

Рассмотрены пути улучшения уровня энергосбережения в транспортных газотурбинных двигателях за счет применения каскадных трансформаторов энергии. Выявлены основные преимущества использования в газотурбинных двигателях каскадных трансформаторов энергии над волновыми обменниками давления. Изложены теоретические предпосылки и особенности рабочего цикла газотурбинных двигателей с каскадными обменниками давления. Выработаны рекомендации по расширению области применения каскадных трансформаторов энергии в транспортных газотурбинных двигателях.

Ключевые слова: энергосбережение, газотурбинный двигатель, трансформация энергии, обменник давления, теплообмен, ротор.

УДК 621.224

Уравнение гидроагрегата как элемента системы автоматического регулирования с учетом универсальной характеристики гидротурбины [Текст] / В. А. Булгаков, О. С. Вахрушева, Е. А. Дяченко // Вісник НТУ «ХПІ». Серія: Енергетичні та теплотехнічні процеси й устаткування. – Х.: НТУ «ХПІ», 2014. – № 13(1056). – С. 169–176. – Бібліогр.: 5 назв. – ISSN 2078-774X.

Разработке новых проточных частей гидротурбин на напоры свыше 300 метров посвящено ряд теоретических и экспериментальных исследований. Системы управления и регулирования гидротурбин полностью автоматизированы. Повышение единичной мощности гидротурбины приводит к изменению конструкции гидротурбин. Поэтому необходимо проводить экспериментальные исследования. Материалы этих исследований были использованы при составлении уравнения турбины. Предлагается способ вычисления коэффициентов уравнения и постоянных времени по данной универсальной характеристики. Эта характеристика используется для построения статических характеристик регулирования.

Ключевые слова: гидротурбина, система автоматического регулирования, проточная часть, водовод, универсальная характеристика, приведенные величины, уравнение машины, гидроудар, дифференциальное уравнение постоянной времени, двойное регулирование, статическая характеристика, линеаризация.

ABSTRACTS

Methodology of the Object-Oriented Complex Optimization of the Flow Passes of Powerful Steam Turbines Taking into Consideration the Variable Operation Mode [Text] / A. V. Boiko, A. P. Usaty, O. P. Avdieieva // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 5–10. – Bibliogr.: 10. – ISSN 2078-774X.

The methods of the object-oriented complex optimization of the flow pass of powerful steam turbine taking into consideration the operation modes has been developed. New optimization objects have been included into the complicated hierarchical structure of the project, which opened more opportunities for the design and modernization of steam turbines. This allows for the high-accuracy estimation of the efficiency of the turbine unit on the whole, for optimal solutions at simultaneous consideration of the control system (valve system), control stage, surge chamber and the remaining flow pass (HPC, APC, LPC). The realization of new optimization levels in the single integrated information space CAD "Turbounit" (computer-aided design system) provided the opportunity for the design of the optimal structure of powerful steam turbine intended for the operation in the broad range of the variation of mode parameters. To organize the efficient information exchange the process of optimal design was realized using the recursive bypass of optimization levels. Using the methods of experiment design theory at each recursion level the appropriate formal macromodels of objective functions and functional limitations have been created.

Key words: single integrated information space, optimal design, operation mode, steam turbine.

Combined Erosion –Preventive Protection of the Blades of the Last Stages of Powerful Steam Turbines [Text] / V. L. Shvetsov, A. E. Kovalskii, G. N. Kartmazov, V. G. Solodov, I. I. Kozheshkurt, V. A. Konev // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 11–20. – Bibliogr.: 7. – ISSN 2078-774X.

This paper presents theoretical and experimental substantiation of the new approach to the creation of highly efficient erosion-preventive protection for the blades of a combined type of the last stages of power turbines manufactured by the JSC "Turboatom". It has been shown that the numerical experiment carried out based on the complex mathematical erosion model that takes into consideration the main operation processes in the flow pass and contemporary technologies for the creation of new erosion resistant coatings using the method of atom-&-ion sputtering (AIS) of the materials in vacuum allows us to substantially increase the erosion

stability of the blades through the rational combination of the measures taken to provide active and passive erosion protection for the last stages of powerful steam turbines developed by JSC "Turboatom".

Key words: stage, blades, mathematical erosion model, erosion resistance, erosion protection methods, atom -&- ion dispersion.

