ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

EXPERIMENTAL RESEARCH OF THE INFLUENCE OF THE POWER PLANS ON PC PERFORMANCE AND ENERGY CONSUMPTION (p. 4–10)

Aleksandr Vdovitchenko

The features of energy consumption in the field of information technology were considered, the impact of information technology on the environment was analyzed. The tasks that form a new direction – green information technology were singled out. The existing programs and standards in the field of energy management of computer and peripheral devices were given. Experimental research by energy consumption criteria and computer performance rating using available performance evaluation tool PC Mark 7 (which allows to estimate the system properties as a whole, and for particular applications) and energy profiler Joulemeter (which allows to estimate the energy spent by devices and processes) were carried out. Based on the resulting data, the analysis was performed using the mathematical statistics and correlation-regression analysis methods and the results were obtained, the transition of the PC energy consumption from the economical plan to maximum performance mode leads to:

– an increase in the energy spent by the CPU on calculations in the test mode by 40 %;

– a reduction of the testing time by 20 %;

– an increase of the performance rating (Scope) according to the PCMark 7 results by 35 %.

It was emphasized that when evaluating energy-consuming characteristics of individual applications (text editors, web-surfing software), performance and energy consumption increase by 2 times. The choice of power supply modes depends on the applied task solved and it can be considered a base for further construction of automatic control systems of the computer performance and energy consumption balance to achieve maximum efficiency.

Keywords: environmental information technology, power supply modes, operating system, load tests, energy profiler.

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FEATURES OF THERMAL CONDITIONSS OF THE NONLINEAR SURGE ARRESTER AT LOW ELECTRIC POWER QUALITY (p. 11–16)

Sergey Shevchenko

The mathematical model for calculating thermal conditions of nonlinear surge arresters based on experimental research of the current-voltage characteristics in the area of leakage currents was improved in the paper. Improvement of the mathematical model for determining the power, dissipated by SA in the area of leakage currents of CVC will allow to consider both conditions of SA, namely when it is an insulator and when it becomes a conductor, and develop a method for evaluating the SA ability to maintain thermal balance throughout the working life. This method is necessary for the correct SA selection of in networks with low electric power quality and calculation of SA operating conditions under peak working voltage of the network.

The results show the presence of the electric power quality influence on the SA thermal conditions. At the SA selection stage, calculation according to the proposed mathematical model allows to determine required bandwidth, which greatly increases the reliability of power supply to electric power consumers. Using the mathematical model, SA manufacturers will be able to produce high-performance devices that will expand their use in networks with low electric power quality.

Keywords: nonlinear surge arrester, current-voltage characteristic, thermal conditions, harmonic oscillations.

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ANALYSIS OF RELIABILITY IMPROVEMENT POSSIBILITIES OF THERMOELECTRIC COOLING DEVICES (p. 17–25)

Vladimir Zaikov, Vladimir Meshcheryakov, Yurii Zhuravlov

The methods of reliability improvement of single- and multistage thermoelectric devices (TED) were considered.

It is shown that in the range of modes from the maximum cooling capacity to the minimum failure rate, there are intermediate modes, in which the influence of the parameters of thermoelements (electric conductivity, thermoEMF, efficiency etc.) is different, which suggests that selecting the combinations of parameters allows to improve reliability indicators of the product.

The methods of reliability improvement in the design of thermoelectric devices when changing the ratio of height to the cross-sectional area of the thermoelement, which reduces the required number of thermoele m ents and TED failure rate were analyzed. Within the construc t ive method, the possibility of choosing the optimal current operating modes of cooling thermoelements for various operating conditions using a criteria-based approach was shown.

Possibilities of a parametric method due to: improving the quality of starting the r moelectric materials and enhancing their effectiveness; using various combinations of starting materials at the same efficiency were defined. According to the results of the comparative analysis of the basic reliability parameters and indicators for various combinations of parameters of starting materials, analytical relations for calculating the basic parameters for various operating modes and temperature fluctuations were obtained.

It is shown that us ing the combined method allows to significantly increase the reliability of the device. The above methods of reliability improve m ent of cascaded TED are a tool in the design of highly reliable thermally loaded equipment using thermoelectric cooling.

Keywords: reliability, thermoelectric devices, efficiency, temperature, failure rate.

