ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

MAINTAINING THE RELATION BETWEEN PRODUCTION AND CONSUMPTION OF ELECTRICITY AND HEAT AT DECISION-MAKING LEVEL (p. 4-9)

Eugene Chaikovskaya

Known optimization methods of cogeneration systems based on static evaluation of process parameters do not always allow to maintain the relation between heat and electricity production in difficult conditions of inconsistency in their consumption, which requires complicating thermal schemes due to additional equipment. For resource and energy-saving, maintaining the relation between production and consumption of electricity and heat, based on the cogeneration system, which is founded on the integrated dynamic subsystem, including the cogeneration unit, heat pump and battery, is proposed. Using the resulting information, obtained due to operability control and state identification of systems: evaporator-compressor, compressor-condenser of heat pump and operability control and state identification of electric accumulator using mathematical models of the dynamics of the evaporator, compressor, condenser of heat pump and electric accumulator, a method for integrated decision-making in conditions of inconsistency in energy production and consumption is developed. At the change in electricity consumption within the change in co-generation unit capacity, it is possible, by connecting the heat pump, which evaluates both energy production, and its consumption by changing the low-grade energy source temperature, to make pre-emptive decisions on changing the heat production level for further heat carrier use in the cogeneration unit. Forecasting the changes in the battery charge and discharge voltage allows not only to provide economical operation of the heat pump system, but also timely perform economical electro-accumulation during both the unprofitable production of electricity, and decline in its production. Thus, in conditions of maintaining the relation between production and consumption of electricity and heat at the decision-making level, it is possible to reduce energy production cost and harmful emissions of carbon dioxide up to 10–15 %.

Keywords: cogeneration system, electricity, heat, heat pump system, electro-accumulation, decision-making.

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MONITORING SYSTEM OF ELECTRICITY QUALITY IN DECENTRALIZED ELECTRICITY SUPPLY SYSTEMS (p. 10-17)

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Considering the ever-growing demand for electricity, there is a need to introduce new generating facilities - distributed energy sources. This in turn leads to the transformation of the centralized electricity supply system - electricity flow goes from the center to the consumer, into an active decentralized system, characterized by new energy and information flows.

All this points to the need for a new information infrastructure, which should contain a monitoring system of electricity supply mode parameters. Herewith, it is necessary to note the following. Taking into account technical characteristics of new energy sources (their instability), electricity quality is one of the most significant factors that affect the efficiency of both electrical systems, and consumers.

Using existing methods for determining the presence of electricity quality distortion is not acceptable for building real-time monitoring system, based on them. An approach to building real-time monitoring system of electricity quality, which lies in constructing a spatial-temporal distribution of the information signal and the subsequent orthogonal analysis of frequency-temporal changes in its spectral components is presented. Introducing a generalized factor for determining the presence of electricity quality distortion has allowed to carry out its real-time monitoring.

Keywords: electricity quality, orthogonal wavelet transforms, decentralized electricity supply systems, distributed energy sources.

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EVALUATION OF UKRAINIAN WATERWORKS POSITIVE IMPACT FACTORS UPON ENVIRONMENT, INDUSTRIAL, AGRICULTURAL AND SOCIAL SPHERES (p. 18-26)

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Hydrotechnical constructions of energy and water facilities play important role in the modern Ukrainian economics.

There're about 300–350 reservoirs of more than 10 000 m^3 and many small reservoirs for various purposes with about 100 hydroelectric power plants (HPP) and thermal power plants (TPP) on them.

Their operation is risky due to possible disasters and their catastrophic effects with significant financial and human losses. Therefore safe operation of hydrotechnical constructions is an important element of national security.

Except for several exceptions, the vast majority of modern scientific works in the field of technological and environmental safety is primarily devoted to waterworks' negative impact on the environment. The researchers often neglect evaluation of their industrial, social, recreational and ecological potential.

Our work presents:

– system classification of Ukrainian waterworks facilities positive impact factors upon environmental, industrial, agricultural and social sectors;

– collection, systematization and analytical processing of information relating to 18 largest Ukrainian waterworks facilities, which determine value of the integral index of positive effects for each object.

