

ABSTRACTS

A Method of Spatial Optimization of Axial Turbine Stage Taking into Account Turbine Profile Flows and the Peripheral Leakage [Text] / A. V. Boiko, D. I. Maksiuta // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 5–11. – Bibliogr.: 5. – ISSN 2078-774X.

The development of the flow pass of powerful steam turbines contributes greatly to the efficiency of turbounits. This paper describes the method of the optimization of axial turbine stages taking into consideration the turbine profile flows and peripheral leakages. The verification of the numerical model and full-scale experiment have been described. Three-dimensional computations of the test stage have been done. Two steps of optimization in terms of the criterion of an increase in the efficiency factor have been realized. The first stage of optimization allowed us to reveal additional reserves for the improvement of the streamline. Using the computing method the efficiency factor of the isolated stage was increased by 0,48 %. Integral and local flow characteristics with regard to the blade height were obtained. The obtained results have been analyzed. The conclusions on the appropriateness of the use of this method during the turbine optimization have been made up.

Key words: spatial profiling, development of the optimization technique, isolated turbine stage, twist law, peripheral leakage.

Investigation of Aerodynamic and Power Characteristics of the Exhaust Compartment of the Low-Pressure Cylinder "Stage-Diffuser" [Text] / V. L. Shvetsov, I. I. Kozheshkurt, V. A. Konev, V. G. Solodov, A. A. Khandrimailov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 12–20. – Bibliogr.: 6. – ISSN 2078-774X.

The numeric investigation of aerodynamic and power characteristics of the last stage of LPC of a powerful steam turbine with the preswitched on channel of the stage gap and with the input section of the diffuser channel of the exhaust branch pipe for the stationary mode was performed using the properties of the wet steam on the basis of one-velocity approximation and the equilibrium condensation. A three-dimensional structure, and averaged aerodynamic characteristics of compartment elements and power characteristics of the stage channel have been given. The influence produced by geometric elements, in particular moisture suction slots, damper wire tie and peripheral integrally machined rack shroud on the flow in the stage channels has been analyzed. The effect of the jet of the over-shroud leakage and also jet parameters on the diffuser flow is discussed including the influence of the damper wire tie on the power characteristics of the stage. The effect of the possible steam flow through the blade slot near the damper wire tie has been studied.

Key words: last stage of LPC, moisture removal system, axial annular diffuser, numerical simulation, wet steam, aerodynamic and power characteristics.

Determining the Parameters behind the Semiopen-Type Impeller of Centrifugal Compressor Stage Taking into Account Disk Friction Losses and Leakage through Clearances between the Body and the Blade Face [Text] / S. S. Evgenev, V. A. Futin, I. M. Shubkin // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 21–24. – Bibliogr.: 5. – ISSN 2078-774X.

Based on experimental data and computations done using the method of finite –dimensional elements the FlowVision program allowed for the generation of parameters behind the semiopen impeller of centrifugal compressor stage. Impeller parameters were determined taking into account disc friction losses and gas leakage in blade channels. These parameters affect the impeller efficiency and are taken as boundary conditions for the computation of axial and radial forces. The updating of these parameters contributes to an increase in the reliability and efficiency of the impeller. To compute relative clearance leakage losses between the impeller blades and the body and also disk friction losses this scientific paper uses generalized experimental data that take into consideration the influence of actual flow coefficients of the stage and the impeller reaction, the geometry of the side clearance between the disc and the body, the value and direction of the leakage flow near the disk required for its friction, and also the influence of boundary conditions behind the impeller in the form of statistical pressure and flow swirl directly in the side clearance.

Key words: centrifugal compressor, semiopen impeller, parameters behind the impeller.

Optimization of Small-Size Gas-Turbine Engines [Text] / V. P. Gerasimenko, M. M. Ovchinnikov, M. Y. Shelkovsky // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 25–28. – Bibliogr.: 7. – ISSN 2078-774X.

