ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

DEVELOPMENT OF LEAKAGE RESISTANCE MONITORING SCHEME ADAPTED TO THE CHANGES OF NETWORK ISOLATION PARAMETRES (p. 4–8)

Aleksandr Kharitonov, Anatoliy Likarenko, Olga Melnyk, Nadiya Lyakhova

Research materials show the effect of isolation capacitance on the conditions of leakage protection operation on alternating control current. The isolation monitoring method, based on using a differential current transformer was applied. To eliminate the destabilizing effect of changes in network isolation capacitance on the leakage relay operation conditions, conditions of adaptation of measuring element to this parameter were found. The research studies have allowed to develop functional diagram of leakage relay, in which functional failures such as the effect of unrecorded leakage currents from the rectified voltage poles on the measuring elements that are configured only to interact with the control current, formed by a special control current source; uncontrolled excess of value of leakage relay, allowable according to the performance charateristics by the actual network isolation capacitance, leading to functional failure because of the failure to provide standard for short-term leakage current through the human body were eliminated. The proposed scheme ensures performing protection functions such as continuous monitoring of the isolation resistance and current leakage values.

Keywords: isolation, leakage, capacitance, scheme factor, relay, functional failure, protective shutdown, control current, monitoring.

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MANAGEMENT MODEL OF EFFICIENCY OF ELECTRIC ENERGY CONSUMPTION BY AIRPORTS (p. 9–15)

Victor Zakharchenko, Nataliya Sokolova

The paper describes a system management model of efficient electric energy consumption by airports, which is based on the improved classical closed-loop management scheme. With the aim of efficient electric energy consumption management, it is proposed to organize a separate energy management service in airports. Information and managerial relationships between the energy management service and airport departments are determined. Management system efficiency is based on the improved methods and algorithms on the regulation of specific electric energy consumption and forecasting of the amount of electric energy consumption by airport objects. The improved regulation method will allow to determine appropriate specific consumption standards for airports for a basic period. The regulation of specific electric energy consumption by airport objects will allow to determine their power-consuming zones and first of all regulate their electric energy consumption efficiency. A system for multifactor forecasting of electric energy consumption by airport objects will allow to execute electric energy consumption management by reducing specific electric energy consumption for the forecast period. The efficiency of these measures is increased through the step-by-step implementation of the complex of practical recommendations. Using the model allows to improve the airport efficiency, which confirms the relevance and practical value of the given study.

Keywords: management, efficiency, electric energy, regulation, forecasting, energy management system, energy saving.

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DEVELOPMENT OF REGRESSION COEFFICIENT SELECTION QUALITY CRITERION IN POWER CONSUMPTION FORECASTING PROBLEMS (p. 16–20)

Sergiy Tymchuk, Igor Katyukha

Forecasting electricity consumption is necessary for industrial enterprises since it allows to optimize its development strategy. The initial information uncertainty problem, arising thereat is also solved using fuzzy regression analysis. Herewith, most authors estimate the quality of determining regression coefficients according to one of the criteria: maximum compatibility of data and model or minimum fuzziness of the model. These criteria are contradictory and using only one of them affects the forecasting quality.

To justify the developed quality assessment criterion of the forecast model, its unambiguous relationship with traditionally used forecast quality assessment based on the relative mean module error by modal values was mathematically proved.

To solve the problem of searching fuzzy regression coefficients using the developed criterion, a simple algorithm that implements the ideas of the method of spatial variable-pitch grid was proposed. The choice of method is caused by the fact that the possible nonlinearity of the regression forecast model requires the global optimum search method. Absolute convergence of the method is also very important.

In general, the results obtained allow to improve informativeness of system for forecasting power consumption of enterprise under initial information uncertainty.

Keywords: power consumption forecast, fuzzy regression analysis, regression quality assessment criterion, fuzzy set.

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COMPARATIVE ANALYSIS OF DECENTRALIZED HEATING SYSTEMS OF RESIDENTIAL BUILDINGS WITH THE USE OF ELECTRICITY (p. 21-25)

Anton Mazurenko, Aleksandr Klimchuk, Oleksandr Shramenko, Olena Syshova

On the threshold of the heating season, Ukraine is in a difficult energy situation. There is a serious shortage of fossil fuels both gaseous and solid. Electricity can become the most viable alternative to fossil fuels in Ukraine. Ukraine produces enough electricity to meet its own needs. However, outdated electricity supply system networks will not allow to resolve the heating problem next winter by a simple transition from gas to electricity. It is necessary to develop a

set of measures that allows to resolve the issue of heat supply systems transition to electricity without significant reconstruction of external networks. Feasibility study of transition ways of heating systems to the electricity use was carried out in the paper. The study has shown that only a comprehensive approach allows to solve the problem of transition of heating systems to electricity without reconstruction of external electricity supply systems. A comprehensive approach should include a number of measures, aimed at reducing the total energy consumption of the building. At the first stage, thermomodernization of buildings should be held, namely wall insulation, replacement of glass with energy-saving. At the second stage, hydraulic balancing of the heating system is organized. The third stage involves replacing the heat source with a heat pump and direct cylinder and can be considered final. Such measures allow to reduce energy consumption for heating needs by at least two times.

