. Kozheshkurt, V. A., Katrich, V. A. (2016). Determining the depth of the temperature anomalies in biological tissue. 2016 8th International Conference on Ultrawideband and Ultrashort Impulse Signals (UWBUSIS). doi: 10.1109/uwbusis.2016.7724180
14. Tamm, I. E. (2003). Osnovy teoriy ehlektrichestva. Moscow: Fizmatlit, 616.
15. Rozenfel'd, L. G., Samohin, A. V., Venger, E. F. et. al. (2008). Distancionnaya infrakrasnaya termografiya kak sovremennyi neinvazivnyi metod diagnostiki zabolevaniy. Ukrainskiy medicinskiy zhurnal, 6 (68) XI-XII, 92–97.
16. DeWitt, D. P., Nutter, G. D. (Eds.) (1988). Theory and Practice of Radiation Thermometry. NY.: John Wiley and Sons, Inc., 1138. doi: 10.1002/9780470172575
17. Troickiy, B. C., Aranzhereev, B. A., Gustov, A. B. et. al. (1986). Izmerenie glubinnogo temperaturnogo profilya bioob'ektov po ih sobstvennomu teplovomu radioizlucheniyu. Izv. VUZov. Radiofizika, 5 (1), 62–68.
18. Troickiy, B. C. (1981). K teoryi kontaktnyh radiometricheskih izmereniy vnutrenney temperatury tel. Izv. VUZov. Radiofizika, 24 (9), 1054–1061.
19. Gaykovich, K. P., Sumin, M. I., Troickiy, R. V. (1988). Opredelenie glubinnogo profilya temperatury metodom mnogochastotnoy radiotermografiy v medicinskih prilozheniyah. Izv. VUZov. Radiofizika, 31 (9), 1104–1112.
20. Antonenko, E. A., Mustecov, N. P., Kozheshkurt, V. A., Karpov, A. I. (2016). Issledovanie vozmozhnostey metoda koaksial'nogo zonda dlya izmereniya dispersiy diehlektricheskoy pronicaemosti bioprob. Prikladnaya radioehlektronika, 15 (1), 57–62.
21. Stec, B., Dobrowolski, A., Susek, W. (2004). Multifrequency microwave thermograph for biomedical applications. Journal of Telecommunications and Information Technology, 1, 117–122.
22. Vesnin, S. G., Sedankin, M. K. (2012). Sravnenie mikrovolnovyh antenn-applikatorov medicinskogo naznacheniya. Biomedicinskaya radioehlektronika, 10, 63–74.
23. Sedel'nikov, Yu. E., Potapova, O. V. (2014). Sfokusirovannye anteny v zadachah medicinskoi radiotermometriy. Inzhenernyi zhurnal: nauka i innovacyi, 2, 1–12.
24. Gaikovich, K. P. (2003). Inverse Problems of the Near-Field Radiothermometry. Radiophysics and Quantum Electronics, 46 (4), 239–248. doi: 10.1023/a:1025315323203
25. Yurasova, N. V., Gaikovich, K. P., Reznik, A. N., Vaks, V. L. (2000). Antennas for near-field radiothermometry. Conference Proceedings 2000 International Conference on Mathematical Methods in Electromagnetic Theory (Cat. No.00EX413). doi: 10.1109/mmet.2000.888569

DOI: 10.15587/1729-4061.2017.108822

DESIGN AND RESEARCH OF FISHING TOOLS WITH RATIONAL PARAMETERS OF MAGNETIC SYSTEMS (p. 17-22)

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One of the effective methods of cleaning wells from ferromagnetic objects is the use of magnetic fishing tools. However, the known designs have a number of drawbacks. Therefore, new designs of high-efficiency fishing tools were proposed in the work. For development of these tools, magnetic systems consisting of cylindrical magnetic cores with segmented radially magnetized permanent magnets made of rare-earth materials between them were used. According to the results of theoretical research performed using the finite element method, rational parameters of the elements of the magnetic systems, namely, the length of the permanent magnets and the height of the magnetic system were established. This has made it possible to develop systems that are characterized by a maximum utilization of the power of permanent magnets. The paper presents results of experimental research into the hoisting capacity which confirm advantage of the developed fishing tools over the known counterparts. The use of new magnetic tools will increase efficiency of cleaning wells from ferromagnetic objects of varied shapes and weight during cutting "windows" in the casing and in the process of drilling branch holes.

Keywords: fishing tool, magnetic system, permanent magnet, hoisting capacity, tractive characteristic, magnetic flux density.