The measures were taken to increase the fuel efficiency of small-size gas-turbine engines and power plants with the regeneration of heat through the thermodynamic optimization of the working process and gas

dynamic optimization of engine components. An optimal degree of an increase in pressure of the gas-turbine engine with an increase in gas temperature is $T_r^* = 1100 \dots 1200$ K and the regeneration degree of $\beta_p = 0,8 \dots 0,9$ is $\pi_{кпе} = 3,5 \dots 4,5$ and the efficiency factor $\eta_e = 0,33 \dots 0,35$. The optimization of the centrifugal compressor and turbine has been performed.

Key words: gas turbine engine, compressor, turbine, heat regeneration, optimization, and efficiency factor.

Studying Working Processes in the Combustion Chamber of Gas Turbine Engine Using RQL-Technologies for Synthetic Gas Combustion [Text] / S. I. Serbin, N. A. Goncharova // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 29–33. – Bibliogr.: 7. – ISSN 2078-774X.

This scientific paper is devoted to the problems of numerical simulation of working processes in the combustion chambers of gas turbine engines that operate using an alternative fuel. The issues related to the possibility of the use of *RQL* technology for synthetic fuel combustion and the need for the introduction of structural modifications of fuel burning plants to improve ecological characteristics of available combustion chambers have been discussed. A conception of *RQL* combustion chamber is given as the strategy to reduce the emissions of nitrogen oxides (NOx) of gas turbine engines. This conception differs by high combustion stability due to the rich primary zone. In stationary conditions standard combustion technologies are considered to be the technologies with a high-speed preliminary mixing. Safety conditions are not very important, the work cycle is more restricted and the reduction of NOx emissions is more essential in contrast to *RQL* technology. Nevertheless, the *RQL* combustion technology is of great interest for the stationary application due to the possibility of more efficient processing of the fuel of a compound composition and also for the processing of fuels of a different component composition. An additional research is required to study the NOx formation in *RQL* configurations.

Key words: combustion chamber, synthetic fuel, *RLQ*-technology, mathematical simulation and combustion.

Rational Distribution of Thermal Load in the Heating Plant of the Turbine T-100/120-130 [Text] / A. L. Shubenko, O. A. Babenko, V. N. Goloshchapov, A. Yu. Kozlovkov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 34–37. – Bibliogr.: 3. – ISSN 2078-774X.

This scientific paper is devoted to the improvement of the operation modes of the extraction turbines of heat power plants, which is possible due to the selection of rational methods for heating the network water. To solve this problem we used the mathematical model "SCAT", which was developed by the Institute for the Mechanical Engineering Problems of the National Academy of Sciences of Ukraine. The purpose of this scientific paper is to increase the efficiency of the power –generating units of the heat power plant through the improvement of heat release modes. It has been shown that the rational distribution of the heat load between the network heaters of the lower and upper stages depending on the temperature of outdoor air allows for the generation of additional electric power maintaining the operation mode of power generating unit.

Key words: heat power plant, extraction turbine, network heater, thermal loading, and electric power.

Continuity Equation for the Flow in the Variable Thickness Layer on the Surface S_2 [Text] / B. N. Subotovich, A. Yu. Yudin // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 38–41. – Bibliogr.: 5. – ISSN 2078-774X.

A constant flow of ideal gas through the cascade of axial turbomachine has been considered. To obtain the approximate solution we used the quasi-three-dimensional (*Q3D*) approach, which in its classical statement was comprehensively developed by Ch.Kh. Wu. The flow is separated into the layers by S_1 and S_2 surfaces. The S_1 surfaces have no symmetry axis that coincides with the turbomachine axis. Three –dimensional flow on the S_2 surface is reduced to the two-dimensional flow with no assumption that the flow is axially symmetric. It is assumed that the flow moves in the layers of a variable thickness on two surfaces S_1 and S_2 . The Euler equation is used by the surface problems to describe the flows. The problem is solved individually for each surface taking into consideration mutual influence of two-dimensional (*2D*) flows. First the solution for axial symmetric problem is sought on arbitrary twisted surfaces S_2 assuming that it gives satisfactory data with regard to the averaged parameters of the cascade flow and then flow parameters are determined on axial symmetric surfaces S_1 in the layers of variable thickness in the interblade channel as the deviation from average parameters. To create new methods for the solution of direct and inverse problems of the theory of turbomachine cascades the following approach to the development of *Q3D* technique is proposed, in particular an assumption of axial

symmetry of the flow is eliminated for the problem on S_2 surfaces and the problem is solved for the layer of variable thickness.