Keywords: heating systems, heat pumps, heat accumulators, feasibility study.

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DETERMINATION OF OPTIMAL TRANSIENT IN THE ANTI-SURGE CONTROL SYSTEM OF THE GAS COMPRESSOR UNIT (p. 26–30)

Georgiy Sementsov, Andriy Lagoyda

The paper examines the problem of determining the optimal transient in the anti-surge control system of the gas compressor unit with gas turbine drive on the example of the C-6.3 type centrifugal supercharger. The problem of determining the switching points, constructing the optimal transient was considered. A method to improve the anti-surge control system performance in conditions of the booster compressor station of underground gas storage was proposed since performance of anti-surge control system of the gas compressor unit is a key factor to improve the booster compressor station reliability.

The defined optimal transient in the anti-surge control system of the gas compressor unit with gas turbine drive and transient time show that they significantly differ from the transient in the system for the case when nonoptimal control action is supplied to the control object input.

Keywords: centrifugal supercharger, surge, performance, anti-surge control, optimal transient.

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DEVELOPMENT OF A MATHEMATICAL MODEL OF SOLAR CONVERTER EFFICIENCY (p. 30–36)

Petro Stolyarchuk , Mykola Mykyychuk, Vasyl Yatsuk, Marina Mihaleva, Oksana Shpak, Taras Oleskiv

A mathematical model of the solar collector efficiency is proposed to assess the effectiveness of their operation and quickly monitor their application. The mathematical model is represented by an interval, which is divided into four segments, depending on the purpose of using solar cells. These segments determine inefficient, moderately efficient, efficient and highly efficient operation of the solar

collectors. The determination of the solar cells' efficiency allows making decisions about their future use.

The proposals are worked out to improve the solar collector test methods by increasing the accuracy of measuring the main components. The measures are proposed to reduce the temperature difference measurement errors by several times for improving the accuracy of calculating the efficiency coefficient of the solar collectors approximately twice.

Keywords: solar collector, heat carrier, thermal converter, radiation, temperature, efficiency, resistance, calibration.

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AS REGARDS THE QUESTION OF STUDYING OPERATION CONDITIONS AND INTRODUCTION OF SOME SAMPLES OF CABLES IN GAS TURBINE PLANTS OF JSC «MOTOR SICH» (p. 36–40)

Vladimir Snigirev, Alexey Afonasiev, Kostyantyn Dudnyk, Alexey Kuklin

The study of temperature conditions of thermometering cable runs of ground-based gas turbine plants in order to determine maximum temperatures during continuous operation is given in the paper. Plants include gas turbine drive (GTD), in a compartment of which it is necessary to lay cable lines, where during the rated power operation, air temperature can reach up to 100 °C (with places of local overheating above 200 °C). Therefore, protection of cable lines from high temperatures is an urgent task.

Testing a number of cables and thermal-insulating pipes for the stated temperature by manufacturers of these products is aimed at recommending the best of them for use in gas turbine plants.

Tests have shown that thermal-insulating tubes of company «SilvynHiprojacket» and «AgrotubeC-HTS», without their internal blowing do not have the necessary thermal-insulating properties since the temperature inside and outside the tested tubes differed by a maximum of 2 °C. Therefore, cables Olflexclassic 110 and 180 OlflexHeat sihf, which for a long time can withstand temperatures up to 120 °C, at ambient temperature in the GTD compartment from +20 °C to +55 °C, which is supported by the ACS are recommended for cable lines of gas turbine plants.

Keywords: gas turbine, power plant, termometering, electric cables and thermal pipes.