Discrete Approach to the Description of High Dispersion Moisture When Determining Mechanical losses in the Last Stage of the LPC of Wet Steam Turbines [Text] / A. L. Shubenko, I. S. Strelnykov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 21–28. – Bibliogr.: 9. – ISSN 2078-774X.

Theoretical methods used for the calculation of mechanical losses caused by the moisture in the last stages of the low pressure cylinders of powerful steam turbines using the discrete approach to the description of high dispersion moisture and conservation laws have been presented. New expressions generalizing the solutions made earlier for the mechanical losses of the impeller power that include deceleration losses thus providing an opportunity for rather easy computation of full mechanical losses of the stage both in the aggregate and in terms of peculiar interactions of the condensed moisture with the steam and blades. The relationships as a function of the reactivity degree of the reduced power of mechanical losses and the return ratio of the moisture flow of high-dispersion that were obtained when studying the improvement tendencies of the geometry of the upper section of the blades have been shown. The recommendations on the selection of some structural parameters of the stage have been given.

Key words: steam turbines, low pressure cylinder, high dispersion moisture, moisture losses, deceleration losses, acceleration losses.

Modernizing the Regeneration Systems of the Turbine Plant to Operate the Energy Unit at a Reduced Load of 300 MW with the Deaerator-Free Thermal Flow Diagram [Text] / E. B. Grigorieva, N. N. Trifonov, S. B. Esin, F. A. Svyatkin, E. K. Nikolaenkova, E. A. Sukhorukova, Yu. G. Sukhorukov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 29–34. – Bibliogr.: 3. – ISSN 2078-774X.

This paper proposes circuit designs to provide stable operation of the regeneration system with the deaerator-free thermal flow diagram. The peculiarities of the application of the diagram with the mounted frequency converter and with the adjustment of the set pressure value of the control valve have been considered. Pressure control circuits for the main condensate before the feed pump have been developed. The paper gives the test results of the deaerator-free thermal flow diagram with the adjustment of the set pressure value of the control valve of the K-300-240 HTGZ turbine that confirm the reliable operation of the regeneration system at a loading of 300 to 150 MW.

Key words: deaerator-free thermal flow diagram, high pressure heaters, condensate discharge of the heating steam from the high pressure heaters, cavitation-free operation of the feed pumps.

Turbine Stage Clearance Design to Solve Reverse Aerodynamic Problems in Free Circular Channels [Text] / V. P. Subotovich, A. Yu. Yudin, S. A. Temchenko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 35–38. – Bibliogr.: 3. – ISSN 2078-774X.

The results of the comparison of computational and experimental data for the axial turbine stage have been given. The computations were done using a new method of the computation of axially symmetric flow in free circular channels. The method was specifically designed for the solution of optimal design problems for turbopmachine flow passes and it takes into consideration the peculiarities of optimization schemes and allows for a considerable paralleling of computational processes. The circular channel is presented as the alternate sections of two types: free sections and the sections blocked up by some devices that are able to change flow swirl angles. The working medium is compressible and nonviscous and the flow is steady, adiabatic, axially symmetric and without separation. The computations done allowed us to find the flow rate distribution, statistical pressure, axial and circumferential velocity components for the cascade height. A good coincidence of the calculated and experimental values of flow parameters has been obtained.

Key words: flow pass, interrow clearance, inverse problem, current line, and turbine stage.

Computer-Aided Estimation of the Resource-Wear of the High-Temperature Turbine Rotor [Text] / M. G. Shulzhenko, P. P. Gontarovskiy, Yu. I. Matiukhin, N. G. Garmash, V. P. Gontarovskiy // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 39–45. – Bibliogr.: 13. – ISSN 2078-774X.

This paper describes the basic principles of the design of the experiment-calculated system for the diagnostics of thermally stressed state, which is intended for the monitoring of the resource of the high-temperature rotors of steam turbines in real operation modes of the turbine unit and also the experimental characteristics of the rotor material. The system allows us to reveal the most dangerous modes of the resource depletion and to optimize start-stop and transient operation modes, which can result in the fuel saving and increased operation reliability of the turbine unit. It can be used for all turbine units of the given type. Its introduction requires the consideration of the operation peculiarities of the automatic control system of technological processes ACS TP mounted on the similar turbine unit. The offered technique and resource diagnosing technology can serve as the base for the development of similar systems for other turbines of Thermal Power Stations and Heat Power Plants.