Key words: blade cascade, stream surface, inverse problem, velocity vector.

Design Problems of a Steam Cooling System for Gas Turbines [Text] / **A. I. Tarasov, O. A. Litvinenko, I. A. Mihaylova** // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 42–48. – Bibliogr.: 5. – ISSN 2078-774X.

A cooling system is an important part of contemporary gas turbine. Its improvement and sophistication is an essential condition for the creation of a competitive turbine design. The possibility of the use of steam as the heat carrier for cooling systems of gas turbines, which is an alternative to air cooling system, has been analyzed. The advantages and disadvantages of the steam cooling structure of gas turbines have been discussed. The main problems are related to the selection of the turbine cascade for the steam extraction and the turbine cascade for the steam return, hydraulic design of a steam cooling network, assessment of steam losses in the turbine caused by its leakage in branched cooling systems, software development for the solution of acute problems. Using the table data we developed approximating equations for the density, specific heat capacity and other thermal-&-physical properties of the water steam for temperature and pressure ranges that can be used for turbine cooling systems. The estimation of the steam efficiency as a cooling agent for gas turbine cooling has been given.

Key words: gas turbine, steam-gas plant, steam cooling system, and heat emission coefficient.

Heat -Exchange Intensification Factors for the Tube with the Turbulator of a Partial Flow Swirl [Text] / **T. V. Donyk, O. V. Shikhabutinova** // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 49–53. – Bibliogr.: 8. – ISSN 2078-774X.

The preliminary results of the experimental research and computer simulation of the heat exchange and hydrodynamics in the tube with the turbulator of the partial swirl of the flow showed that the dependence of the intensification factor of the average heat exchange on the vortex angle has nonmonotonous character with a local maximum and minimum and such a character is conditioned by the simultaneous influence of several factors, including the vortex angle and flow velocity near the channel surface, the turbulence intensity and the vortex mixing. This paper determined the degree of influence of these factors on the heat exchange intensification in the tube with the turbulence of the partial swirl of the flow. The obtained data showed that the main contribution to the heat exchange intensification is done by the vortex mixing, whose value exceeds a factor of 2,0. Flow swirling and turbulence factors are commensurable between themselves and are equal to approximately 1,2. The velocity reduction factor near the tube surface is equal to approximately 0,6.

Key words: Turbulence, partial swirl of the flow, and heat-exchange intensification factors.

Development of the Thermal Deaerators of High Pressure for the Turbine Plants of the Power Units of Nuclear Power Stations [Text] / **H. V. Grigoriev, P. V. Egorov, M. V. Chuprakov, A. S. Gimmelberg, Yu. G. Sukhorukov** // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 54–60. – Bibliogr.: 2. – ISSN 2078-774X.

Based on the experience gained in the design and commercialization of the deaerators for the Tian Van Nuclear Power Station in China and Nuclear Power Station "Cudanculum" in India we developed new deaerators with the capacity of 6400t/h for the power units No1 and 2 of 1200MW for Novovoronezh NPS-2 and Leningrad NPS-2 under the project NPS-2006. The structure of new deaerators has many advantages, in particular the capacity was increased, the rated content of oxygen in the deaerated water was decreased, and the technological effectiveness during the manufacture and assembly on the site of nuclear power station has been improved. The results of the development and operation of new deaerators are used for the design of new deaerators for the power units No 1 and 2 of 1200 MW intended for the Byelorussian NPS and also rather promising power units for NPS and TPS in Russian and abroad.

Key words: new thermal deaerator of high pressure, low-head water distribution unit, PJSC "NPO CKTI", Project NPS-2006, and feed water deaerator.

