ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

DETECTION OF «PROBLEM» AREAS IN THE POWER SUPPLY CIRCUIT FOR VERIFICATION OF CALCULATED ELECTROBALANCES (p. 4–10)

Volodymyr Nahodov, Elena Borichenko, Dmytro Ivanko, Iryna Yakobyuk

The paper deals with the issue of identifying the areas in the power supply circuit and types of equipment that create the greatest uncertainty in constructing the electrical balances of an industrial facility. For this purpose, a probabilistic-statistical method and expert survey are used. Expert surveys were conducted for more information about power consumption. This allows to define an interval of electric energy consumption of each type of equipment. Identifying not only the intervals of consumption, but also the frequency was proposed.

Determining the most "problem" areas for monitoring energy efficiency at industrial enterprises allows the verification of electrical balances obtained by computational-analytical or probabilistic-statistical methods. Through a series of calculations, the areas, which make the largest uncertainty and require installing additional metering devices were defined. These calculations are needed to develop an operational control system of energy efficiency.

Keywords: electric balance, power consumption, expert survey, simulation, energy efficiency, verification.

References

1. Kovalko, M. P., Denysiuk, S. P. (1998). Enerhozberezhennia – priorytetnyi napriamok derzhavnoi polityky Ukrainy, 506
2. Nahodov, V. F. (2007). Energosberezhenie i problema kontrolya effektivnosti energoispolzovaniya. Promyslova elektroenerhetyka ta elektrotekhnika, 34–42.
3. Nakhodov, V. F., Borychenko, O. V. (2010). Pobudova optymalnykh rozrakhunkovykh modelei elektrobalansiv vyrobnycho-hospodarskykh obiektiv. Promyslova elektroenerhetyka ta elektrotekhnika, 47–51.
4. Kreith, F., Goswami, D. Y. (2007). Energy management and conservation handbook. CRC Press, 440.
5. Gofman, I. V. (1966). Normirovanie potrebleniya energii i energeticheskie balansyi promyishlennyih predpriyatiy. Energiya, 319.
6. Iliev, I., Kloyanov, N., Gramatikov, P. (2011). Energy Efficiency and Energy Management. Energy Efficiency for Competitive Industry Financing Facility. Handbook Bulgaria.
7. Hasanbeigi, Ali, Lynn K. (2010). Guidelines for Conducting an Energy Audit in Industrial Facilities. Lawrence Berkeley National Laboratory.
8. Volobrinskiy, S. D. (2007). Elektricheskie nagruzki i balansyi promyishlennyih predpriyatiy Energozberezhennya. Palyvno-enerhetychni balansy promyslovykh pidpryiemstv, 25.
9. Nakhodov, V. F., Borychenko, O. V., Musatova, O. O. (2010). Pobudova balansiv spozhyvannia elektroenerhii vyrobnychykh obiektiv z vykorystanniam imovirnosno-statystychnykh metodiv.
10. Nordell, D. E. (1985). Principles for Effective Load Management. IEEE Transactions on Power Apparatus and Systems, 1450–1454.
11. Efron, B., Tibshirani, R. (2000). An Introduction to the Bootstrap. CRC Press LLC, 456. doi: 10.1109/tpas.1985.319159
12. Chernick, M. R. (1999). Bootstrap methods, a practitioner's guide. Wiley Series in Probability and Statistics, 369.
13. Shitikov, V. K., Rozenberg, G. S. (2013). Randomizatsiya i butstrep: statisticheskiy analiz dannyih po biologii i ekologii s ispolzovaniem R Tolyatti, 305.
14. Narasimhan, S., Jordache, C. (2000). Data Reconciliation and Gross Error Detection: An Intelligent Use of Process Data. Shankar Narasimhan and Cornelius Jordache, 405.

STUDY OF INTRODUCTION PROSPECTS OF COGENERATION TECHNOLOGIES IN MUNICIPAL ENERGY OF UKRAINE (p. 11–17)

Sergey Andreev, Vitaly Malyarenko, Inna Temnokhud, Alexander Shubenko, Nikolai Babak, Alexander Senetskyi

The analysis of low-power electric generating plants, used in the transition of existing boiler houses into a mini-CHP was conducted. The main comparative characteristics of the RGE and GTP for small electric generating facilities were presented.

The forecasts of the Ministry of Housing and Communal Services of Ukraine regarding trends in tariffs for heat, electricity and natural gas in Ukraine were analyzed.

The characteristics of the structure, energy equipment and energy efficiency of the ME "Kharkiv heating networks", based on which the feasibility estimation of cogeneration principles on the example of the boiler house, included in the association were considered. For the selected facility, the feasibility study on its transition into a mini-CHP by installing reciprocating gas engines was carried out. The way the gas price affects the project payback period is shown.

Keywords: cogeneration, energy efficiency, mini-CHP, feasibility study, reciprocating gas engine, gas turbine.