Key words: resource, rotor, turbine unit, damageability, low cycle fatigue, thermoelasticity and creepage.

Contemporary Methods of the Thermoeconomic Analysis and Diagnostics of Cooling Machines and Heat Pumps [Text] / E. G. Bratuta, D. Kh. Kharlampidi, A. V. Sherstyuk, E. L. Snikhovsky // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 46–54. – Bibliogr.: 36. – ISSN 2078-774X.

The paper shows that the realization of the principles of energy saving with regard to cooling machines and thermal pumps based on the improvement of the structural and geometric performances of thermotransformers taking into consideration the interrelation and mutual influence of circuit elements turns out to be impossible when the traditional energy approach is used. This is related to the fact that the energy approach makes no difference between such conceptions as "heat" and "work". At the same time particularly that fundamental difference defined the prospects of exergic-&-economic methods that can be used for the estimation of the efficiency of thermotransformer circuits, in which energy acts as the universal characteristic of the thermal properties of the working medium. A short background of the creation of thermoeconomics based on the scientific papers written by G. Keenan, M. Tribus, R. Gaggioli, B. Erlach, A. Valero, C. Torres, El-Saed, A. Benelem and M. Feidt has been given. Two classes of thermoeconomic methods, in particular algebraic and numerical have been analyzed. The theory of exergic cost, theory of exergic non –aggregate value, theory of average value, method of specific exergic cost, modified efficient structural analysis and the principle of local average costs were attributed to the first class. The thermoeconomic functional analysis, engineering functional analysis and structural analysis were attributed to numerical methods. The options of more efficient use of the above methods were considered depending on the structure and technological purpose of thermotransformers.

Key words: cooling machines, heat pumps, exergonomics, and diagnostics.

Appropriateness of the Use of the Method of the Inverse Formation of Temperature Inhomogeneity for the Split Cylinder Bodies of Steam Turbines [Text] / A. G. Knabe, M. M. Nechuiviter, I. G. Shelepov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 55–60. – Bibliogr.: 1. – ISSN 2078-774X.

This paper deals with the problem related to the power engineering in Ukraine, in particular, an increase in the efficiency, maneuverability, and reliability of power stations with regard to the extension of the operation time of the thermal power equipment of operated power plants (steam turbines) and search for the opportunities of using energy saving modes to increase their technical efficiency. The control methods of the thermal state of steam turbines with supercritical and high parameters operated in start-up conditions have been analyzed. The application of the method of the reverse formation of temperature inhomogeneity by maintaining the density of the horizontal opening of external and internal cylinder bodies taking into consideration the operation of many units of the steam turbine that retard the speed of starting operations has been proposed. A criterion that provides a stable use of the method of inverse formation of the temperature inhomogeneity in starting modes of steam turbines using different thermal states with and/or without heating the flanges and pins and using also appropriate control programs has been defined and its appropriateness has been studied. The appropriateness of the use of the method of the inverse formation of temperature inhomogeneity for the split cylinder bodies of steam turbines has been determined.

Key words: steam turbine, steam turbine cylinder body, horizontal split opening, thermal state control, starting mobility.

Design of Multistage Centrifugal Pumps on the Basis of the Solution of Inverse and Direct Hydrodynamic Problems [Text] / A. S. Kostornoy, A. O. Bondarev // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 61–71. – Bibliogr.: 7. – ISSN 2078-774X.

High rates of the development of the chemical, coal and oil branches of industry, ferrous and non-ferrous metallurgy, power engineering and agriculture, marine and river crafts demand the advanced development of the mechanical engineering and pump mechanical engineering, which is its inseparable part. The substantiated mathematical model (MM) of the liquid flow in the flow pass (FP) of vane-type hydraulic machines (HM) (turbine and pump) contributed to the development of the methods of their design and determination of hydrodynamic parameters for the task-oriented improvement of energetic, cavitation and power characteristics at the stage of their design, which considerably reduces the time required for the fulfillment of the technical task and replaces the expensive physical experiment by the computational one.

Key words: inverse problem, direct problem, quasipotential (composite laminar) flow, and spiral flow.

Investigation of Multiphase Ejectors [Text] / V. A. Sychenkov, V. I. Panchenko, R. R. Khaliulin // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 72–76. – Bibliogr.: 6. – ISSN 2078-774X.