References

1. Zalizniak, B. V. (2015). Efficient Cooperation of Academic and University Science. Interview with Ye. I. Kryzhanivsky, Rector of Ivano-Frankivsk National Technical University of Oil and Gas, Academician of NAS of Ukraine. Nauka ta innovacii, 11 (4), 13–17. doi: 10.15407/scin11.04.013
2. Kotskulych, Ya. S., Kyrchei, O. I., Lazarenko, O. H., Livinskyi, A. M. (2016). Vidnovlennia sverdlovyn shliakhom zaburiuvannia novykh stovburiv. Molodyi vchenyi, 12.1 (40), 45–49. Available at: http://molodyvcheny.in.ua/files/journal/2016/12.1/12.pdf
3. Stavychnyi, Ye. M., Piatkivskyi, S. A., Plytus, M. M., Prytula, L. Ya., Kovalchuk, M. B. (2014). Vidnovlennia sverdlovyn – perspektyvnyi napriam zbilshennia obsiahiv vydobutku vuhlevodniv u Zakhidnomu naftopromyslovomu raioni Ukrainy. Naftohazova haluz Ukrainy, 6, 3–6. Available at: http://nbuv.gov.ua/UJRN/ngu_2014_6_3
4. Vdovychenko, A. I., Koval, A. M., Chepil, P. M. (2016). Naroshchuvannia vydobutku vuhlevodniv v Ukraini za rakhunok vidnovliuvalnykh protsesiv. Naftohazova inzheneriya, 1, 112–121. Available at: http://journals.pntu.edu.ua/index.php/oge/article/view/295/262
5. Coll, B., Laws, G., Jenpert, J., Sportelli, M., Svoboda, C., Trimble, M. (2012). Specialized Tools for Wellbore Debris Recovery. Oilfield Review, 24 (4), 4–13. Available at: http://www.slb.com/~/media/Files/resources/oilfield_review/ors12/win12/1_specialized.pdf
6. Minnahmetov, I. R. (2012). Analiz raboty sushchestvuyushchih tekhnologiy ochistki zaboya skvazhin ot metalla. Vestnik PNIPU. Geologiya. Neftegazovoe i gornoe delo, 3, 45–53.
7. DeGeare, J. (2014). The Guide to Oilwell Fishing Operations: Tools, Techniques, and Rules of Thumb. Gulf Professional Publishing, 234.

8. Douglas, J. (1999). Fishing techniques for drilling operations. In. Proc. of AAPG Southwest Section Meeting.
9. Johnson, E., Land, J., Lee, M., Robertson, R. (2012). Landing the big one – the art of fishing. Oilfield Review, 24 (4), 26–35. Available at: http://www.slb.com/~/media/Files/resources/oilfield_review/ors12/win12/3_fish_art.pdf
10. Ermolaev, A. M., Kobylyanskiy, M. T., Bogdanova, T. V., Kobylyanskiy, D. M. (2016). Magnitnye loviteli kak sredstvo snizheniya travmatizma pri burenyi podzemnyh skvazhin. Vestnik nauchnogo centra po bezopasnosti rabot v ugol'noy promyshlennosti, 1, 89–92.
11. Kryzhanovskiy, E. I., Rayter, P. N., Romanishin, L. I., Romanishin, T. L. (2014). Ehksperimental'nye issledovaniya harakteristik magnitnyh sistem lovil'nyh ustroystv. Neftyanoe hozyaystvo, 7, 104–106.
12. Kobylyanskiy, M. T. (2009). Analiz vliyaniya neblagopriyatnyh skvazhinnyh faktorov na parametry magnitnyh loviteley burovogo instrumenta. Vestnik KuzGTU, 6, 14–16.
13. Romanyshyn, T. L. (2013). Obhruntuvannia vyboru materialiv postiynykh mahnitiv dlia lovylnykh prystroiv. Rozvidka ta rozrobka naftovykh i hazovykh rodovyshch, 1, 143–152. Available at: http://nbuv.gov.ua/UJRN/rrngr_2013_1_16
14. Anoshkin, A. P., Muradov, A. V. (2012). Remkomplekt dlya kapital'nogo remonta skvazhin. Nedropol'zovanie XXI vek, 2 (33), 38–40.
15. Gasanov, R. A., Amirov, R. G., Ehyvazova, Z. Z. (2009). Razrabotka novogo parametricheskogo ryada magnitnyh loviteley na osnove visokoehnergetichnyh magnitnyh zahvatnyh mekhanizmov. Neftepromyslovye delo, 10, 39–41.
16. Gutfleisch, O. (2000). Controlling the properties of high energy density permanent magnetic materials by different processing routes. Journal of Physics D: Applied Physics, 33 (17), R157–R172. doi: 10.1088/0022-3727/33/17/201
17. Kurnikov, Yu. A., Koncur, I. F., Kobylyanskiy, M. T., Romanishin, L. I.; Kurnikov, Yu. A. (Ed.) (1988). Magnitnye ustroystva dlya ochistki skvazhin. Lviv: Vishcha shkola, 108.

DOI: 10.15587/1729-4061.2017.108831

A METHOD OF V-FUNCTION: ULTIMATE SOLUTION TO THE DIRECT AND INVERSE PROBLEMS OF DYNAMICS FOR A HYDROGEN-LIKE ATOM (p. 23-32)

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Based on the method of V-function, a continuation of the optical-mechanical analogy is attained. In contrast to classic quantum mechanics, a trajectory-wave motion of the particle is explored. We highlight the presence of energy quantization of the particle and the availability of solution without a particle in the case of rectilinear uniform motion at constant speed. A solution to the direct and inverse problems of dynamics is searched for in a new statement for a hydrogen-like atom. When solving a direct problem, we find a stationary wave function of the electron in a hydrogen-like atom, with its properties investigated. When searching for a final solution to the stationary wave equation, we take into account a solution to the inverse problem of dynamics for the electron. A linear dependence between two particular solutions is shown. The second linearly independent solution is found, decaying exponentially to zero. We present charts of the stationary solution for a wave of the particle (electron) for three lower stationary states. Energy levels of a hydrogen-like atom are determined as a solution to the inverse problem of dynamics, which fully coincide with the classical results by Schrödinger and Bohr. A wave function is regarded as a physical reality, which makes it possible to open up new possibilities in order to study the structure of the microcosm.