References

1. Zakon Ukrainy «Pro enerhozberezhennia» [Law of Ukraine "On Energy Saving"] (1994). Kyiv: Vidomosti Verkhovnoi Rady, 30, 283. Available at: http://zakon2.rada.gov.ua/lavs/shov/74/94-vr [in Ukrainian]
2. Nakaz Ministerstva Finansiv Ukrainy «Pro vyznachennia pryorytetnykh napriamiv enerhozberezhennia» vid 04.07.2006 № 631 [Order of the Ministry of Finance of Ukraine "On the determination of the priority energy efficiency" from 04.07.2006 № 631], 1. Available at: www.waste.com.ua/law/nakaz nakaz040706-631.html [in Ukrainian]
3. Borovkov, V. M., Zysin, L. V. (2001). Osnovnye napravlenija razvitija mini-TJeC na osnove sovremennyh parogazovyh tehnologij [The main directions of development of CHP on the basis of modern combined cycle technology]. Moscow: AN. Jenergetika, 1, 100–105. [in Russian]
4. Canev, S. V., Burov, V. D., Remezov, A. N. (2006). Gazoturbinnye i parogazovye ustanovki teplovyh jelektrostancij [Gas turbine combined-cycle plants and thermal power plants]. Moscow: Izdatel'skij dom MjeI, 584. [in Russian]
5. Dolinskij, A. A., Basok, B. I., Bazeev, E. T., Kolomejko, D. A. (2006). Jenergoeffektivnost' kogeneracionnyh shem, rabotajushhih na baze gazo-porshnevyh dvigatelej [Energy promises more effective cogeneration schemes operating on the basis of gas-piston engines]. Kharkov: Jenergosberezhenie. Jenergetika. Jenergoaudit, 11, 16–27. [in Russian]
6. Mitsubishi Gas Engine. Honlin Heavy Industries Co. Ltd, Taiwan. Available at: http://honlin-hp.com/web/images/MitsubishiGasEngine.pdf (Last accessed: 15.03.2015). [in English]
7. Packham Keith Evaluating cogeneration for your facility: A look at the potential energy-efficiency, economic and environmental benefits. Power topic #GLPT-5660-EN. Technical information from Cummins Power Generation. Columbus, USA, 6. Available at: http://www.cummins.co.kr/board/ DATA/Evaluating%20 cogen%20final%20web%20 A4.pdf (Last accessed: 15.03.2015). [in English]
8. MAN gas engines for power generation in cogeneration plants. Site MAN Engines. Available at: http://www.engines.man.eu/global/en/power/gas-power-generation/overviews/Overview.html (Last accessed: 15.03.2015). [in English]
9. Generating power and heat, wherever you need it. On-site power supply with Jenbacher gas engines. GE Energy, 5. Available at: http://site.ge-energy.com/prod_serv/products/recip_engines/en/downloads/as_cogen_feb08.pdf (Last accessed: 15.03.2015). [in English]
10. Gazoporshnevye jelektrostancii (GPJeS–GPU) [Gas engines power cogeneration plant (GPP-GPU)]. Sajt GK «Prostor», Jaroslavl', RF. Available at: http://prostor-vrn.ru/?page_id=595 [in Russian]
11. Gazoporshnevye jelektrostancii [Gas engines power cogeneration plant]. Site IC «Jenergija TJeK», Sankt-Peterburg, RF. Available at: http://www.energy-tek.com/oborudovanie/gazoporshnevie-elektrostancii.html [in Russian]
12. Taryfy na elektroenerhiiu ta haz v Ukraini. Prohnozy Ministerstva z pytan' zhytlovo-komunal'noho hospodarstva Ukrainy [The tariffs for electricity and gas in Ukraine. Forecasts of the Ministry of Housing and Communal Services of Ukraine]. "ProfyK-South" Company. Available at: http://www.profik.com.ua/2011/07/21/tarify-na-elektroenergiyu-i-gaz-v-ukraine [in Ukrainian]
13. Postanova Kabinetu Ministriv № 106 vid 17 kvitnia 2014 r. Pro vnesennia zmin do postanovy Kabinetu Ministriv Ukrainy № 81 vid 25 bereznia 2014 r. Pro vdoskonalennia derzhavnoi polityky rehuliuvannia tsin na pryrodnyj haz i taryfiv na teplovu enerhiiu ta zabezpechennia posylennia sotsial'noho zakhystu naselennia pid chas oplaty zhytlovo-komunal'nykh posluh [Resolution of Cabinet of Ministers № 106 of April 17, 2014 On Amending Resolution of the Cabinet of Ministers of Ukraine № 81 of 25 March 2014. On improving state policy regulating natural gas prices and tariffs for thermal energy and strengthening social

protection when paying for housing services] (2014). Kyiv: Uriadovyj kur'ier, 73. Available at: http://zakon4.rada.gov.ua/laws/show/106-2014-п [in Ukrainian]
14. Rappoport, A. N., Gorjunov, P. V., Antonova, E. M. (1997). Prakticheskie rekomendacii po ocenke jeffektivnosti i razrabotke investicionnyh proektov i biznes-planov v jelektrojenergetike (s tipovymi primerami). Oficial'noe izdanie [Practical advice on assessing the effectiveness and development of investment projects and business plans in the power sector (with typical examples). Official publication]. Moscow: AO «NCPI», 171. [in Russian]
15. Shubenko, A. L., Maljarenko, V. A., Seneckij, A. V., Babak, N. Ju. (2014). Kogeneracionnye tehnologii v jenergetike na osnove primenenija parovyh turbin maloj moshhnosti [Cogeneration energy technologies based on the use of steam turbines of low power]. Kharkiv: Institut problem mashinostroenija NAN Ukrainy, 320. [in Russian]
16. Burov, V. D., Dudolin, A. A., Makarevich, V. V., Makarevich, E. V. Vozmozhnosti i preimushhestva gazoporshnevyh ustanovok v kogeneracionnyh avtonomnyh jelektrostancijah [Possibilities and advantages of cogeneration gas turbine installations in the autonomous power stations]. Available at: http://www.manbw.ru/analitycs/gazoporshnevye-installations-cogeneration-autonomus-power-stations.html [in Russian]

SELECTION OF ECONOMICAL SCHEMES HEAT RECOVERY COGENERATION POWER PLANT (p. 17–22)

Yurii Todorcev, Olga Tarkhtii, Anatolii Bundyuk

The paper considers several schemes of flue gas heat recovery in a cogeneration plant based on the gas turbine engine. We have considered two types of schemes: those that include only an HRSG for utilizing flue gas heat and schemes supplied with a gas air heater for post-compressor air heating. A coefficient of fuel heat utilization was accepted as a major indicator of the power plant efficiency.