The results of numerical and experimental investigations of the ejectors have been given. The computational and experimental results of the determination of the coefficient of ejection for gas and gas-liquid ejectors that are widely used in different spheres of the technology have been presented. Gas ejectors are particularly used for the reduction of the temperature field of the combustion products in gas turbine engines. Gas-liquid ejectors found broad application in the field of fire-fighting equipment, which is used for the generation of water-air jet and remote mixture delivery to fight the seats of fire. Optimal geometric parameters that effect the ejector operation and possess a high coefficient of ejection at reduced energy losses of active flow have been determined. The peculiarity of these investigations of the ejectors is that the passive flow pressure and ejector output pressure are equal to atmospheric pressure. The comparison of the results of calculated and experimental data shows their close convergence.

Key words: ejector, ejection coefficient, mixing chamber and diffuser.

Measuring Axial Gas Loadings Acting on the Rotor of Centrifugal Compressor with Magnetic Bearings [Text] / S. S. Evgenev, V. A. Futin // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 77–81. – Bibliogr.: 10. – ISSN 2078-774X.

Exact distribution of axial gas loadings that act on the rotor of centrifugal compressor allows for an increase in the reliability and operating life of the compressor. Based on the experimental data and computations done using the well-known method axial gas loads that act on the closed impeller have been determined. The methods of the determination of axial gas loads that act on the rotor of centrifugal compressor have been described including the gauging of the axial channel of the magnetic suspension and the measurement of the current intensity in axial electric magnets during the compressor operation. For the computation of axial gas load the following parameters were taken into consideration: the geometry of the side clearance between the disks and the body, the values and directions of the leakage flow near the disks, static pressure behind the impeller and the flow swirl directly in the side clearance. The comparison of the computational and experimental data showed their good qualitative coincidence.

Key words: centrifugal compressor, impeller, axial force and magnetic suspension.

Optimization Criteria of Turbocompound Transport Engines [Text] / S. A. Alyohin, V. P. Gerasimenko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 82–84. – Bibliogr.: 10. – ISSN 2078-774X.

The peculiarities of the choice of the engine type for different transport facilities, operation conditions and also the estimation of their efficiency have been described. The efficiency criteria of the transportation facilities during the optimization of their engines have been analyzed. The applicability of some analogous facilities to evaluate the efficiency of surface transport vehicles has been established. The relations of the specific parameters of the engines to some efficiency criteria have been shown.

Key words: gas turbine engine, piston engine, surface transport machine, power, efficiency criterion and optimization.

Determining the Efficiency of the Reduction of Nitrogen Oxide Emissions Using the System of Phasic Coal Combustion of the TPP-312 Boiler, Block No 6 DTEK of Ladyzhinskaia Thermal Power Station [Text] / S. G. Kobzar, A. A. Khalatov // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 85–91. – Bibliogr.: 5. – ISSN 2078-774X.

The adaptation of the bundled software model of the coal combustion to the chemical composition of the fuel, which is burned by DTEK of Ladyzhinskaia Thermal Power Station, has been performed. The computer simulation of the operation of the TPP boiler furnace of the Block No 6 DTEK of Ladyzhinskaia Thermal Power Station equipped with the system of phasic coal combustion for the turbine load mode of 280 MW has been carried out. Computations were done for the designed values of the mode parameters of phasic coal combustion system; the air excess in the main burners was 1, 15; the coal amount, which is delivered to the additional burners is 20 %. The efficiency of nitrogen oxide reduction using the phasic coal combustion system was defined by the comparison with computational data obtained for the TPP-312 boiler operation without the phasic combustion system. It was established that for the designed values of mode parameters the phasic coal combustion system provides the reduction of nitrogen oxide emissions by 22,6 %. A further increase in the reduction of nitrogen oxide emissions by the phasic coal combustion system can be reached through the optimization of the coefficient of excess air in the main and additional burners and the use of carbon dust in additional burners with a lower fraction composition.

Key words: coal combustion, burner, nitrogen oxides, and phasic coal combustion.

Mathematical Model of the Horizontal Steam Generator of a WSG-1000 type of the Power Unit of Nuclear Power Station with Water-Cooled and Water-Moderated Energy Reactor (WCER) [Text] / A. V. Yefimov, V. L. Kavertsev, T. V. Potanina, T. A. Garkusha, T. A. Yesypenko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 92–102. – Bibliogr.: 4. – ISSN 2078-774X.