The study confirmed: said facilities are involved in many areas of social life, apart from electricity production.

Analysis of the results showed that the waterworks facilities potential has not been used in full. This especially concerns large reservoirs of the Dnieper cascade and Dniester reservoir, while smaller reservoirs have a well-developed economic and recreational infrastructure.

Management recommendations for local executive and governing bodies, which are responsible for the operation of researched facilities, are to be developed on the basis of obtained data.

Keywords: hydrotechnical constructions, water reservoirs, dams, integral index of positive effects.

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ALGORITHM OF CALCULATION AND ANALYSIS OF CORROSIVE WEAR OF SIDE ENCLOSURES OF GLASS FURNACE BATH (p. 27-33)

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Corrosive wear of refractory materials when in contact with high-temperature melt is the main reason to stop the melting units for cold repair. In continuous fiery glass furnaces, side enclosure of melting chamber is exposed to the most widespread and intense destruction in the flux block-glass melt contact zone. Maximum corrosion rate is observed in the glass melting area, which is caused by the highest temperatures of combustion and melting products. In this regard, longitudinal section of side enclosure of the melting area was selected as the subject of the study. Using finite-element modeling, an algorithm that allows to calculate two-dimensional temperature field in the given section of refractory and insulating materials was developed. Based on the obtained data, thickness of destroyed refractory material for each nodal point of the finite element mesh on the flux block-glass melt boundary for a time period equal to one day is calculated. Furthermore, the flux block geometry is rebuilt considering the destroyed sites, and the calculation is repeated. The basis for finishing calculations is achieving a minimum flux block thickness. According to the operational data, this value is 40–50 mm. Also the analysis, confirming the appropriateness of the selected size of the finite element, used for model partitioning was conducted. Based on the algorithm, a software package, allowing to calculate temperature fields in the section of multilayer side enclosure of the melting chamber of the glass furnace, determine the service life of the enclosure, as well as to define the configuration of corrosive wear-prone sites of flux block was developed.

Keywords: algorithm, corrosion of refractories, configuration of refractories, glass furnace, temperature field.

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EFFICIENCY OF HEAT PUMP VENTILATION AND WATER HEATING SYSTEM IN AN INDOOR SWIMMING POOL (p. 34-39)

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The thermodynamic efficiency of the heat pump ventilation and water heating system of indoor swimming pool with partial exhaust air recirculation and heat pump bypass is analyzed in the paper. The purpose of the work is to determine the system efficiency depending on the change of fresh supply air temperature, ventilation system intensity and heat pump bypassing factor. As a result of implementing the developed mathematical model using the method of successive approximations, dependences of the change of recirculation factor, bypass, air temperatures at the outlet of condenser and heat pump evaporator, as well as the specific energy consumption on the change of supply air temperature are obtained. It is determined that using the heat pump for ventilation air handling and water heating in the swimming bath allows significantly reduce the specific energy consumption compared to the ventilation heat pump system, where water heating in the pool is implemented from external traditional heat source. The developed model allows to determine the specific energy consumption in these heat pump systems based on a combination of the considered factors, affecting their efficiency. The obtained data are the theoretical basis for designing energy-efficient heat pump heating systems for maintaining the comfort conditions in indoor pools.

Keywords: heat pump, swimming pool, ventilation, water heating, moisture content, bypass, recirculation, condenser, evaporator.