We have calculated efficiency indicators of a cogeneration plant to select a recovery scheme of maximum efficiency. The indicators prove the importance of utilizing flue gas heat for heating air after the compressor. The post-compressor increase of air temperature allows reduction of fuel consumption.

Therefore, flue gas heat after a gas turbine should be used primarily for heating air after the compressor, and only later it can be utilized in a recovery boiler.

The calculations result in a conclusion that the most economical recovery scheme suggests using successively a gas air heater and an HRSG. Such a heat scheme has the lowest fuel flow (qт=0.229 kg/s) and maximum efficiency (ηccpp=0.9122).

Keywords: cogeneration plant, regeneration, gas turbine power plant, heat scheme, efficiency indicators.

References

1. Osnovy kogenertsii i maloi energetyki. Available at: http://www.cogeneration.ru/base-benefits/base.html?&students=1–
2. Basok, B. I., Bazeev, E. T., Didenko, V. M., Kolomeiko, D. A. (2006). Analis koheneratsionnykh ustanovok. Part 1. Klassifikatsiya i osnovnye pokazateli. Prom. Teplotekhnika, 28 (3), 83–89.
3. Dolinski, A. A., Basok, B. I., Bazeev, E. T., Pirogenko, I. A. (2007). Komunalna teploenergetika Ukraini: stan, problem, shlyakhi modernizatsii, 828.
4. Hitelman, L. D., Ratnikov, B. E. (2006). Energeticheskii biznes, 600.
5. Hanzha, A. N., Marchenko, N. A. (2012). Usovershenstvovanie statsionarnoi hazoturbinnioi ustanovki vyborom ratsionalnnykh parametrov regeneratora-vozdukhopodogrevatelya. Sbornik nauchnykh trudov "Vestnik NTU KHPI"", 7, 124–128.
6. Fialko, N. M., Serenkovskii, Yu. V., Stepanova, A. I. (2008). Effektivnost sistem utilizatsii teploty otkhodyashchikh gazov energeticheskikh ustanovok razlichnogo tipa. Prom. teplotekhnika, 30 (3), 68–76.
7. Tsenaev, S. V. (2002). Gasoturbinnye i parogazovye ustanovki dlya teplovykh elektrostantsii, 584.
8. Dmitrichenkova, Ye. I., Monakh, S. I., Orlov, S. M. (2009). Analitychni doslidzhennya strukturnykh skhem kogeneratsiinykh ustanovok dlya sistem teplopostachannya. Suchasne promyslove ta tsivilne budivnytstvo, 5 (3), 107–112.
9. Herushin, A. N., Nishchik, A. P. (2009). Energoekonomicheskaya effektivnost utilizatsii teploty. Prom. teplotekhnika, 31 (2), 82–86.
10. Kotler, V. R. (2006). Mini cogenerenation stations: Foreign experience. Thermal Engineering, 53 (8), 659–662. doi: 10.1134/s0040601506080143
11. Klimenko, V. N., Mazur, A. I., Sabashuk, P. P. (2008). Kogeneratsionnye sistemy s teplovymi dvigatelyami, 560.
12. Kostiuk, A. H., Frolov, V. V., Bulkin, A. Ye., Trukhnii, A. D. (2008). Parovye I gazovye turbiny dlya elektrostantsii, 556.
13. Balasanyan, H. A., Mazurenko, A. S. (2008). Analiz effektivnosti integrirovannykh sistem energosberezheniya na baize ustanovok kogeneratsii maloi moshchnosti i vozobnovlyaemykh istochnikov energii, Teplova energetika, 1, 7–10.
14. Basok, B. I., Kolomeiko, D. A. (2006). Analiz kogeneratsionnykh ustanovok. Chast 2. Analiz energeticheskoi effektivnosti. Prom. teplotekhnica, 28 (4), 79–83.
15. Herushin, A. N., Nishchik, A. P. (1997). Razrabotka i vnedrenie effektivnykh teploutilizatorov na osnove teploperedaiushchikh elementov isparitelno-kondensatsionnogo tipa, Prom. teplotekhnika, 19 (6), 69–73.
16. Bundiuk, A. N., Ulitskaya, E. O. (2013). Razrabotka algoritma dlya rascheta statiki kogeneratsionnoi energeticheskoi. Kholodilnaya tekhnica i tekhnologiya, 3 (143), 34–40.

ACTIVE ENERGY LOSSES RESEARCH IN AN ASYNCHRONOUS ELECTRIC MOTOR IN OPERATING TERMS (p. 22–28)

Sergey Ovcharov, Alexandr Strebkov

The paper presents the results of an analytical active power losses research in an asynchronous electric motor with a squirrel-cage rotor in a function of operating parameters.

The studies were conducted due to the fact that the electric motor operating modes at other deviations from the nominal operating mode: overvoltage, undervoltage, open-phase operating conditions, deterioration of cooling conditions, ambient temperature increase remain unexplored.

An improved equivalent circuit of the asynchronous electric motor with the squirrel-cage rotor taking into account active losses of power for eddy electric currents and hysteresis in the magnetic core was proposed.

An expression of active power losses in the electric motor coils taking into account the coil heating and the ambient temperature was derived.

The concept of the factor of active power losses in the electric motor as the ratio of active power losses in the electric motor to the active power on its shaft was introduced.

The dependence of the factor of active power losses in a function of power on its shaft, allowing to optimize the electric motor operating mode was investigated.

A pie chart of power losses in the asynchronous electric motor in a function of its slip was proposed.

The obtained research results allow to take into account the active energy losses in the asynchronous electric motor at all operationg deviations from the nominal operating mode.

Keywords: electric motor, losses, specific, load, temperature, optimum, energy saving, slip, chart, resource.