Design and Experimental Studies of the Stable Operation of Mixing Low Pressure Heaters for Thermal Power Stations and Nuclear Power Stations [Text] / **T. G. Sintsova, N. N. Trifonov, Yu. P. Sukhorukov, V. F. Ermolov** // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 61–68. – Bibliogr.: 5. – ISSN 2078-774X.

One of the methods used for an increase in the operation efficiency of the turbine plant is considered to be the use of low pressure heaters of a mixing type for the regeneration system. A broad application was found for the gravitation diagram in which mixing heaters are arranged at different heights to provide the possibility of the use of the gravity water overflow from the heater with a lower steam pressure to the heater with a higher steam pressure. However this diagram requires taking additional measures to provide reliable operation of the regeneration system. PJSC "NPO CKTI" developed a technique for the design of the system of mixing heaters of low pressure that are connected according to the gravitational scheme together with condensate electric pumps of the second stage for the purpose of the study of their operation in the regeneration system. The results of statistical and dynamic tests of the mixing heaters of low pressure for the power unit No4 at Kalinin NPS have been given. The comparison of computational data and experimental data that were obtained during the tests showed their satisfactory matching.

Key words: mixing heater, load dropping, tests, and safety.

The Analysis of the Efficiency of Radial Slide Bearings of Turbomachines Operating on Water Lubricating Liquid [Text] / V. V. Rukhlinskiy, V. P. Kozhevnikov, O. M. Borisenko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 69–76. – Bibliogr.: 10. – ISSN 2078-774X.

The purpose of studies described in this scientific paper was to investigate the mechanisms of the behavior of thermal and hydrodynamic processes that occur in slide bearings in water and their influence on the reliability and operation efficiency of friction bearings in different modes of turbine operation and also to develop reliable techniques for the design of bearings based on up-to-date achievements of the theory of lubrication. Lately, the problem of the use of alternative lubricating liquids for the slide bearings of TPS and NPS turbines becomes more and more vital. This problem is vital because the fire safety and ecological safety of power stations should be increased and because of the deficiency of oils. One of the possible trends in the solution of this problem is related to the use of water lubricating liquid for the lubricating systems of turbogenerators. The experimental and theoretical studies of radial bearings lubricated with the water -containing liquid have been carried out. Numerical studies were carried out using the three-dimensional nonisothermal flow of the lubricant liquid in the radial bearing clearance taking into account the heat exchange between the lubricating layer and the bearing elements restricting it. A low viscosity of water provides turbulent mode of the flow, which was taken into account using the Reyhard model.

Key words: bearing, turbine, lubricant, water, oil, power station, operation, mode, investigations, economy, experiment, theory, and the flow.

Optimization of the Periodicity of the Equipment Repair for Power Facilities Taking into Consideration the Aging Factor [Text] / A. V. Efimov, T. V. Potanina // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 77–82. – Bibliogr.: 14. – ISSN 2078-774X.

This investigation presents the method of decision making on the selection of the strategy of technical maintenance and repair of the equipment of the power units of power stations. A scheme for the assessment of artificial risk and risk control has been described. This scheme includes the decomposition of a complicated technical system, ranging the equipment in terms of risk importance (risk estimation, assessment of failure after-effects), conclusions made on the safety of elements and system on the whole, and the methods of the risk control, in particular operative control, diagnostic tests, technical maintenance, and repair jobs. This paper describes the mathematical model used for the optimization of the duration of the periods between the repairs taking into consideration the equipment aging factor. The optimization of restoration jobs allows us to obtain such a result at lower losses. A criterion has been selected to establish the range of repair jobs, in particular the level of artificial risk, which is lower than the adopted admissible level. The costs required for the realization of the considered strategy of technical maintenance should be assessed including the operating costs and the costs related to the situation of adverse outcome, which is measured by the critical consequences of the failures of equipment required for the power station operation. A criterion of the decision making is to reduce to a minimum equipment failure costs taking into consideration the expenses and the possibility of the occurrence of failure scenario. The classification of equipment states, including the "intermediate" ones was performed using Kijima and Sumita models.