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FLOW SIMULATION IN COMPRESSOR CASCADES AT HIGH ANGLES OF ATTACK (p. 26–30)

Yuriy Tereschenko, Ekaterina Doroshenko, Jalal Abolhassan zade

The research objective was to assess the possibilities of using the method of numerical simulation for calculating the aerodynamic characteristics of single-row and double-row of compressor cascades. The flow calculation is performed by the numerical solution of the Navier-Stokes equations, to close which the SST Menter turbulence model is used. The first stage was the flow calculation in the single-row compressor cascade. The flow calculation was held at the angle of attack i=0° and speed ratio λ=0.42–0.83. According to numerical experiment and physical experiment, the dependence of the total pressure loss coefficient ξ and speed ratio λ was constructed. Calculations have shown that the calculation error is allowable (3.1–5.6 %) and the possibility to use the numerical experiment with a given topology of the cascade, SST turbulence model and High resolution design scheme for further research. The second stage was a series of gas-dynamic calculations of the flow in the above compressor cascade for building aerodynamic characteristics. The calculations were performed at a fixed Mach number M_w1=0.72, the angle of attack varied from 0º to +20º. At small angles of attack, the flow separation does not occur. At the angle of attack +20º for the given cascade, boundary layer separation occurs. The third stage was a series of calculations of geometrically equivalent double-row cascade for building aerodynamic characteristics. Comparison of aerodynamic characteristics of single-row and geometrically equivalent double-row compressor cascade in the field of the Reynolds self-similar modes ($Re>10^5$) at the Mach number M_{w1}=0.72 and angles of attack i=0º...20º, obtained using the numerical experiment has shown that double-row compressor cascades have a wider variation range of angles of attack of the unseparated flow. This finding is well consistent with the results of other authors. Thus, using the computational experiment allows to solve the problems of determining the efficiency of double-row blade rows.

Keywords: simulation, angle of attack, cascade, separation, compressor, flow, aerodynamic characteristics, viscosity, vortex, boundary layer.

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DEVELOPMENT AND STUDY OF CONTACT-MODULAR HEATING SYSTEM USING IMMERSION COMBUSTION UNITS (p. 31–35)

Valery Nikolsky

Contact-modular systems for individual heating of various installations using low-emission immersion combustion units with the organization of multiple phase inversion and oscillation modulation of contacting phases were developed and tested in industrial conditions. In order to intensify heat-mass transfer processes in the developed contact units, they were equipped with the organization system of multiple inversion of contacting phases, or a device for oscillation modulation of contacting phases. The design, operation principle, and a brief description of these units were presented. The units are equipped with an additional contact heat exchanger for heat recovery of combustion products by partial heating of water from the heating system. Analysis of the results of the state tests has confirmed the high energy-technological efficiency of the proposed design.

Keywords: immersion combustion units, condensing boilers, heat-mass transfer, energy-technological efficiency.

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DEVELOPMENT OF ENERGY-EFFICIENT IR DRYER FOR PLANT RAW MATERIALS (p. 36–41)

Alexander Cherevko, Lyudmila Kiptelaya, Valeriy Mikhaylov, Alexey Zagorulko, Andrey Zagorulko

Due to the deterioration of the ecological situation in Ukraine and other European countries, the main purpose of the processing industry is the manufacture of high-quality dried products with a high content of biologically active substances (BAS). Since the existing technological equipment for processing plant raw materials has high efficiency and long heat treatment period, which leads to the product quality deterioration, the development of energy-efficient IR dryers is the topical issue.

To implement these requirements it is necessary to solve the following tasks, namely to explore modern IR generators and justify the use of inertialess film electric heater (FEH), develop the IR dryer with an optimal shape of the working chamber, simulate the heat flow distribution on the receiving surface using TracePro software and develop energy-saving system and mechanism for shaking the wire-mesh trays based on the IR device.

As a result of the research, a vertical cylindrical IR dryer ("VC-IR-20"), which has the energy- and resource-saving characteristics for manufacturing high-quality dried plant semi-finished products with a high content of biologically active substances (BAS), which can be used in most food productions, pharmacology, as impurities, and in bulk form, was developed. The device has an optimal geometric shape of the working chamber in the form of a vertical cylinder, ensuring maximum uniform heat flow distribution on the receiving surface. The developed device uses 100 % of the secondary moist air to heat the fresh air by approximately 5 °C, and the shaking mechanism prevents caking of plant raw materials during drying.