References

1. Ovcharov, V. V. (1990). Operational modes and continuous diagnostics of electrical machines in agricultural production. Kyiv: Publ. USH, 168.
2. Sun, D. S. (2012). Research on Voltage-Chopping and Energy-Saving Controlling Technology for Three-Phase AC Asynchronous Motor. Advanced Materials Research, 433-440, 1033–1037. doi: 10.4028/www.scientific.net/amr.433-440.1033
3. Hung, N. T., Thien, N. C., Nguyen, T. P., Le, V. S., Tuan, D. A. (2014). Optimization of Electric Energy in Three-Phase Induction Motor by Balancing of Torque and Flux Dependent Losses. AETA 2013: Recent Advances in Electrical Engineering and Related Sciences, 497–507. doi: 10.1007/978-3-642-41968-3_50
4. Grouni, S., Ibtiouen, R., Kidouche, M., Touhami, O. (2010). Novel Loss Optimization in Induction Machines with Optimum Rotor Flux Control. International Journal of Systems Control, 1 (4), 163–169.
5. Dhaoui, M., Sbita, L. (2010). A New Method for Losses Minimization in IFOC Induction Motor Drives. International Journal of Systems Control, 1 (2), 93–99.
6. Alssa, K., Eddine, K. D. (2009). Vector Control Using Series Iron Loss Model of Induction Motors and Power Loss Minimization. World Acad. Sci., Eng., Technol., 52, 142–148.
7. Kosmodamianskii, A. S., Vorob'ev, V. I., Pugachev, A. A. (2012). Induction motor drives with minimal power losses. Russ. Russian Electrical Engineering, 83 (12), 667–671. doi: 10.3103/s1068371212120073
8. Yang, Y. (2010). Improvement of Electric Submersible Pump in High Temperature. China Science and Technology Fortune.

9. Ostrovsky, A. (2012). Bazitratina method of determining the circuit parameters of the induction motor replacement. Praci Tavria State Agrotechnological University, 12 (2), 66–72.
10. Ovcharov, S., Vovk, A. (2013). Ways to reduce energy consumption in mobile units. Praci Tavria State Agrotechnological University, 13 (4), 21–26.

MODELING OF THE FLOW STRUCTURE IN ECHELONED GRIDS OF STABILIZERS BY VARYING THEIR DISPLACEMENT STEP (p. 29–34)

Nataliia Fialko, Yulii Sherenkovsky, Viktor Prokopov, Nina Polozenko, Nataliia Meranova, Sergey Aleshko, Gennadiy Ivanenko, Vladimir Yurchuk, Evgeniy Milko, Nina Olkhovskaya

The paper deals with investigating the fuel and oxidizer flow patterns in the ladder echeloned grids of flame stabilizers by varying their displacement step relative to each other along the flow. Based on the mathematical modeling, the effects of the specified step on the redistribution nature of the air flows in stabilizer grid channels were studied, and the fact of the flow pattern asymmetry increase with the displacement step increase was established. The analysis of the features of the circulation flow in the near wake of stabilizers at different values of their displacement step along the flow was performed.

The results of investigations on determining the influence patterns of the stabilizer displacement step on pulsating flow characteristics were presented. It was found that an increase of this step causes a significant reduction in velocity fluctuations in astern stabilizer areas.

Studies on determining the dependence of the pressure loss on the stabilizer displacement step in the considered stabilizer-type burner device were performed. It is shown that specified pressure losses are reduced considerably with displacement step increase.

Keywords: flame stabilizer grid, stabilizer displacement step, fuel and oxidizer flow.