Keywords: variational principle, direct problem of dynamics, inverse problem of dynamics, optical-mechanical analogy, wave motion, trajectory motion, wave function, wave equation.

References

1. Hamilton, W. R. (1834). On a General Method in Dynamics. Philos. Trans., 247–308.
2. De Broglie, L. (1925). Recherches sur la théorie des Quanta. Annales de Physique, 10 (3), 22–128. doi: 10.1051/anphys/192510030022
3. Broglie, L. (1967). Kvanty sveta, difrakciya i interferenciya. Kvanty, kineticheskaya teoriya gazov i princip Ferma. Uspekhi Fizicheskih Nauk, 93 (9), 180–181. doi: 10.3367/ufnr.0093.196709j.0180
4. Broglie, L. (1986). Sootnosheniya neopredelennostey Geyzenberga i veroyatnostnaya interpretaciya volnovoy mekhaniki. Moscow: Mir.
5. Schrodinger, E. (1926). Quantisierung als Eigenwertproblem. Annalen Der Physik, 384 (4), 361–376. doi: 10.1002/andp.19263840404
6. Carmichael, H. (1993). An Open Systems Approach to Quantum Optics. Lecture Notes in Physics Monographs. Springer-Verlag Berlin Heidelberg, 182. doi: 10.1007/978-3-540-47620-7
7. Mensky, M. B. (1993). Continuous quantum measurements and path integrals. Bristol and Philadelphia: IOP Publishing.
8. Bloch, A. M., Rojo, A. G. (2016). Optical mechanical analogy and nonlinear nonholonomic constraints. Physical Review E, 93 (2). doi: 10.1103/physreve.93.023005
9. Abdil'din, M. M., Abishev, M. E., Beissen, N. A., Taukenova, A. S. (2011). On the optical-mechanical analogy in general relativity. Gravitation and Cosmology, 17 (2), 143–146. doi: 10.1134/s0202289311020034
10. Khan, S. A. (2017). Hamilton's optical-mechanical analogy in the wavelength-dependent regime. Optik – International Journal for Light and Electron Optics, 130, 714–722. doi: 10.1016/j.ijleo.2016.10.112
11. Valishin, N. T. (2014). Variational principle and the problems dynamics. Life Science Journal, 11 (8), 568–574.
12. Valishin, N. T. (2016). An Optical-Mechanical Analogy And The Problems Of The Trajectory-Wave Dynamics. Global Journal of Pure and Applied Mathematics, 12 (4), 2935–2951.
13. Knoll, Y., Yavneh, I. (2006). Coupled wave-particle dynamics as a possible ontology behind Quantum Mechanics and long-range interactions. Cornell University Library. Available at: https://arxiv.org/pdf/quant-ph/0605011v2.pdf
14. Pang, X. (2011). The wave-corpuscle properties of microscopic particlesin the nonlinear quantum-mechanical systems. Natural Science, 03 (07), 600–616. doi: 10.4236/ns.2011.37083
15. Matzkin, A., Nurock, V. (2007). Are Bohmian trajectories real? On the dynamical mismatch between de Broglie-Bohm and classical dynamics in semiclassical systems. Cornell University Library. Available at: https://arxiv.org/pdf/quant-ph/0609172v2.pdf
16. Vaidman, L. (2014). Quantum Theory and Determinism. Cornell University Library. Available at: https://arxiv.org/pdf/1405.4222.pdf

17. Bohr, N. (1913). I. On the constitution of atoms and molecules. Philosophical Magazine Series 6, 26 (151), 1–25. doi: 10.1080/14786441308634955

DOI: 10.15587/1729-4061.2017.108805

HYDROCAVITATIONAL ACTIVATION IN THE TECHNOLOGIES OF PRODUCTION AND COMBUSTION OF COMPOSITE FUELS (p. 33-42)

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Special methods and means for production and use of new types of liquid composite fuels with addition of industrial wastes of various origins were developed and scientifically substantiated.

The studies enabled production of composite fuels with improved physical and chemical qualities. For this purpose, a rotary cavitation device for tryout of hydrocavitational activation of fuel components was worked out. The possibility of introduction of various industrial wastes including ecologically hazardous wastes of various origins into production of composite fuels was proved.

Comprehensive studies of producing and burning composite fuels with application of methods for activation of physical and chemical processes were carried out. Liquid composite fuels obtained on the basis of "classical" hydrocarbons with addition of various types of waste meet present-day energy, environmental and consumer requirements.

The developed technology of burning composite fuels is helpful for solving the environmental problem of recycling industrial waste and the problem of generation of a cheaper thermal energy. The proposed technological approach is universal and applicable for utilization and neutralization of organic and mineral wastes of various origins using hydrocavitational activation methods at the stages of production and combustion of composite fuels.

Theoretical studies of hydrodynamics of flow of a viscous incompressible fluid in channels of a complex shape have enabled design of new types of atomizers and hydrocavitational activators.

Keywords: hydrocavitation technology, composite fuels, nozzles, rotary cavitation device, industrial wastes.