The structure, schematic thermal diagram, technological process parameters, thermal, hydraulic and structural characteristics, function peculiarities and the mathematical model of the horizontal steam generator of a WSG-1000 (water steam generator) type, which is a part of the main equipment of double-circuit nuclear power stations with WCER-1000 have been described. A consideration has been given to different contemporary structure modifications of the horizontal steam generator of WSG-1000; WSG-1000M, WSG-1000M (V) and WSG-1000 MK types. Their differences, advantages and drawbacks have been analyzed. Based on the equations of thermal balance, heat transfer, thermodynamic and thermophysical properties of the heat carrier and working medium, tube wall material heat conduction, the heat transfer and heat release coefficients of heat carriers, hydraulic and structural characteristics of the steam generator we developed the steam generator model, which is realized in the form of computer program and it can be considered as a component of computer-aided bundled software included into the automated process control system of the power units of NPS with WCER-1000. The structure of program units used for the computation of the parameters of technological processes in steam generators of a WSG-1000 type has been considered.

Key words: mathematical simulation, simulated experiment, steam generator, power unit of NPS, heat engineering diagram, thermal balance, and heat exchange processes.

Ventilation and Hot Water Supply Solar-Heat Collector [Text] / I. M. Ovsjannikova, I. A. Nemirovskij, A. N. Ganzha // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 103–107. – Bibliogr.: 8. – ISSN 2078-774X.

Solar collectors intended for hot water supply needs are widely used today. However, the territorial position of Ukraine prevents their efficient use during the cold period of the year. This reduces their utilization factor and increases the payback period. The use of solar collectors as the recuperators of exhaust air will allow for their efficient operation during the heating season. This becomes possible because the cold air is heated by the indoor waste air heat particularly in the solar collector (heat transfer process) and the preheated air is delivered from this solar collector to the room. In the solar collector-recuperator the cool air circulates in the tube space and the hot air circulates in the intertube space and two flows never mix together. This allows us to use the ventilation and hot-water supply solar-heat collector actually in all the premises including residential buildings and offices. The tests showed that solar collectors used as the recuperators of exhaust air can heat the outside air in the range of minus 10°C to (4,55–6,07) °C. The range is defined by the air exchange value in the room. Thus, the heat consumption for heating is considerably reduced thanks to the fact that the heated air is supplied through the forced ventilation system into the room.

Key words: solar reactor, recuperator, and ventilation exhausts.

An Efficient Methods of the Analysis of the Dynamics of Two-Way Plate –Type Heat Exchanger [Text] / A. A. Shevelev, S. Yu. Abdullin // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 108–114. – Bibliogr.: 8. – ISSN 2078-774X.

Using the method of numerical simulation of the dynamics of the heat-exchange unit the consideration was given to transient processes that occur in the two-way plate-type heat exchanger for the exponential law of the temperature variation of the heating heat carrier. A method of numerical simulation was developed using the modification of the finite-difference implicit diagram of the running counting with regard to the approximation of the system of coherent differential equations of the dynamics of recuperative heat exchangers. The dynamics parameters include transient process time, the output temperatures of the heat carrier, time constant and heat removal from the modular section. The numerical simulation and computer version of the investigation were carried out in the broad range of the change of input parameters that allowed us to make a number of theoretical and practical conclusions: for the temperature rise rate of the heating heat carrier $m \geq 0,1$ the time constant and the duration of the transient process strictly correspond to the dynamics factors of instantaneous change in temperature to a maximum value at the heat –exchanger input; the transient process time and the heat removal value at the stationary state has the linear dependence on the velocity of the heating heat carrier, the offered method can be recommended for the analysis of the transient modes of heat exchangers with the complicated scheme of the motion of heat carriers.

Key words: mathematical model, time constant, heat removal, process time, heat carriers, design module, two-way plate-type heat-exchanger, and distributed parameters.

Methods and Results of the Exergic Analysis of Different Circuits of Biogas Power Plants [Text] / **A. S. Mazurenko, A. E. Denysova, A. A. Klimchuk, Ngo Minh Hieu** // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 115–121. – Bibliogr.: 3. – ISSN 2078-774X.