References

1. Lyubchik, G. N., Mikulin, G. A, Varlamov, G. B., Marchenko, G. S.; Voronovsky, G. K., Nedina, I. V. (Eds.) (2006). Use of tubular combustion technology in devices and decentralized heating systems. In. “Small-scale power in the economic security of the state”. Kiev: Knowledge of Ukraine, 139–151.
2. Mikulin, G. A., Lyubchik, G. N. (2004). Aerodynamic characteristics and mass transfer properties of the tubular combustion enhancers and stabilizers flame. Energy: the economy, technology, ecology, 15 (2), 54–62.
3. Abdulin, M. Z., Isaev, S. A., Lysenko, D. A. (2005). Numerical simulation of turbulent heat transfer in the burner based on the jet-fuel combustion technology niche. Heat and mass transfer and hydrodynamics in swirling flows: Tr. 2nd Russian Conference. Moscow: MEI Publishing, 84–85.
4. Sjunnesson, A., Nelsson, C., Erland, M. (1991). LDA measurements of velocities and turbulence in a bluff body stabilized flame. NUTEK Report, 89–95.
5. Gran, I. R., Magnussen, B. F. (1996). A numerical study of a bluff-body stabilized diffusion flame. Part 2. Influence of combustion modeling and finite-rate chemistry. Combustion Science and Technology, 119 (1-6), 119–191. doi: 10.1080/00102209608951999
6. Granovska, O. O. (2014). Improving stabilizatornyh burners with gas burning mikrofakelnomu. Thermal and nuclear power plant. Kyiv, 26.
7. Rauschenbach, B. V., White, S. A., Bespalov, I. V. et al. (1964). Physical basis of the working process in the combustion chambers of jet engines. Moscow: Engineering, 526.
8. Fialko, N. M., Prokopov, V. G., Butovsky, L. S., Sherenkovsky, Y. V., Meranova, N. O., Aleshko, S. A., Polozenko, N. P. (2010). Simulation of flow structure isothermal flow in layered lattice plane flame stabilizers. Industrial Heat Engineering, 6, 28–36.
9. Fialko, N. M., Prokopov, V. G., Butovsky, L. S., Sherenkovsky, Y. V., Aleshko, S. A., Meranova, N. O., Polozenko, N. P. (2011). Peculiarities of fuel and oxidant when layered arrangement of flame stabilizers. Industrial Heat Engineering, 2, 59–64.
10. Fialko, N. M., Prokopov, V. G., Sherenkovsky, Y. V., Aleshko, S. A., Meranova, N. O., Polozenko, N. P., Abdulin, M. Z., Butovsky, L. S., Melnik, P. M. (2014). Influence quantity flame stabilizers on the course in echelon stabilizer lattices. “Problems of ecology and exploitation of energy facilities”. Kiev: CPI ALCON of NAS of Ukraine, 125–128
11. Fialko, N. M., Prokopov, V. G., Sherenkovsky, Y. V., Aleshko, S. A., Ivanenko, G. V., Abdulin, M. Z., Kutniak, O. N., Ozerov, A. A., Butovsky, L. S. (2014). The structure of the flow in microjet burners with flame stabilizers layered lattices. Scientific Bulletin of National University of Life and Environmental Sciences of Ukraine. A series of “Technology and Energy AIC”, 194/3, 107–113.
12. Fialko, N. M., Prokopov, V. G., Sherenkovsky, Y. V., Aleshko, S. A., Polozenko, N. P., Butovsky, L. S., Abdulin, M. Z. (2014). Laws of mixing in echelon arrays of flat flame stabilizers. Naukova News NLTU Ukraine, 24.7, 187–191.
13. Snegiryov, A. J. (2009). High-performance computing in technical physics. Numerical simulation of turbulent flows: a tutorial. St. Petersburg: Publishing House of the Polytechnic. University Press, 143.
14. Volkov, K. N., Emelyanov, V. N. (2008). Large-eddy simulation of turbulent flows in the calculations. Moscow:: FIZMATLIT, 368.
15. Garbaruk, A. V., Strelets, M. Kh., Shur, M. L. (2012). Simulation of turbulence in the calculation of complex flows: a tutorial. St. Petersburg: Publishing House of the Polytechnic. University Press, 88.
16. Spalart, P. R. (2000). Strategies for turbulence modeling and simulations. Int. Jun 2000 in International Journal of Heat and Fluid Flow, 21 (3), 252–263. doi: 10.1016/s0142-727x(00)00007-2
17. Ferziger, J. H., Rodi, W., Bergeles, G. (1996). Recent Advances in Large Eddy Simulation. Engineering Turbulence Modelling and Experiments, 3, 163–176. doi: 10.1016/b978-0-444-82463-9.50022-8
18. Oran, E. S., Boris, J. P. (2001). Numerical simulation of reactive flow. Cambridge University Press, 529. doi: 10.1017/cbo9780511574474.001
19. Grinstein, F. F., Margolin, L. G., Rider, W. J. (2007). Implicit Large Eddy Simulation. Cambridge University Press, 562. doi: 10.1017/cbo9780511618604
20. Spalart, P. R., Deck, S., Shur, M. L., Squires, K. D., Strelets, M. Kh., Travin, A. (2006). A new version of detached-eddy simulation, resistant to ambiguous grid densities. Theoretical and Computational Fluid Dynamics, 20 (3), 181–195. doi: 10.1007/s00162-006-0015-0

EVALUATION AND INCREASE OF LOAD CAPACITY OF ON-LOAD TAP CHANGING TRANSFORMERS FOR IMPROVEMENT OF THEIR REGULATING POSSIBILITIES (p. 35–41)

Olga Buslavets, Petro Lezhniuk, Olexander Rubanenko

Among measures, aimed at reduction of electric energy losses, usage of the transformers for power flows correction in electric networks is recommended as the most efficient means of energy losses reduction during its transmission. The efficiency of this method considerably increases when the process of power flows optimal control is carried out in automatic mode. For this purpose automatic regulators and systems of automatic control of transformation ratios of the transformers with on load tap changing have been developed.

However, electric energy losses reduction using optimal control of power flows in electric networks will become efficient only when technical states of the transformers and autotransformers, involved in the process of control must be satisfactory and their residual resource and current loading capacity must have certain reserve. For their determination it is necessary to create corresponding methods and means of on-line diagnostics of the transformers and autotransformers. It is obvious that they must use the possibility of modern hardware and software and be based on SMART GRID principles.

Mathematical model of the forecast temperature of upper levels of oil has been developed, among other parameters, the given model takes into account the coefficient of residual resource of the coolers.

For evaluation of technical state of the transformers cooling system the facilities of neuro-fuzzy models will be used, as a result, functional dependences between important factors are taken into consideration.

Neuro-fuzzy model of the transformers loading capacity, depending on the resource coefficient of its cooling system has been developed. It is shown that maximum usage of transformers loading capacity, if it operates within automatic control system of electric energy system, is realized by means of the mechanism of establishment of the corresponding non-sensitivity zone of on-load tap champing operation.

Coordination of transformers operation in the system of optimal control of power flows in EES is realized by setting parameters and non-sensitivity zones of SAC, determined taking into account loading capacity of the transformers.

Key words: mathematical model, temperature of upper levels of oil, power transformer, loading capacity, on-load tap changing, non-sensitivity zone, optimal control.