References

1. Gerpen, J. V. (2005). Biodiesel processing and production. Fuel Processing Technology, 86 (10), 1097–1107. doi: 10.1016/j.fuproc.2004.11.005
2. Kalargaris, I., Tian, G., Gu, S. (2017). Combustion, performance and emission analysis of a DI diesel engine using plastic pyrolysis oil. Fuel Processing Technology, 157, 108–115. doi: 10.1016/j.fuproc.2016.11.016
3. Serrano, A., Garcia-Labiano, F., de Diego, L. F., Gayan, P., Abad, A., Adanez, J. (2017). Chemical Looping Combustion of liquid fossil fuels in a 1 kW th unit using a Fe-based oxygen carrier. Fuel Processing Technology, 160, 47–54. doi: 10.1016/j.fuproc.2017.02.015
4. Abas, N., Kalair, A., Khan, N. (2015). Review of fossil fuels and future energy technologies. Futures, 69, 31–49. doi: 10.1504/ijret.2015.067515
5. Chareonpanich, M., Kongkachuichay, P., Donphai, W., Mungcharoen, T., Huisingh, D. (2017). Integrated transdisciplinary technologies for greener and more sustainable innovations and applications of Cleaner Production in the Asia–Pacific region. Journal of Cleaner Production, 142, 1131–1137. doi: 10.1016/j.jclepro.2016.10.174
6. Serebrykov, R., Stepanov, A., Stenkin, A. (2013). Composite fuel. Research in agricultural electric engineering, 4 (4), 137–140.
7. Remon, J., Arcelus-Arrillaga, P., Garcia, L., Arauzo, J. (2016). Production of gaseous and liquid bio-fuels from the upgrading of lignocellulosic bio-oil in sub- and supercritical water: Effect of operating conditions on the process. Energy Conversion and Management, 119, 14–36. doi: 10.1016/j.enconman.2016.04.010
8. Baicha, Z., Salar-Garcia, M. J., Ortiz-Martínez, V. M., Hernandez-Fernández, F. J., de los Rios, A. P., Labjar, N. et. al. (2016). A critical review on microalgae as an alternative source for bioenergy production: A promising low cost substrate for microbial fuel cells. Fuel Processing Technology, 154, 104–116. doi: 10.1016/j.fuproc.2016.08.017
9. Dolinsky, A., Avramenko, A., Basque, A. (2006). Discrete-pulse input and energy transformation – a new approach to the impact on multifactor systems. Prom. Heat engineering, 28 (2), 7–13.
10. Fedotkin, I., Guliy, I. (1997). Cavitation, cavitation technology and technology, their use in industry: Theory, calculations and designs of cavitation devices. Part 1. Kyiv: Poligrafbook, 840.
11. Fedotkin, I. M., Guliy, I. S., Borovskiy, V. V. (1998). Intensification of mixing processes of dispersing by hydrodynamic cavitation. Kyiv: Arthur-A, 128.
12. Kravchenko, O., Suvorova, I., Baranov, I. (2014). Hydrocavitation activation in technologies of production and combustion of composite fuels and an appraisal of its efficiency. Pumps. Turbines. Systems, 4 (13), 57–65.
13. Kravchenko, O., Suvorova, I., Baranov, I. (2014). Method for determining the effectiveness of hydrocavity treatment in the production and combustion of composite fuels. Problems in Mechanical Engineering, 2 (17), 58–62.
14. Myroshnychenko, I. I., Suvorova, I. H., Matsevytyi, Yu. M., Kravchenko, O. V., Tarelin, A. O., Myroshnychenko, I. I. (2005). Pat. No. 81479 UA. Method for processing fuel oil and a rotor-cavitation disperser therefor. IPC7 B01F 7/00, C 10 G 7/06. No. 200510753; declareted: 14.11.2005; published: 10.01.2008, Bul. No. 1, 2.
15. Suvorova, I. H., Kravchenko, O. V. (2006). Pat. No. 82138 UA. Mixing nozzle. IPC7 B01F 5/02, 04, 06, B02C 19/06. No. U200606857; declareted: 19.06.2006; published: 11.03.2008, Bul. No. 3, 4.
16. Chung, T. (2002). Computational fluid dynamics. Cambridge Univ. Press, 1012. doi: 10.1017/cbo9780511606205
17. Wesseling, P. (2001). Principles of computational fluid dynamics. Berlin-Heidelberg: Springer, 644. doi: 10.1007/978-3-642-05146-3
18. Roache, P. (185). Computational fluid dynamics. Albuquerque, N. M.: Hermosa Publishers, United States, 434.
19. Rvachev, V. (1982). Theory of R-functions and its applications. Kyiv: Naukova Dumka, 1982. – 552.
20. Suvorova, I. G., Kravchenko, O. V., Baranov, I. A. (2012). Mathematical and computer modeling of axisymmetric flows of an incompressible viscous fluid by the method of R -functions. Journal of Mathematical Sciences, 184 (2), 165–180. doi: 10.1007/s10958-012-0861-9

21. Landau, L. & Lifshitz Ye. (2015). Theoretical Physics: v.6. Fluid Mechanics. Moscow: Fizmatlit, 728.
22. Loitsiansky, L. (2003). Mechanics of Fluids and Gases. Moscow: Drofa, 840.
23. Baranov, I., Kravchenko, O., Suvorova, I. (2008). Analysis of the fluid dynamics of a flow of viscous incompressible liquid with the R-functions method. Bull. Kharkiv national University, 809, 9–19.
24. Mikhlin, S. (1970). Variational Methods in Mathematical Physics. Moscow: Nauka, 512.
25. Andrienko, Ye., Basteev, A., Tarasenko, L., Yussef, K. (2009). Improving the environmental and technical performance of energy installations with simultaneous deactivation of phenol wastes. Aerospace Engineering and Technologies, 7 (64), 104–108.
26. Kravchenko, O., Tarelin, A., Mikhailenko, V., Baranov, I. (2015). No-effluent technology of recovering spent HF fluid. Materials of International Geological Forum «Topical issues and prospects of development of geology: research and production». Kyiv: UkrDGRI, 2, 108–115.
27. Kravchenko, O., Suvorova, I., Goman, V., Musienko, Ye., Danilenko, A. (2013). Complex for conducting investigations in the processes of production, preparation and combustion of new kinds of composite fuels. Technical Thermophysics and Industrial Heat and Power Engineering, 5, 150–160.