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NUMERICAL SIMULATION OF FLOW AND MIXING PROCESSES WITHIN CYLINDRICAL STABILISER BURNER (p. 40-44)

Nataliia Fialko, Yulii Sherenkovskii, Nikolai Maison, Nataliia Meranova, Mikhail Abdulin, Leonid Butovskii, Nina Polozenko, Andrei Klishch, Svetlana Stryzheus, Aleksandra Timoshchenko

A complex of numerical simulation on determining the patterns of the influence of various ways of transfer processes intensification in cylindrical stabilizer burners with fuel feed by introducing in the cross flow of oxidant on the characteristics of these processes is performed. The studies of the influence of a rectangular annular recess on the flow parameters in cylindrical burner are conducted. It is found that, in the presence of recess, the flow turbulence intensity increases. Moreover, at places of its maximum values it may almost twice exceed the corresponding quantities in the absence of recess. Zone of the greatest influence of the recess on the flow turbulization is localized near its position, which is important for fuel ignition and flame stabilization. Pressure losses, associated with the presence of the annular rectangular recess are small and, for the considered conditions, do not exceed 6% of the total pressure losses in the burner in the absence of recess. The analysis of opportunities of flow and mixing intensification in cylindrical burners by mounting plate flow turbulators on stalling edges of the stabilizer is carried out. It is shown that using turbulators provides significant flow turbulization, which is to the greatest extent apparent near the boundaries of recirculation mixing zones. This is accompanied by mixing processes intensification in accordance with fuel and oxidant flow turbulization.

Keywords: stabilizer burner, cylindrical flame stabilizer, transfer processes intensification.

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THE OUTLET FLOW STRUCTURE OF VORTEX CHAMBER WITH DEAD END JET ACTIONS (p. 45-51)

Vladimir Turick, Dmytro Miliukov

The analysis of the flow structure uniformity in the running (active) part of the vortex chamber in conditions of organizing various

control jets, which affect coherent energy-carrying vortex formations in the dead end region of the vortex chamber is conducted. Thermoanemometry data on multiscale outlet flow structure of chamber in the form of distributions of axial and transverse components of the averaged velocity and the corresponding relative intensity of velocity pulsations depending on the control jet parameters is given. The effect of the ratio of working medium flow rate through the control nozzle and at the vortex chamber outlet on the velocity profiles and their pulsations is studied. For the analysis of the flow structure in the active part of the vortex chamber, a new integral parameter - the intensity irregularity degree of velocity pulsations in the exit section is proposed. It is found that the highest values of the integral intensity irregularity degree of axial pulsations are provided by the flow structure control scheme using a coaxial dead end jet, and transversal pulsations - by control scheme using concurrently directed jet with respect to the spiraling energy-carrying vortex formation in the dead-end part of the chamber. The research results are of interest to vortex chamber developers since the obtained profiles of hydrodynamic characteristics of the outlet flows with the investigated jet control schemes indicate the zones of maximum shear effects, so they allow approximately take into account the anisotropy of mass and energy transfer in evaluating the operating modes of chambers with relatively elongated dead end part. These data may be also useful in selecting rational design solutions at the design stage of vortex devices in energy, metallurgical, chemical, aerospace and other industries depending on the purpose of chambers (mixing, separation of media with different densities, the second component supply to the swirling flow and etc.).

Keywords: vortex chamber, flow structure, energy-carrying vortex formations, control jet, thermoanemometry.

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STUDY OF CARBONATE DEPOSITS ON HEAT EXCHANGE SURFACES OF CONDENSERS (p. 52-58)

Victor Kishnevsky, Vadim Chichenin

The technique and the results of studying the formation and deposition rate of carbonates on heat exchange surfaces of condensers from supersaturated solutions of circulating water of the integrated circulating cooling system at thermal and nuclear power plants are given. The dependence of deposition rate on the inhibitor dose and the circulating water salinity is obtained.

The minimum period of the one cycle of studying calcium carbonate crystallization from circulating water during its evaporation, needed to accumulate the smallest possible amount of deposits, sufficient to ensure the representativeness of the experimental data, which is usually 350...400 hours is shown.

The analytical dependence of the influence of scale inhibitor concentrations in the circulating water with given chemical composition on the deposition intensity of calcium carbonate on heat exchange surfaces of the condenser is obtained.

High efficiency of scale inhibitor Acumer 1000 (up to 84 %) in preventing scaling on heat exchange surfaces of condensers of integrated circulating cooling systems is shown.

Keywords: circulating cooling systems, TPP and NPP condensers, deposition rate, scale inhibitors.

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