Key words: power equipment, operation, repair period, restoration, risk and aging.

Mathematical Simulation and Identification of Actual Heat Losses Caused by the Damaged Insulation of the Pipelines of Heating Mains [Text] / V. N. Pidkopay, A. N. Ganzha, N. A. Marchenko //

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This scientific paper delves into the problems of qualitative heat supply to the housing estate from the central power sources. To provide the required amount of heat energy for the customers it is necessary to compensate heat losses during the heat transfer. It is rather difficult to determine a real value of thermal losses in our country due to the availability of many problems faced by the heat supply sector. The solution of this problem is of great importance for the energy saving. Therefore, the mathematical model and the technique were developed for the determination of actual losses of thermal energy through the surface of the insulation material of pipelines taking into consideration the insulation damage during the operation and operation modes of thermal network. The enlargement coefficients of the normative heat flow and equivalent coefficients of an increase in the insulation heat conduction have been determined. The model adequacy is confirmed analytically. Using this model we can estimate and predict thermal losses in the heat network and also the heat supply efficiency and the energy saving potential.

Key words: mathematical model, thermal network, heat conduction coefficient and temperature field.

A Model of Energy Saving Control Using the Discharge Units of Thermal Power Stations [Text] / G. I. Kanyuk, A. Yu. Mezerya, I. P. Laptinov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 90–97. – Bibliogr.: 3. – ISSN 2078-774X.

The model of energy saving control of discharge units (pumps and fans) of thermal power stations has been proposed. The factors that affect the power efficiency of the supercharger operation have been shown. The influence of the technical performances of pipeline systems on the power station efficiency has been demonstrated. The function of power losses in the supercharger that can be varied in real time depending on the changes of power responses in the discharge units (bearing wear, a change in the Reynolds number, etc.) has been plotted. The vectorial block diagram of the discharge unit has been elaborated and the analytical dependence of power losses on major process parameters of the discharge unit has been obtained. The dependencies between the basic parameters of pump station, in particular, pressure, volumetric supply, control action parameters and pump rotation frequency and control slide position have been established. The experimental energy response of the real centrifugal pump mounted at the thermal power station was used as an example to demonstrate the technique used for the determination of the power efficiency of pump operation varying the rotation frequency and the methods of the determination of the pump operation range, which provides for the minimum power losses has been given.

Key words: supercharging unit, pump, fan, thermal power station, energy saving control, and supercharger control model.

Simulation of the Influence Produced by Creepage Phenomena on the Mode of Deformation of the Highly Stressed Elements of Steam Turbines [Text] / N. N. Grishin, A. N. Gubsky, I. A. Palkov, S. A. Palkov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 98–103. – Bibliogr.: 4. – ISSN 2078-774X.

A numerical realization of the technique used for the assessment of the influence produced by creepage phenomena on the mode of deformation of highly stressed elements of the steam turbine has been given. The technology used for the processing of the experimental curves of the creepage given in the references has been considered. The technology is based on the method of least squares. A modified time model of the creepage with the reinforcement was selected as the creepage model. It belongs to the models of implicit creepage and it is characterized by the stability, accuracy and high-speed solution. The experimental curves of the creepage and the curves obtained using analytical methods have been compared. The influence of the creepage on the mode of deformation of steam turbine elements has been analyzed. The results of numerical studies have been shown at the background of a change in stresses and deformations as a function of time for the lock joint of blades with the disk and in the inner shell of the steam turbine K-500-240.

Key words: irreversible deformation, creepage, method of final elements, method of least squares, experimental curve, modified time model with the reinforcement, two-dimensional approximation, lock joint of the blades, inner shell.

Mobile Tools Used for the Assessment of the Vibratory State of Power Units [Text] / M. G. Shulzhenko, Yu. G. Yefremov, V. Io. Tsybulko, O. V. Deparma // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 104–110. – Bibliogr.: 9. – ISSN 2078-774X.