DOI: 10.15587/1729-4061.2017.108535

A STUDY OF PHASE TRANSITION PROCESSES FEATURES IN LIQUID-GAS SYSTEMS (p. 43-50)

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The results of designing the mathematical model of non-stationary thermal conductivity of the bubble's oscillating wall, with account of the changes in the aggregate state and the thermal and physical characteristics of the substance, are presented. It is shown that when applying the finite elements method, it is a system of nonlinear differential equations of the 1st order. Consideration of these features in the mathematical model allows obtaining the temperature values of liquid and solid phases at any time when changing the bubble's size and the heat flow direction at its boundary.

Based on the suggested mathematical model, a series of assessment calculations was performed. Applying mathematical modeling, the temperature fields' distribution in the liquid under the conditions of the phase transition processes and changes in the bubble size is obtained. The performed studies show that for an immobile bubble under the boundary condition of the 2nd kind, the icing and ice melting velocities are almost equal, but the temperature on the interphase gas-water surface is approximately four times exceeding the temperature on the gas-ice surface, which corresponds to the water and ice thermal conductivity ratio.

The temperature in the phase liquid-ice transition zone is practically constant. With the expansion of the bubble, liquid freezing and ice melting are going more than 1.6 times faster than in the immobile bubble. When compressing the bubble, the thickness of the ice formed or melted is approximately 1.7 times smaller than that of the immobile wall bubble. The analysis of the results obtained has shown that they are predictable and fully correspond to the physicists' ideas of the heat transfer and phase transition processes flow in the liquid.

The suggested calculation method can be used to determine the thermal characteristics of the liquid and steam in various technological processes associated with gases dissolution in the liquid, foam hardening and gas hydrates formation. The mathematical model designed can be applied as a component for calculation of more complicated physical processes. The study results can be applied to optimize various technological processes associated with materials swelling, gases adsorption, liquids boiling and gas hydrates formation.

Keywords: thermal and physical characteristics of gas-saturated liquid, gas-to-steam bubble, heat transfer in two-phase medium, phase transformations.

References

1. Pavlenko, A. M., Basok, B. I. (2005). Regularities of Boiling-Up of Emulsified Liquids. Heat Transfer Research, 36 (5), 419–424. doi: 10.1615/heattransres.v36.i5.90
2. Yakushev, V. S., Kvon, V. G., Gerasimov, Yu. A., Istomin, V. A. (2008). Sovremennoe sostoyanie gazogidratnyh tekhnologiy. Moscow: OOO «IRTS Gazprom», 88.
3. Takeya, S., Ebinuma, T., Uchida, T., Nagao, J., Narita, H. (2002). Self-preservation effect and dissociation rates of CH_4 hydrate. Journal of Crystal Growth, 237-239, 379–382. doi: 10.1016/s0022-0248(01)01946-7
4. Stern, L. A., Circone, S., Kirby, S. H., Durham, W. B. (2003). Temperature, pressure, and compositional effects on anomalous or "self" preservation of gas hydrates. Canadian Journal of Physics, 81 (1-2), 271–283. doi: 10.1139/p03-018
5. Behkish, A., Lemoine, R., Oukaci, R., Morsi, B. I. (2006). Novel correlations for gas holdup in large-scale slurry bubble column reactors operating under elevated pressures and temperatures. Chemical Engineering Journal, 115 (3), 157–171. doi: 10.1016/j.cej.2005.10.006
6. Hashemi, S., Macchi, A., Servio, P. (2007). Dynamic Simulation of Gas Hydrate Formation in an Agitated Three-Phase Slurry Reactor. The 12th International Conference on Fluidization – New Horizons in Fluidization Engineering, 329–336.
7. Shagapov, V. Sh., Koledin, V. V. (2013). K teoryi rosta parovyh puzyr'kov v metastabil'noy zhidkosti. Teplofizika vysokih temperature, 51 (4), 543–551. doi: 10.7868/s0040364413040212
8. Veretel'nik, T. I., Difuchin, Yu. N. (2008). Matematicheskoe modelirovanie kavitatsionnogo potoka zhidkosti v himiko-tekhnologicheskoy sisteme. Visnyk ChDTU, 3, 82–85.
9. Aktershev, S. P., Ovchinnikov, V. V. (2013). Modelirovanie vskipaniya metastabil'noy zhidkosti pri nalichii frontov ispareniya. Sovremennaya nauka: issledovaniya, idei, rezul'taty, tekhnologi, 1, 77–82.
10. Nigmatulin, R. I., Habeev, N. S. (1978). Dinamika i teplomassoobmen parogazovyh puzyr'kov s zhidkost'yu. Nekotorye voprosy mekhaniki sploshnoy sredy. Moscow: In-t mekhaniki MGU, 229–243.
11. Kulinchenko, V. R., Zavialov, V. L., Mysiura, T. H. (2007). Peredumovy stvorennia matematychnoi modeli – osnovni polozhennia i rivniannia rukhu Releia. Naukovi pratsi Natsionalnoho universytetu kharchovykh tekhnolohyi, 22, 36–41.
12. Dolinskiy, A. A., Ivanitskiy, G. K. (1995). Teoreticheskoe obosnovanie printsipa diskretno-impul'snogo vvoda energyi. Model' dinamiki odinochnogo parovogo puzyr'ka. Prom. teplotekhnika, 17 (5), 3–28.