Keywords: vitamins, IR technology, development, simulation, inertialessness, dynamics, intensification, energy saving, plant raw material, shaking.

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OPTIMIZATION OF HEAT EXCHANGERS OF REFRIGERATION MACHINES BY ENTROPY GENERATION MINIMIZATION METHOD (p. 42–48)

Larisa Morozyuk

The development of new and modernization of serial heat exchangers are inextricably linked with the identification of their effectiveness. The effectiveness of the heat exchanger as part of the refrigeration machine was analyzed from three perspectives: economic, energy and thermodynamic using specific criteria.

Considering modern thermodynamic analysis methods, which are based on determining irreversible losses in the processes of refrigeration machines, the entropy generation minimization method for analyzing heat exchangers was proposed. The choice of the method has provided an analysis of the processes in a particular heat exchanger of the refrigeration machine irrelatively of other elements, and analysis of one flow in the heat exchanger, which determines the energy side of the operation.

It is shown on a particular example of the water condenser that using the entropy generation minimization method eliminates complex and unproductive calculations, providing the designer with the tools, the action principle of which is based on scientific and independent thermodynamic laws. The characteristics that meet the entropy generation minimum, ensure power-saving mode at the design stage and in a subsequent operation. The method is an alternative to a feasibility study and preferred for refrigeration machines due to the absence of cost indexes.

Keywords: heat exchanger, entropy generation minimization method, characteristics, water condenser.

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ANALYSIS OF THE FOULING IN HEAT EXCHANGERS BY IRREVERSIBLE THERMODYNAMICS METHODS (p. 48–54)

Viktoriya Sokolovskaya

The source of reduced efficiency of the heat exchanger during operation are the fouling layers.

In the analysis of existing theoretical research methods of the fouling dynamics in heat exchangers, it was proposed to use a method of entropy production minimization for the growth analysis of the thermal resistance of the heat transfer wall with the fouling layers. At the design stage, the method has shown the possibility to determine the energy performance of the heat exchanger in the time function, to evaluate the irreversibility in the transition of the heat exchanger to the operation with different temperature conditions and qualitative compositions of flows, to assess the behavior of a single flow, without calculating the entire heat exchanger.

The developed mathematical model of the formation dynamics of solid fouling layers on the heat exchange surface has allowed to introduce the approximate to the real values additional thermal resistances into the calculation at the design stage. The model more accurately describes the heat transfer and fluid dynamics, taking into account the uncertainty of the solid fouling layer formation.

This approach to the fouling layer formation analysis allows to forecast the behavior of the individual flow in heat exchangers and improve repair schedule under the continuous operation of the heat exchanger.

Keywords: fouling, heat exchange surface, irreversible thermodynamics.

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ENERGY SECURITY ASSESSMENT WHEN INTRODUCING RENEWABLE ENERGY TECHNOLOGIES (p. 54–59)

Lilia Nakashydze, Tetiana Gil'orme

Large-scale introduction of energy-saving technologies, especially renewable energy technologies, is closely linked with the problems of energy independence of domestic enterprises. In implementing the latest energy-saving technologies, including advanced technologies of conversion and utilization of renewable energy such as solar energy, heat from venting emissions and etc., forming a kind of the system of enterprise energy security indicators is necessary. Based on certain indicators, enterprise energy security strategy can be evolved in the future taking into account the principles of sustainable development.

To select the best embodiment of the energy supply systems using renewable energy, a set of requirements that will provide effective technical support of the production process were defined.

The system of interconnected stages, which allows the energy security investigation was identified.

The method, which suggests using an indicative method, qualimetric assessment, decoupling etc. to calculate the integral index of the enterprise energy security was proposed.

Qualimetric assessment of the enterprise energy security is carried out in the following stages: forming a hierarchical system; expert evaluation of the weight (importance) indicators: combining quantitative and qualitative estimates by certain rules into the overall estimate of the object.

In the study of the system of the enterprise energy security indicators, consideration of the "effect decoupling", which determines the need to change processes, especially when using renewable energy sources is important.

The obtained indicators can be used in the future when forming the enterprise energy security strategy. Reduction of the indicator value indicates the degradation of the enterprise energy security.

Using indicators when developing the energy supply strategy, including utilization of renewable energy will promote systemic saving of fossil fuel, reducing the harmful effects of energy systems on the environment and energy supply stabilization.

Keywords: energy saving, indicators, energy security, energy, enterprises, strategy.

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