References

1. Kholmsky, V. G. (1975). Calculation and optimization of electric networks modes. Moscow ENAC, 279.
2. Siddiqui, A. S., Khan, S., Ahsan, S., Khan, M. I., Annamalai, A. (2012). Application of phase shifting transformer in Indian Network. 2012 International Conference on Green Technologies (ICGT), 186–191. doi: 10.1109/icgt.2012.6477970
3. Zhelezko, Y. S. (2009). Loss of electricity. Reactive power. Power quality. Guide for practical calculations. Moscow ENAC, 456.
4. Methodical guides to the analy0sis of technological losses of electric energy and selection of measures of their reduction (2014). Kyiv: GRIFRE, 89.
5. Stogniy, B. C. (2010). Sustainable development of power sector and smart energy system. Proceedings of the Institute of Electrodynamics of National Academy of Sciences of Ukraine, Special issue, 6–9.
6. Kirilenko, O. V., Prakhovnik, A. V. (2010). Sustainable energy: Challenges and ways of development. Proceedings of the Institute of Electrodynamics of National Academy of Sciences of Ukraine, Collection of works, Special issue, 10–16.
7. Kirilenko, O. V., Prakhovnik, A. V. (2010). Information and intellectualization of control systems in energy sector: certain conclusions of the recent years. Technical electrodynamics, Special issue, 10–17.
8. Bahadornejad, M. (2014). Intelligent Control of On-Load Tap Changing Transformer. IEEE Transactions on Smart Grid, 5 (5), 2255–2263. doi: 10.1109/tsg.2014.2329017
9. Lopez-Fernandez, X. M., Ertan, H. B., Turowski, J. (2013). Transformers. Analysis, design and measurement. CRC Press. Taylor & Francis Group, 593.
10. Alekseev, B. A. (2010). Large power transformers: state control in the process of operation and revision. Moscow: NTF «Energoprogress», 88.
11. Rassalsky, A. M. Integrated approach to the diagnostics of high-voltage substation equipment 220–1150 kW under operating voltage in operation conditions. Electric engineering and electro mechanics, 4, 23–25.
12. Gan, Y., Zhang, R. (2013). Distributed supervisory control solution for under-load tap-changing transformers. 2013 IEEE International Conference of IEEE Region 10 (TENCON 2013), 1–5. doi: 10.1109/tencon.2013.6718518
13. Dolli, S. A. (2012). Modeling and optimal placement of voltage regulator for a radial system. 2012 International Conference on Power, Signals, Controls and Computation, 2012, 1–6. doi: 10.1109/epscicon.2012.6175262
14. Aguero, J. R. (2012). Improving the efficiency of power distribution systems through technical and non-technical losses reduction. Transmission and Distribution Conference and Exposition (T&D) on, 1-8. doi: 10.1109/tdc.2012.6281652
15. Zhuravlev, D. V. (2012). Technical measures for improvement the reliability of electric networks 330-500 kV operation. Energy and electrification, 11, 39–45.
16. Buslavets, O. A., Kwitsinsky, A. O., Kudatsky, L. N., Lyakh, V. V., Mezhennaya, S. J., Molchanov, V. M., Stafiychuk, V. G. (2013). Determination of maximal load of transformer substations by calculation method. Energy and electrification, 5, 25–31.
17. Lezhniuk, P. D., Rubanenko, A. E., Nikitorovich, O. V. (2012). Operational diagnostics of high voltage equipment in the problems of optimal control of energy systems modes. Technical electrodynamics, 3, 33–36.
18. Rubanenko, A. E., Kazmiruk, O. I. (2011). Control and improvement of loading capacity of the transformer. Visnyk of Vinnytsia Politechnical Institute, 6, 63–68.
19. Agamalov, O. N., Kosterev, N. V., Lukash, N. P. et al. (2004). Application of fuzzy nonlinear autoregressive model with an external input for the assessment of electrical equipment state. Technical electrodynamics, 2, 49–58.
20. Zhelezko, Yu. S., Artemyev, A. V., Savchenko, O. V. (2008). Calculation and analysis of energy losses in electrical networks. Moscow ENAC, 280.
21. Babu, P. R., Sushma, B. (2013). Operation and control of electrical distribution system with extra voltage to minimize the losses. 2013 International Conference on Power, Energy and Control (ICPEC), 165–169. doi: 10.1109/ICPEC.2013.6527643

THE IMPACT OF CAPILLARY STRUCTURE PROPERTIES ON HEAT TRANSFER FROM BOILING IN LIMITED SPACE (p. 42–46)

Oleksandra Bascova, Vladimir Kravets, Olga Alekseik, Natalia Lebed

Modern cooling systems for radio and electronic equipment widely use heat pipes. The main element of heat pipes is capillary and porous structure (CPS), on which a heat transfer agent boils and condensates. Previous studies showed that intensity of heat transfer depends on geometric parameters of the CPS. Our research is devoted to analyzing experimental data on the intensity of heat transfer from boiling in limited space on the CPS with various fiber lengths. We have determined the impact of space limit on boiling intensity on the CPS. The analysis of the findings has proved that within limited space, when the height of the volume limiter is 5 to 16 mm above the working surface and the density of the heat flow rises to 200 kW/m^2, the intensity of heat transfer increases.

A comparison of boiling intensity on CPSs in large space with boiling intensity in limited space has shown that at the fiber length of 5 mm heat transfer coefficients are similar. Further fiber lengthening leads to decrease in heat transfer intensity.

Keywords: heat transfer intensification, fiber length, boiling, capillary and porous structure (CPS), limited space.