13. Pavlenko, A. M., Basok, B. I. (2005). Kinetics of Water Evaporation from Emulsions. Heat Transfer Research, 36 (5), 425–430. doi: 10.1615/heattransres.v36.i5.100
14. Butcher, J. C. (2008). Numerical Methods for Ordinary Differential Equations. New York: John Wiley & Sons, 482. doi: 10.1002/9780470753767
15. Kushnir, S. V., Kost, M. V., Kozak, R. P. (2016). Barbotazhni khimichni efekty: yikh vydy, mekhanizmy vynyknennia ta heokhimichni proiavy. Nakovo-tekhnichni visti, 3 (20), 30–47.
16. Ermolaeva, G. A., Kolcheva, P. A. (2000). Tekhnologiya i oborudovanie proizvodstva piva i bezalkogol'nyh napitkov. Moscow: IRPO; Izd. tsentr «Akademiya», 416.
17. Mosin, O. V. (2012). Fiziko-himicheskie osnovy opresneniya morskoy vody. Soznanie i fizicheskaya real'nost', 1, 19–30.
18. Semenov, M. E., Shits, E. Yu. (2013). Sintez gidratov gazov laboratornyh usloviyah. Tekhnicheskie nauki – ot teoryi k praktike. Novosibirsk: SibAK, 55–61.
19. Okutani, K., Kuwabara, Y., Mori, Y. H. (2008). Surfactant effects on hydrate formation in an unstirred gas/liquid system: An experimental study using methane and sodium alkyl sulfates. Chemical Engineering Science, 63 (1), 183–194. doi: 10.1016/j.ces.2007.09.012
20. Mel'nikov, V. P., Podenko, L. C., Nesterov, A. N., Reshetnikov, A. M. (2010). Relaksatsionnyy YAMR-analiz fazovyh prevrashcheniy vody v dispersnoy sisteme voda/gidrat freona -12/uglevodorod pri dissotsiatsyi gidrata. DAN, 433 (1), 59–61.

DOI: 10.15587/1729-4061.2017.108545

SYNTHESIS OF THE SYSTEM FOR MINIMIZING LOSSES IN ASYNCHRONOUS MOTOR WITH A FUNCTION FOR CURRENT SYMMETRIZATION (p. 50-58)

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The operation modes of the TVC-AM electric drive in which the power losses can be reduced were mathematically described. It was defined more precisely that what was at issue is the continued operation of an asynchronous motor at artificial characteristics in the region of nominal slip with an energetics better than at the working section of the natural mechanical characteristic. The system of automatic minimization of power losses of asynchronous motors was developed. It was shown that under conditions of feeding the electric drive from a source with asymmetrical voltage, it is necessary to use phase-by-phase control which requires the use of three control channels and three feedback channels. The logic of the feedback action is that when the load on the AM shaft decreases, it reduces the output voltage of the TVC and the motor currents. As a consequence, it becomes possible to maintain equality of the load angles of all phases to the optimum value. This makes it possible to solve the problem of minimizing the AM losses in a case of equality of the load angles to the optimal value and symmetrization due to equality of load angles by the phases of the motor. The quantitative indices of power loss decrease as well as the symmetrization indices when the electric drive is powered from a source with an asymmetric voltage were shown. The features of the power loss minimization system and the ways of improvement of its efficiency were illustrated. It was shown that the use of the proposed control system led to an improvement in both the power and dynamic parameters of the asynchronous electric drive. A 5 to 45 % reduction of power losses in the range of operating moments of $0 \leq M \leq M_{bo}$ relative to losses during operation at the main mechanical characteristic was recorded. The symmetrization effect was characterized by a 1.5 to 6 times reduction of the current asymmetry coefficients.

The use of a thyristor voltage converter makes it possible to realize controlled transient start-up and braking modes. Symmetrization of the acting currents of the asynchronous motor results in an 80–150 % reduction of vibrational components of the electromagnetic moment in a steady-state regime.

Keywords: asynchronous motor, thyristor converter, electric drive, loss minimization, voltage asymmetry, symmetrization.