The hardware used by the mobile multifunctional measuring-&-diagnostic system for the nondestructive control and assessment of the technical state of power and transport units of a continuous service has been

described. The technical performances and functional possibilities of mobile units used for the online control and analysis of the vibratory state of the equipment, in particular rotation frequency measurement (vibrometer); determining the imbalance sites of rigid rotors (the balancing device) have been given. The described tools can be used both as offline measuring devices and as the part of mobile and stationary systems to diagnose the vibratory state of the units. An example of the use of the developed mobile system to diagnose the reasons for the increased vibration of turbounit K-200-130 has been given. The obtained results can be used to solve the problems related to vibrodiagnostics and to establish the reasons for an increased vibration of power units.

Key words: vortex sensor, converter, vibration, vibration state, and diagnostics system.

The Influence of the Circumferential Inhomogeneity of Material Properties on the Asymmetric Deformation of the Turbine Rotor [Text] / M. G. Shulzhenko, P. P. Gontarovskiy, T. V. Protasova // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 111–115. – Bibliogr.: 11. – ISSN 2078-774X.

The consideration was given to the irreversible deformation of steam turbine rotors caused by the circumferential inhomogeneity of material properties, based on the numerical analysis of their three-dimensional mode of deformation. To analyze asymmetric mode of deformation of the elements and units of power machines in the form of rotary bodies we developed the technique based on the use of semianalytical method of finite elements. The meridian section of the structure is split into finite elements and in the circumferential direction the solution is described by Fourier series. The ductility strain, anisotropy and a change in material characteristics in the circumferential direction have been taken into consideration. The rotor flexures at the circumferential inhomogeneity of yield point have been determined. It has been shown that as the nominal rotation frequency is exceeded originating local ductility strains result in the considerable rotor flexure, which produces negative influence on the operation reliability of the turbine unit.

Key words: steam turbine rotor, circumferential inhomogeneity of material properties, asymmetric deformation, rotor flexure, semianalytical method of finite elements.

Methods and Tools Used for the Reduction of the Uncertainty of the Estimation of the Heat Exchange Intensity in Compound Mixtures [Text] / S. I. Tkachenko, N. V. Pishenina, T. Yu. Rumyantseva // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 116–126. – Bibliogr.: 12. – ISSN 2078-774X.

To reduce the uncertainties of the estimation of the heat exchange intensity in compound mixtures we studied the experimental-&-design method (EDM) used for the determination of the heat exchange intensity between the metal wall and the compound mixtures, whose thermal and physical properties-related information is unknown. The experimental and design component of the EDM has been improved. The experimental unit was added to the experimental bench used for the realization of the EDM to determine the intensity in the conditions of forced motion. The experimental determination of the temperature distribution along the height of heating and heated thermal carriers has been provided. To provide computer-aided data collection and processing the experimental information was keyboarded into the computer. A method of the processing of experiments by specifying the parameter range for the studies has been proposed. The method used for the determination of the type of liquids (Newtonian or non-Newtonian) to which the natural mixture (solution) is attributed was proposed and introduced into the EDM system. The methods of the selection of the "model" and "partially model liquid" in definite hydrodynamic conditions and the use of thermal and physical properties for the estimation of the heat exchange intensity in compound mixtures in full-scale equipment elements have been proposed and scientifically substantiated.

Key words: heat exchange, experimental-&-design method, compound mixture, non-Newtonian liquid, thermal and physical properties.

Determining the Geometric Parameters of the Sealing Units of Turbogenerators with the Hydrogen Cooling [Text] / A. N. Minko, V. V. Shevchenko, V. Yu. Gordienko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 127–130. – Bibliogr.: 4. – ISSN 2078-774X.

This scientific paper proposes the criterion for the selection of efficient geometric parameters for the oil trap of the sealing units of the turbogenerator with the hydrogen cooling of its internal space (using the oil trap as an example). The mathematical simulation of the working zone of the oil trap taking into consideration its geometry and the parameters of the cooling medium used for the internal space of the machine has been carried out. The simulation was performed using the parameters of the minimum value of leakages through the sealing (Q), oil pressure drop level ($P\Delta$) for the sealing, number of labyrinth grooves (z) and the value of the radial clearance (slot) between the rotor shaft and the working surface of the oil trap. The region of optimal values of

the geometry of the working zone of the oil trap, which allows for the selection of the length of the working zone for the oil trap, number of rotor grooves, the groove depth and the distance between the grooves has been established. Obtained practical recommendations can be of interest for the engineers and scientists involved in the design, repair and optimization of the sealing units for large electrical machines.