The methods of the exergic analysis of different circuits of biogas power plants that allow for the replacement of the traditional types of energy and improvement of the environmental conditions have been presented. Schematic heat diagrams of biogas units have been proposed and their efficiency has been analyzed. The cycle parameters of different biogas units (gas turbine unit, steam gas unit with the gas vent to the boiler and the steam gas unit with high temperature steam generator and intermediate steam overheating have been compared and their exergic characteristics have also been compared. The exergic analysis proved that the cycle of the biogas steam gas unit with the intermediate steam overheating using the high –pressure steam generator is the most efficient, which is explained by the fact that the fraction of the thermal energy of combustion products for the steam cycle and gas cycle is approximately the same in contrast to traditional steam and gas units.

Key words: exergic characteristics, gas turbine unit, steam gas unit with the gas vent to the steam generator, steam gas unit with the high –temperature steam generator and intermediate steam heating.

Biogas Production and Consumption Cogeneration System [Text] / **E. E. Chaikovskaya** // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 122–128. – Bibliogr.: 12. – ISSN 2078-774X.

Heat-to-electric energy production ratio control was proposed based on the prediction of a change in the parameters of biogas consumption and production processes. The cogeneration system that allows for the decision making with regard to the fermentation process maintenance, raw material handling and electric power storage has been developed. The conditions of continuous biogas output and no losses of the generated heat for the fermentation process maintenance allow for the accumulation of the generated energy, which can be used not only to provide the operation of heat pump compressor but also during the period of the chargeback production of electric energy. Such an approach allows for an increase in the marketability of the biogas unit and a decrease in the price cost of electric energy production down to (10 to 15 %). The biogas saving, for example, during the raw material fermentation in amount of 60,2 t/day is equal to 49,4 m³/hour, which gives an annual decrease in the carbon dioxide emissions in amount of 75,6 t/year. Moreover, the waste of anaerobic fermentation can be used not only as a low-potential source of energy but also as the fertilizer, which satisfies environmental protection conditions.

Key words: cogeneration, biogas unit, heat pump, electroaccumulation.

Optimization of the Interblock Processes that Occur in Thermal Power Stations [Text] / **M. A. Duel, G. I. Kanjuk, T. N. Fursova** // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 129–138. – Bibliogr.: 6. – ISSN 2078-774X.

This scientific paper discusses the problems related to the optimization of the interblock technological processes that occur in thermal power stations. The purpose of the research is to improve the quality and efficiency of the operation of automatic control system in the real operation conditions of power units. To solve the optimization problem the decomposition of the power unit as a control object has been done. The

optimization system of burning processes in the steam generator furnace of the thermal power station has been taken as an example for the optimization of the subsystems of automatic power unit control. The technoeconomic effect provided by the system introduction was assessed in terms of an increase in the efficiency factor of the steam generator by (0,2 to 0,3) %. The obtained investigation data can be of interest for the specialists working for thermal power stations. The design and implementation of optimal automatic control systems that are based on up-to-date technical tools and are used for technological energy production processes will provide positive influence on reliability and technoeconomic indices of those processes.

Key words: automatic regulation and control systems, technological processes, optimization, and power unit.

Operation Indices of the Back-Pressure Turbine PR-6-35/5/1,2 in Cogeneration Systems [Text] / M. M. Chepurniy, S. I. Tkachenko, N. V. Resyent // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 139–146. – Bibliogr.: 9. – ISSN 2078-774X.

The main indices of the operation efficiency of the turbine generator with the steam turbine PR-6-35/5/1,2 for different steam and power loadings have been determined and analyzed. The specific consumption of the reference fuel for joint production of thermal and electric energy, the fuel heat utilization coefficient and the fuel heat fraction spent for the thermal energy production have been determined. The use of the indices given above allowed us to establish that the most efficient operation of the given turbine unit is reached under the condition of nominal electric power and permissible steam flow rate through the low pressure compartment and a decrease in pressure of the regulated steam bleeding of the turbine will condition an increase in the efficiency of its operation. In addition it has been shown that the underload of the back-pressure turbine with the steam bleeding in any operation modes results in the considerable degradation of the operation efficiency of steam-turbine unit.

Key words: steam generator, steam turbine, power generator, conventional fuel, and specific flow rate.

The Influence Produced by the Stiffening Members of the Water Chamber of the Steam Turbine Condenser on the Dynamic Action Response [Text] / Yu. S. Vorobyov, M. A. Solokhin, A. N. Gubsky // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 147–155. – Bibliogr.: 3. – ISSN 2078-774X.