Refrences

1. Liang, X., Ilochonwu, O. (2011). Induction Motor Starting in Practical Industrial Applications. IEEE Transactions on Industry Applications, 47 (1), 271–280. doi: 10.1109/icps.2010.5489897
2. Babakin, V. I. (2007). Avtomatizirovannyi elektroprivod tipovyh proizvodstvennyh mekhanizmov i tekhnologicheskih kompleksov. Ufa: UGNTU, 224.
3. Gui-xi, J., Hong-jun, S. (2009). Research on Intelligent Soft Starter of Asynchronous Electromotor. 2009 WRI Global Congress on Intelligent Systems. doi: 10.1109/gcis.2009.104
4. Boyko, A. A. (2014). Analiz vozmozhnosti ekonomyi energyi potreblyaemoy liftovymi lebedkami pri primenenyi tiristornyh preobrazovateley napryazheniya. Pidiomno-transportna tekhnika, 3 (43), 54–63.
5. Tremlin, R. (2006). Soft–Start drives. Wire Ind, 626, 92–96.
6. Tunyasrirut, S., Wangsilabatra, B., Suksri, T. (2010). Phase control thyristor based soft-starter for a grid connected induction generator for wind turbine system. Control Automation and Systems (ICCAS), International Conference. Available at: http://ieeexplore.ieee.org/document/5669944/
7. Yeh, C.-C., Demerdash, N. A. O. (2009). Fault-Tolerant Soft Starter Control of Induction Motors With Reduced Transient Torque Pulsations. IEEE Transactions on Energy Conversion, 24 (4), 848–859. doi: 10.1109/tec.2009.2025340
8. Braslavskij, I., Zyuzev, A., Nesterov, K. (2008). Thyristor controlled asynchronous electrical drive without speed sensor. 2008 International Symposium on Power Electronics, Electrical Drives, Automation and Motion. doi: 10.1109/speedham.2008.4581098
9. Lyutarevich, A. G., Goryunov, V. N., Dolinger, S. Yu., Hatsevskiy, K. V. (2013). Voprosy modelirovaniya ustroystv obespecheniya kachestva elektricheskoy energyi. Omskiy nauchnyy vestnik, 1 (117), 168–173.
10. Pinchuk, O. G. (2008). Energeticheskie pokazateli asinhronnogo dvigatelya pri razlichnyh parametrah nessimetryi pitayushchego napryazheniya. Elektrotekhnika i enerhetyka. Naukovi pratsi DonNTU, 8 (140), 201–205.
11. Zhang, P., Du, Y., Habetler, T. G., Lu, B. (2012). A Nonintrusive Winding Heating Method for Induction Motor Using Soft Starter for Preventing Moisture Condensation. IEEE Transactions on Industry Applications, 48 (1), 117–123. doi: 10.1109/tia.2011.2175875
12. Boyko, A. A., Budashko, V. V., Yushkov, E. A., Boyko, N. A. (2016). Synthesis and research of automatic balancing system of voltage converter fed induction motor currents. Eastern-European Journal of Enterprise Technologies, 1 (2 (79)), 22–34. doi: 10.15587/1729-4061.2016.60544
13. Boyko, A. O., Beresan, A. A. (2010). Modelirovanie sistemy TPN-AD. Matematicheskoe modelirovanie, 39–42.

14. Mityashin, N. P., Derunov, V. A., Aref'ev, L. Yu. (2005). Modeli chuvstvitel'nosti fazovyh napryazheniy k izmeneniyu upravlyayushchih vozdeystviy sistemy simmetrirovaniya napryazheniy avtonomnoy seti. Problemy energetiki, 99–106.
15. Petrov, L. P., Andryushchenko, O. A., Kapinos, V. I. et. al. (2000). Tiristornye preobrazovateli napryazheniya dlya asinhronnogo elektroprivoda. Moscow: Energoatomizdat, 200.
16. Prado, A., Kurokawa, S., Bovolato, L., Filho, J. (2011). Phase-Mode Transformation Matrix Application for Transmission Line and Electromagnetic Transient Analyses. New York: Nova Science Pub Inc, 40.
17. Kravchik, A. E., Shlaf, M. M., Afonin, V. I. (1982). Asinhronnye dvigateli serii 4A. Moscow: Energoizdat, 504.

DOI: 10.15587/1729-4061.2017.26256

EFFECT OF EXTERNAL PRESSURES IN DYNAMIC GAS MIXERS (p. 59-65)

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Analysis of the effect of pressures P_v of the sources of pure components, barometric pressure P_0 and output pressure P_w in the gas-dynamic synthesizer on the component concentrations in the obtained mixtures has been carried out. In this regard, the use of typical pressure stabilizers in the synthesizer does not provide high accuracy of concentration of the prepared mixture components.

It was shown that synthesizers designed on the basis of throttle flow summarizers are characterized by a significant effect of external pressures. Limit concentration deviation resulting from the changes in P_v, P_w and P_0 measure (in % abs/kPa) 1; 0.6 and 0.03, respectively.

It was established that equalizing of pressures at the ends of the dosing capillaries in the scheme of the flow summarizer leads, at least, to a partial compensation for the effect of external pressures. This is due to a unidirectional change in pressures and corresponding changes in the component flows metered by dosing capillaries.

Full compensation for the effect of external pressures can be provided by choosing dimensions of the capillaries applying the obtained system of equations.

Application of the dosing capillaries with dimensions differing from the calculated dimensions causes deviation of the component concentrations from the specified values at a level of 4 % rel. This deviation, if necessary, can be reduced by shortening capillary lengths during the measuring control of the synthesized mixture component concentrations using the gas analyzer.

The synthesizer of binary (CO_2+N_2) and ternary (O_2+CO_2+N_2) mixtures for calibration of analyzers of the blood gases was developed and studied. It was established that the limiting deviations of the component concentrations resulting from the effect of external pressures did not exceed $4\cdot10^{-3}$ %/kPa and, therefore they can be neglected.

Gas-dynamic synthesizers with a pressure equalizing scheme and the capillaries with dimensions determined by the compensation dependences are practically independent from the influence of external pressures and do not require high-precision means of their stabilization.

Keywords: pressure compensation, capillary throttle, flow mixer, gas mixture, component concentration.