Key words: turbogenerator, oil trap, and geometric parameters.

The Identification of the Quantitative Composition of Unknown Gaseous Fuel and its Combustion Products using the Measured Technological Parameters of the Fuel Combustion Process [Text] / A. I. Brunetkin, M. V. Maksimov, A. V. Bondarenko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 131–141. – Bibliogr.: 5. – ISSN 2078-774X.

An emphasis is laid to the extensive base and high potential of the alternative (not certified) types of combustion gases. Special attention was paid to the reason that hampers their use, in particular unknown and variable composition. As a result fuel of such a kind in many cases is burned not at optimal (not stoichiometric) fuel –to-oxidizer ratios. The mathematical model based on the relationships of chemical thermodynamics, which allows for the computation of combustion products in such conditions has been selected. This is realized on the basis of the known fuel composition (fuel and air as an oxidizer), their calorific value (enthalpy) and qualitative composition of combustion products. As a result we can determine the quantitative composition of combustion products and their appropriate temperature. The approximation relationships used for the computation of appropriate thermodynamic functions have been obtained. Based on the marked out relationships taken for the solution of the above “direct” problem we proposed the solution for the “inverse” problem using the known qualitative composition of the combustion products, their measured volumetric flow rate and temperature (measured technological parameters), their measured quantitative composition and calorific value (enthalpy). This allows us to provide optimal combustion of the fuel of a similar type. The adequacy of the proposed model has been assessed. Model restrictions were defined.

Key words: not certified fuel, variable composition, combustion products, and mathematical model.

Scientific and Technological Basics of Thermal Power Processes that Occur during the Thermal Vacuum Drying of Carbon Materials [Text] / V. M. Koshelnik, V. A. Kutovoy, A. S. Lutsenko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 142–149. – Bibliogr.: 7. – ISSN 2078-774X.

The development of new energy saving heat technology plants is an important scientific-&- engineering problem related to the use of the system approach to the solution of the problems of energy saving with regard to thermal and physical phenomena realized by heat technology systems and complexes. This paper gives the research results obtained for the energy-efficient drying process and brown coal milling in the thermovacuum unit. The computations of the heating element of the thermovacuum unit have been given. While analyzing thermodynamical processes running in the heat technology plant the consideration was given to the conditions that provide maximum exergic power efficiency factor for the thermovacuum drying unit. This provides an opportunity for the determination of the mode parameters for the drying process and the fabrication of the energy saving highly efficient drying unit and also the assessment of the degree of the thermodynamic sophistication of the heater, based on the selected criterion of the optimality and varied factors. A practical value of the research done is related to the possibility of the setting up of the full-scale production of ecologically safe energy saving thermovacuum drying units of a new generation.

Key words: energy saving, ecology, milling, and vacuum.

Methods Used for the Determination of the Efficient Operation of the Central Heat Supply System Equipped with the Thermal Station [Text] / M. A. Martynyak, J. S. Mysak // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 150–155. – Bibliogr.: 4. – ISSN 2078-774X.

This paper considers the method used for the analysis of the operation of central heat supply system. This method allows for the comprehensive analysis of all the components of the system, which consists of the heat generation source (electric power plant or boiler room), thermal station, energy supply pipelines and water supply pipelines that supply water to the thermal station and also the heat consumer. Using this method we can determine step by step the operation efficiency of system components and the amount of heat supplied to the heat consumer and its losses during the generation and transportation. To increase the operation efficiency of the available system of central heat supply we need to up-date or replace outdated systems for central heat supply, whose technological resource has already been exhausted. The primary task with regard to the system modernization was to determine the system units with the greatest heat losses and to use the most efficient

components of the central heat supply system that comply with the up-to-date engineering level. It has been shown that total losses in contemporary central heat supply systems are within 10%. The efficient use of the heat generated by the boiler room requires the modernization of thermal networks by mounting highly efficient equipment and the replacing boilers with high efficiency factor.