The mode of deformation in the water chamber of the steam turbine condenser of a high power was calculated for dynamic action. The operability of the water chamber of a specific structure after varying the rigidness of its elements has been estimated. A formula for flat walls reinforced with ties, which shows the relationship between the mode of deformation in the ties and the structure geometry has been derived. Test computations were done to verify the universality of this relationship. Test computations confirmed the validity of statements done in the paper with regard to the universality of the formula obtained for flat wall structures reinforced with the ties of circular cross section at a known value of dynamic pressure. The conclusion was made that some K value that depends on geometric characteristics of the structure can be calculated for the structure with flat walls reinforced with the ties of circular cross section, for example, the water chambers of steam turbine condensers. The structure response to the dynamic action will depend on this value.

Key words: water chamber, tie, stresses, mode of deformation and dynamic action.

The Evaluation and Analysis of the Thermal Parameters of Solid Heat Storage Elements in Charging and Heat Emission Modes of the Electric Thermal Accumulator [Text] / A. V. Khimenko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 156–161. – Bibliogr.: 7. – ISSN 2078-774X.

The computational investigation of the nonstationary thermal mode of the heat-storage element of the electric thermal accumulator (ETA) of a proposed structure has been carried out. The heating and cooling dynamics of the heat storage element has been analyzed. The thermal efficiency of heat storage elements of a proposed structure was evaluated and compared with that of standard structure elements. Mathematical relationships used for the computation of the temperature of heat storage elements during the charging and heat emission period of ETA have been proposed. The temperature distribution in time on the channel wall of the heat storage element for the selected velocity range of the air motion in the channels taking into consideration heat exchange with the environment and the channel-height change in the temperature of the heated air during the charging and heat emission period has been obtained. Based on the obtained temperature distribution the values of heat emission coefficients, the values of thermal flow from the channel wall to the heated air flow, and the heated air temperature at the channel output have been calculated. The use of the proposed structure of the heat

storage element for ETA will allow for a decrease in power of the tubular electric heater and reduction of electric power consumption.

Key words: Electric thermal accumulator, heat storage element, charging and heat emission mode, and storage capacity.

Improving the Energy Saving for Transport Gas Turbine Engines Using Cascade-Type Energy Transformers [Text] / Yu. V. Starcheous // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 162–168. – Bibliogr.: 8. – ISSN 2078-774X.

The ways of raising the energy saving level for transport gas turbine engines by using cascade-type energy transformers have been considered. The main advantages of the use of cascade-type energy transformers for gas turbine engines instead of wave pressure exchangers have been determined. The theoretical background and peculiarities of the working cycle of gas turbine engines with cascade pressure exchangers have been given. The main idea of the organization of the working process of gas turbine engine based on the cascade pressure exchanger consists in the total replacement of the turbocompressor part by the aggregate that provides a direct conversion of the heat delivered to the cycle into the available work of the compressed gas flow for the removal of air from the rotor seats. The power efficiency of the working cycle of cascade-type energy transformers exhibits a considerable excess of the flow rate of compressed air with regard to the compressed media, whose degree increases with the temperature increase of the latter. The recommendations on the expansion of the application field of cascade-type energy transformers for transport gas-turbine engines have been worked out.

Key words: energy saving, gas turbine engine, transformation energy, pressure exchanger, heat exchange and rotor.

The Equations of Hydraulic Unit as an Element of Automatic Control System Taking into Consideration the Universal Characteristic of a Hydraulic Turbine [Text] / V. A. Bulgakov, O. S. Vakhrusheva, E. A. Diachenko // Bulletin of NTU "KhPI". Series: Power and heat engineering processes and equipment. – Kharkiv: NTU "KhPI", 2014. – № 13(1056). – P. 169–176. – Bibliogr.: 5. – ISSN 2078-774X.

A lot of theoretical and experimental investigations were carried out to develop new hydroturbine flow passes for the heads exceeding 300 meters. Hydroturbine control and regulation systems are totally computer-aided. An increase in the unit capacity of hydroturbine results in a change of the hydroturbine structure. Therefore, we need to carry out experimental investigations. The materials of these investigations were used to formulate the turbine equation. A method of the computation of equation coefficients and time constants using this universal characteristic has been proposed. This characteristic is used for the construction of statistic characteristics of the control procedure.

Key words: hydroturbine, computer-aided control system, flow pass, water line, universal characteristic, reduced values, machine equation, hydraulic shock, differential equation of the time response, double control, statistic characteristic, and linearization.