Refrences

1. The 8th international Gas Analysis Symposium & Exhibition (GAS 2015) (2015). Beurs-WTC Rotterdam, the Netherlands. Available at: http://www.gas2015.org/publicaties/4349
2. Slominska, M., Konieczka, P., Namiesnik, J. (2014). New developments in preparation and use of standard gas mixtures. TrAC Trends in Analytical Chemistry, 62, 135–143. doi: 10.1016/j.trac.2014.07.013
3. Moshkovska, L., Prymiskyi, V., Nikolaiev, I. (2010). Metrolohichne zabezpechennia hazoanalitychnykh vymiriuvan. Standartyzatsiya, sertyfikatsiya, yakist, 2, 34–38.
4. Malczewski, M. L., Heiderman, D. C. (2008). Pat. No. 7390346 USA. System and apparatus for producing primary standard gas mixtures. MPK G01N1/00. No. US11/127,144; declareted: 12.05.2005; published: 24.06.2008. Available at: http://www.google.ch/patents/US7390346
5. Pratzler, S., Knopf, D., Ulbig, P., Scholl, S. (2010). Preparation of calibration gas mixtures for the measurement of breath alcohol concentration. Journal of Breath Research, 4 (3), 036004. doi: 10.1088/1752-7155/4/3/036004
6. Nelson, G. O. (1992). Gas mixtures: preparation and control. Lewis Publishers, 294.
7. Barratt, R. S. (1981). The preparation of standard gas mixtures. A review. The Analyst, 106 (1265), 817. doi: 10.1039/an9810600817
8. Reyman, L. V. (1985). Tekhnika mikrodozirovaniya gazov. Metody i sredstva dlya polucheniya gazovyh smesey. Leningrad: Himiya, 224.
9. Dilai, I. V., Tepliukh, Z. M., Vashkurak, Yu. Z. (2014). Basic throttling schemes of gas mixture synthesis systems. Eastern-European Journal of Enterprise Technologies, 4 (8 (70)), 39–45. doi: 10.15587/1729-4061.2014.26257
10. Bondarenko, V. L., Losyakov, N. P., Simonenko, Yu. M., D'yachenko, O. V., D'yachenko, T. V. (2012). Metody prigotovleniya smesey na osnove inertnyh gazov. Vestnik MGTU im. N. E. Baumana, 41–53.
11. Youn, C., Kawashima, K., Kagawa, T. (2011). Concentration measurement systems with stable solutions for binary gas mixtures using two flowmeters. Measurement Science and Technology, 22 (6), 065401. doi: 10.1088/0957-0233/22/6/065401
12. Dilay, I., Teplukh, Z., Brylyns'kyy, R., Kubara, I.-R. (2016). Development gas dynamic linear systems tasks of low pressure. Eastern-European Journal of Enterprise Technologies, 4 (7 (82)), 30–36. doi: 10.15587/1729-4061.2016.75231
13. ISO 6145-5:2009. Gas analysis – Preparation of calibration gas mixtures using dynamic volumetric methods. Part 5. Capillary calibration devices (2009). Geneva, Switzerland: International Organization for Standardization.
14. Alboiu, E. F., Rus, S., Alboiu, N. I., Degeratu, M. (2017). Continuous Flow Type Gas Blending Facility Used for Autonomous and System Diving. Energy Procedia, 112, 3–10. doi: 10.1016/j.egypro.2017.03.1054
15. Vitenberg, A. G., Dobryakov, Y. G., Gromysh, E. M. (2010). Preparation of stable gas mixtures with microconcentrations of volatile

substances in vapor-phase sources at elevated pressures. Journal of Analytical Chemistry, 65 (12), 1284–1290. doi: 10.1134/s1061934810120142

16. Helwig, N., Schüler, M., Bur, C., Schutze, A., Sauerwald, T. (2014). Gas mixing apparatus for automated gas sensor characterization. Measurement Science and Technology, 25 (5), 055903. doi: 10.1088/0957-0233/25/5/055903
17. Haerri, H.-P., Mace, T., Waldén, J., Pascale, C., Niederhauser, B., Wirtz, K. et. al. (2017). Dilution and permeation standards for the generation of NO, NO2and SO2calibration gas mixtures. Measurement Science and Technology, 28 (3), 035801. doi: 10.1088/1361-6501/aa543d
18. Brewer, P. J., Goody, B. A., Gillam, T., Brown, R. J. C., Milton, M. J. T. (2010). High-accuracy stable gas flow dilution using an internally calibrated network of critical flow orifices. Measurement Science and Technology, 21 (11), 115902. doi: 10.1088/0957-0233/21/11/115902
19. Prohorov, V. A. (1984). Osnovy avtomatizatsiy analiticheskogo kontrolya himicheskih proizvodstv. Moscow: Himiya, 320.
20. Dilai, I. V., Tepliukh, Z. M. (2010). Hazodynamichnyi metod vyznachennia diametra kapiliara. Visnyk Natsionalnoho universytetu "Lvivska politekhnika", 677, 128–134.
21. Dilai, I. V. (2013). Modeliuvannia paralelnoho ziednannia droselnykh elementiv. Visnyk Natsionalnoho universytetu "Lvivska politekhnika", 758, 192–198.
22. ABL700 series reference manual. Available at: http://biomed.au.dk/fileadmin/www.biomed.au.dk/faenotypering/Pdf/Radiometer-ABL-700-serie.pdf