Key words: method, central heat supply system, electric power plant, boiler room, thermal station, heat consumer and efficiency.

Studying the Operation of the Combined Heat Supply System for the Academic Building Using the Energy-Efficient Analysis [Text] / G. A. Balasanian, A. A. Klimchuk, E. V. Kirilova // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 156–158. – Bibliogr.: 2. – ISSN 2078-774X.

This paper gives consideration to the optimization methods of the parameters of the thermal circuit of combined heat supply system for the academic building of the University based on the exergic-&-economic analysis. The circuit diagram of the introduced heat supply plant has been given. The parameters of the given diagram were optimized to minimize the total cost of produced products, using the boundary conditions related to the reliability, easy operation and diagram design technology. The method described in this paper is a powerful tool to provide understanding of the relation between the thermodynamics and economics and it allows us to analyze the operation modes of the heat supply system from the point of view of the cost. The exergic-&-economic analysis of the operation efficiency of different heat sources depending on different external factors has been done. The optimization technique of technical and economic parameters of the thermal circuit of combined heat supply system has been proposed. The formulated optimization problem is attributed to the nonlinear programming task and it was solved using electronic tables. The optimization problem of the working parameters was solved for the combined heat supply system of the academic building.

Key words: renewable heat sources, combined heat supply, exergic-&- economic method, and operation optimization of the heat supply system.

Waste Oil-Based Heating System [Text] / S. P. Polyakov, G. E. Kalejnikov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 159–162. – Bibliogr.: 6. – ISSN 2078-774X.

This paper proposes the heating technique for the industrial and residential buildings using the process heat of the combined combustion in the two-phase flow of the water emulsions of waste motor oils and gas, which is formed at high-temperature pyrolysis of oil organic components. The up-to-date methods used for the disposal combustion of low-grade fuels have been analyzed and their disagreement with ecological standards has been established. The mathematical simulation of combustion processes has been carried out. The obtained models allowed for the selection of the rational modes of the combustion behavior of waste oil emulsions and for the determination of pyrolysis gas composition at prescribed process temperature. It has been established that released gases contain no H_2 and CO at certain volume relations of the excess air and water steam that evaporates from the emulsion; it means that the complete combustion of waste oils takes place.

Key words: waste oils, combustion, emulsion, pyrolysis

Flow Modes of Two-Phase Mixtures in the Flow Bubbling Balloon of the Heat-Utilizer of Released Gases [Text] / O. P. Kostyuk // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 12(1055). – P. 163–170. – Bibliogr.: 14. – ISSN 2078-774X.

This paper is devoted to the research done to increase the operation efficiency of contact units through an increase of the interphase heat -exchange surface and the rate of motion of the phases. The problem related to the cooling of steam -gas mixture in the flow bubbling layer (a dynamic two-phase layer with the rates of light and heavy phases that are not equal to zero) is very vital for high-efficiency contact heat utilizers of released gases emitted by different power supply units. The studies of the processes that occur in the system under the consideration include. Hydrodynamic studies, in particular with regard to the bubbling mode in the vertical pipes of a small diameter were limited to the studies of the flow structure and parameters in the sections of a considerable height. The attention was not paid to the region in the vicinity of the phase mixer, which is responsible for the transfer of a considerable amount of heat and mass. This scientific paper gives the results of experimental research of hydrodynamic modes and the motion forms of gas liquid mixtures in the flow two-phase balloon of the heat utilizer of released gases. It also determines the boundaries of the stable two-phase mode, which correspond to the ultimate values of the stability criterion of the two-phase flow (Kutateladze criterion) and dimensionless liquid velocity (Froude criterion).

Key words: nitrogen liquid mixture, cocurrent flow, two-phase flow, flow bubbling layer, contact -type heat-exchange unit, and the vertical channel.