References

1. Report Ukrainian participant of the project «Development and creation of heat pipes on a basis metalfibrous capillary structures with improved thermophysic characteristics for temperature control systems of the perspective space vehicles» - Institute for Problems of Materials. IN Frantsevich National Academy of Sciences of Ukraine for the 2007–2008 year. Sat. scientific. Works (2007–2008). National Academy of Sciences of Ukraine. Kiev, 55.
2. Genske, P., Stephan, K. (2006). Numerical simulation of heat transfer during growth of single vapor bubbles in nucleate boiling. International journal of thermal sciences, 45, 299–309. doi: 10.1016/j.ijthermalsci.2004.07.008
3. Nakoryakov, V. E., Kuznetsov, V. V. (2010). Teplomassobmen pri fazovikh perekhodakh s himicheskih prevrasheniakh v mikrocanalnikh sistemakh, 167.
4. Grigoriev, V. A., Krokhin, Y., Kulikov A. S. (1972). Teploobmen pri kipenii v verticalnukh shelevukh kanalakh, Proc. MEI. Heat and mass transfer processes and devices, 141, 58–68.
5. Amethyst, E. V., Klimenko, V. V., Pavlov, Y. M. (1995). Kipenie kriogennukh gidkostei, Energoatomizdat, 400.
6. Ishibashi, T., Nishikawa, H. (1969). Saturated boiling heat transfer in narrow spases, Journal Heat and Mass Transfer, 12 (8), 863–893.
7. Vishnev, I. P., Vinokur, J. G., Shaposhnikov, V. A., Gorokhov, V. V. (1972). Heat and Mass, 2, 263–270.
8. Wojcik, T. M. (2009). Experimental investigation of boiling heat transfer hysteresis on sintered, metal – Fibrous, porous structures. Experimental Thermal and Fluid Science, 33 (3), 397–404. doi: 10.1016/j.expthermflusci.2008.10.011
9. Alam, M. S., Prasad, L., Gupta, S. C., Agarwal, V. K. (2008). Enhanced boiling of saturated water on copper coated heating tubes. Chemical Engineering and Processing: Process Intensification, 47 (1), 159–167. doi: 10.1016/j.cep.2007.07.021
10. Kim, J. H., Rainey, K. N., You, S. M., Pak, J. V. (2002). Mechanism of nucleate boiling heat transfer enhancement from micro-porous surfaces in saturated FC – 72. Journal of Heat Transfer, 124 (3), 500–506. doi: 10.1115/1.1469548
11. Butkovskiy, A. A. (1985). Teploobmen pri kipenii vodu i acetona na poverkhnostiakh s metallovoloknistumi kappiliarno-poristumi pokrutiami. Kiev, 23.
12. Alekseik, O. S. (2013). Vlianie kharakteristik poristoi structuri na intensivnost kipenia v teplovoi trube. Energy and energy efficiency, 6/5, 29–31.
13. Ovsyannikov, A. V. (2004). Teploobmen pri kipenii na razvitukh poverkhnostiakh v promushlennukh teploobmennukh apparatakh. Moscow, 43.
14. Nishikava, K., Fujita, Y., Ohta, H., Hidaka, S. (1982). Effects of system pressure and surface roughness on nucleate boiling heat transfer. Memoirs of the Faculty of Engineering, Kyushu University, 95–111.
15. You, S. M., Simon, T. W., Bar-Cohen, A. (1990). Experiments on nucleate biling transfer with a highly-wetting dielectric fluid: effects

of pressure, subcooling and dissolved gas content. Cryogenic and Immersion Cooling of Optics and Electronic Equipment, 131, 45–52.

16. Alekseik, O. S., Kravets, V. Y. (2012). Influence of free space high on boiling heat-transfer intensity on porous structure. Eastern-European Journal of Enterprise Technologies, 4/8 (58), 24–27. Available at: http://journals.uran.ua/eejet/article/view/5725/5132

ASSESSMENT OF THERMODYNAMIC PERFECTION OF WORKING SUBSTANCESIN CASCADE REFRIGERATORS (p. 47–52)

Larisa Morozyuk

Cascade compressor refrigerators maintain the cooled object temperature at the level of –110 ºC to –50 ºC. Their complex cycle consists of sequentially aligned single-stage cascade cycles with various working substances and mass flows. Cascade refrigerators at a high temperature upper stage (US) mainly worked on such substances as R12 and R22, whereas R13 and R14 were used at a lower stage (LS). According to the Regulations of International Protocols and Agreements on environmental safety of refrigerating machines, the above mentioned working substances are banned, which has resulted in the search of new pairs of working substances that would meet the requirements of both energy saving and environment safety.

The study considers a technique for selecting a pair of working substances for cascade machines at the first stage of entropy-cyclic method of thermodynamic analysis, i.e. determining the rate of thermodynamic perfection of the actual complex cycle. Three working substances—R744, R717, and R290—in different combinations within cycles-stages, have been used to compare thermodynamic perfection of pairs and shown a mutual impact of working substance properties on the machine perfection as a whole.

Keywords: cascade refrigerator, working substance, the rate of thermodynamic perfection.

References

1. Morozjuk, T. V. (2006). Teorijaholodil'nyhmashin I teplovyhnasosov. Odessa.-Studija «Negociant», 712.
2. Dopazo, A., Femandez-Seara, J. (2011). Experimental Evaluation of a Cascade Refrigeration System Prototype with CO_2 and NH_3 for Freezing Process Application. International Journal of Refrigeration, 34 (1), 257–267. doi: 10.1016/j.ijrefrig.2010.07.010
3. Bingming, W., Huagen, W., Jianfeng, L., Ziwen, X. (2009). Experimental Investigation on the Performance of $NH_3/C0_2$ Cascade Refrigeration System with Twin-Screw Compressor, International Journal of Refrigeration, 32 (6), 1358–1365. doi: 10.1016/j.ijrefrig.2009.03.008
4. Lee, T., Liu, C., Chen, T. (2006). Thermodynamic analysis of optimal condensing temperature of cascade-condenser in CO_2/NH_3 cascade refrigeration systems. International Journal of Refrigeration, 29 (7), 1100–1108. doi: 10.1016/j.ijrefrig.2006.03.003
5. Sachdeva, G., Jain, V., Kachhwaha, S. S. (2014). Performance Study of Cascade Refrigeration System Using Alternative Refrigerants. International Scholarly and Scientific Research & Innovation, 8 (3).
6. Bitzer Kühlma schinenbau GmbH (2004). Obzorhladagentov, 13 (A-501-13), 36. Available at: http://ykaxolod.com.ua/file/Obzor%20hladagentov%20-i%20ix%20vzaimozamenjaemost.pdf
7. Bhattacharyya, S., Kumar, A., Khurana, R. K., Sarkat, J. (2005). Optimization of a CO_2-C_3H_8 Cascade System for Refrigeration and Heating. International Journal of Refrigeration, 28 (8), 1284–1292. doi: 10.1016/j.ijrefrig.2005.08.010
8. Di Nicola, G., Giuliania, G., Polonaraa, F., Stryjekb, R. (2005). Blends of Carbon Dioxide and HFCs as Working Fluids for the Low-Temperature Circuit in Cascade Refrigerating Systems, International Journal of Refrigeration, 28 (2), 130–140. doi: 10.1016/j.ijrefrig.2004.06.014
9. Yamaguchi, H., Niu, X.-D., Sekimoto, K., Neksa, P. (2011). Investigation of Dry Ice Blockage in an Ultra-Low Temperature Cascade Refrigeration System Using CO_2 as a Working Fluid. International Journal of Refrigeration, 34 (2), 466–475. doi: 10.1016/j.ijrefrig.2010.11.001
10. Fiorit, J. J., Lima, C. U. S., Junior, V. S. (2012). Theoretic-experimental evaluation of a cascade refrigeration system for low temperature applications using the pair r22/r404. EngenhariaTermica (Thermal Engineerung), 11 (1–2), 07–14.
11. Martynovskij, B. C. (1972). Analiz dejstvitel'nyh termodinamicheskih ciklov. Jenergija, 216.
12. Morosuk, T., Nikulshin, R., Morosuk, L. (2006). Entropy-cycle method for analysis of refrigeration machine and heat pump cycles. Thermal science, 10 (1), 111–124. doi: 10.2298/tsci0601111m
13. Nikulshin, R. (2012). Entropy method applied for the modeling and analysis of the cycles of two-stage refrigeration machines and heat pumps. Proceedings of the 8th International scientific and technical Conference "Sustainable development and artificial refrigeration", 1, 8–16.

A COMPARISON OF THE COMBINED SOLAR COLLECTOR EFFICIENCY AT DIFFERENT MODES OF ITS OPERATION (p. 53–57)

Ostap Pona, Bogdan Gulai

The systems of solar heat supply that use conventional solar collectors are rather expensive. Therefore, at present it is important to improve and create new combined solar collectors in which the absorber of solar energy is made of a corrugated roofing material. This allows reducing the cost of a solar collector, increasing its strength and simplifying its structure.

The paper suggests increasing the productivity of solar energy use by means of combining a solar collector with a building roof. We present our research findings on incoming solar radiation onto the combined solar collector. We have determined the graphic dependence between various orientations of the roof-based solar collector and its efficiency. The research has proved that efficiency of the combined solar collector without transparent roofing at the change of the angles of heat flow incidence decreases by 40 %, whereas the efficiency of a conventional solar collector decreases by 60 %.

We have described the research findings on the impact of air flow upon the operation of the combined solar collector without transparent roofing. We have determined graphic dependencies between various velocities, directions of air flow and efficiency of the solar collector. It has been proved that efficiency of the combined solar collector when exposed to wind decreases by 45 %. We have determined that efficiency of the combined solar collector being exposed to wind is most of all affected by the air velocity, whereas the air flow direction and intensity of the heat flow affect less.

Keywords: solar collector, heat flow, solar radiation, air flow.

References

1. Halchak, V., Boyarchuk, V. (2008). Alternatyvni dzherela enerhiyi. Lviv: Aral, 135.
2. Tuyakhov, A. Y. (2007) Vozobnovlyaemye y alternatyvnye ystochnyky enerhyy.Ucheb. Donetsk, 184.
3. Renewables Global Status Report (2009). Paris: Global Status Report, 32.
4. Hazami, M., Kooli, S., Lazaar, M., Farhat, A., Belghith, A. (2005). Thermal Performance of a Solar Heat Storage Accumulator Used For Greenhouses Conditioning. American Journal of Environmental Sciences, 1 (4), 270–277. doi: 10.3844/ajessp.2005.270.277
5. Viessmann (2010). Knyha o «solntse». Rukovodstvo po proektyrovanyyu system solnechnoho teplosnabzhenyya.
6. Shapoval, S. P., Romaniv, A. S., Datsko, O. S. (2009). Problemy enerhetyky Ukrayiny. Zakhyst navkolyshnoho seredovyshcha. Enerhooshchadnist. Zbalansovane pryrodokorystuvannya : zb. materialiv I Mizhnarodnoho konhresu. Lviv: V-vo NU «LP», 112.
7. Maczulak, A. E. (2010). Renewable energy: Sources and Methods. NY : Infobase Publishing, 206.
8. Pluta, Z. (2007). Sloneczne instalacje energetzczne. Warsyava: Oficyna Wydawnicza Politechniki Warszawskiej, 246.
9. Chaykovska, Y. E., Ishchuk, N. F. (2011). Technical and economic estimation of energy –saving technology of combined heating. Eastern-European journal of Enterprise Technologies, 4/8(52), 45–48. Available at: http://journals.uran.ua/eejet/article/view/1464/1362
10. Piotrowski, R. (2006). Katalog Projektów Domow Pasywnych i Energooszczędnzch. Warszawa, 1 (1), 71.
11. Wiśniewski, G., Gołębiowski, S., Grzciuk, M. et. al. (2008). Kolektorz Słoneczne: energia słoneczna w mieszkalnictwie, hotelarstwie i drobnzm pryemyśle. Warszawa: Medium, 201.
12. Odyntsov A. N. (2009). Tselesoobraznost yspolzovanyya vertykalnykh solnechnykh kollektorov dlya termorehulyatsyy pomeshchenyy. Visnyk SevDTU, Mekhanika, enerhetyka, ekolohiya, 97, 204–209.
13. Strashko, V. V., Sobkiv, D. I., Holovchenko, V. K. (2006). Patent № 103003 UA MPK (2006), F24J 2/26, F24J 2/52. Helioprofil. Promyslova vlasnist', № 17.