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INFLUENCE OF ENERGY-ENVIRONMENTAL FACTORS ON THE COMPETITIVENESS OF HYDROGEN AS A MOTOR FUEL (IN TRANSPORT ENERGY INSTALLATIONS) (p. 41–46)

Victor Solovey, Natalia Vnukova, Anatoliy Grytsenko, Pavel Kanilo

It is described in the paper that for maintaining ecosafe motor transport systems evolution, the development of criteria, based on which it would be possible to evaluate the perfection and technical condition of automobiles is necessary. On the basis of experimental data handling, obtained while testing automobiles of a various make, based on the analysis and coordination of numerous

research results, the authors have confirmed that benzopyrene is a reliable indicator of prioritized carcinogenic hydrocarbon emission level and can be used as an indicator of total carcinogenicity ($M_{\Sigma ПАР}$) of automobile exhaust gases. Formulas for the $M_{\Sigma ПАР}$ calculation are given. The changes in specific cost expenditures ($\delta\overline{З}_{(П+H_2)}$) when using hydrogen, as an additional energy carrier were calculated. An assessment of the total energy expenditure and atmospheric emissions when using different fuel technologies in motor transport was made. It is proved that adding hydrogen to the diluted air-fuel mixture in the ICE is economically sound. The expediency of wind-power potential at the self-supporting motorway filling stations was found. It is emphasized that with the full implementation of the mentioned technologies, an increase in socio-economical attractiveness of the hydrogen energetics transport component is expected.

Keywords: hydrogen, motor fuel, renewable energy sources, automobile life cycle, energy-environmental factors.

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INFLUENCE OF TiO_2 NANOPARTICLES ON ENERGY EFFICIENCY OF REFRIGERATORS USING ISOBUTENE AS WORKING FLUID (p. 47–52)

Denis Kuleshov

The practical aspects of using a mixture of R600a/TiO_2 in refrigerators were considered. The experimental studies on the refrigerator characteristics running with the compressor BOCK F2-NH_3 were conducted. The results showed that a mixture of R600a/TiO_2 can work effectively in the refrigerator. The addition of nanoparticles leads to the improvement of the thermophysical properties and heat transfer characteristics of the refrigerant. In comparison with a refrigerator that uses pure R600a as a refrigerant, the use of TiO_2-R600a of 0.1 and 0.5 g/L can reduce energy consumption by 6 % and 8 % respectively. The energy consumption test was performed for comparing the refrigerator performance with a nanorefrigerant and a pure refrigerant to provide the basic data for the use of nanoparticles in refrigeration systems. This research showed that nanoparticles can improve the refrigerator efficiency factor.

Keywords: energy efficiency, nanorefrigerant, isobutane, TiO_2 nanoparticles, refrigerating factor, energy consumption.

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THE OPTIMAL ALGORITHM OF EQUIPMENT OPERATION DETERMINED BY THE DYNAMIC PROGRAMMING METHOD (p. 53–58)

Tatiana Dobrovolskaya

The paper presents an algorithm of managing the units of equipment for burning fuel of different calorific capacities in steam boilers DKVR No 20/13. Burning such kinds of fuel enables an enterprise both to reduce fuel consumption and to decrease burning expenses 13 to 19 times. The three algorithms considered in the research were: an equel distribution of the load between three boilers, between two boilers while the third one remains in reserve, and the boilers operation at the maximum load. The optimal algorithm was based on the criterion that accounted for such factors as equipment reliability and the efficiency of its use. The reliability indicator was based on such parameters as the entire time of the equipment performance, different load rates of the equipment, and the performance time beyond the rated operation. The optimal criterion was calculated by the method of dynamic programming. The criterion determined the optimal algorithm for the equipment performance with each kind of fuel. The research has shown that the suggested method for determining the optimal load management algorithm facilitates an efficient steam boilers operation. Consequently, the use of uncertified fuel allows to decrease the use of certified (purchased) fuel and to reduce the expenditure.

Keywords: control algorithm, gas calorific capacity, optimal criterion, dynamic programming method.

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CALCULATION OF THE THERMAL MODE IN SEMICONDUCTOR DEVICES IN CONDITIONS OF THEIR OPERATION IN SEMICONDUCTOR APPARATUSES (p. 58–65)

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The study of the temperature field of power semiconductor devices, operating in semiconductor apparatuses, either non-contact or hybrid was carried out in the paper.

It was also shown that the main mode of the current load of power semiconductor devices, operating in semiconductor apparatuses is a pulse mode.

Analytical method for calculating the values of the temperature rise in the structure of power semiconductor devices when subjected to a current pulse of arbitrary shape based on a model that adequately reflects the design of semiconductor devices was used during the studies. To calculate the thermal mode of power semiconductor devices, a technique, based on using the simplified thermal models, where the solder layers are taken into account due to expansion of thermal-resistance equivalent tungsten layers is also used. However, unlike it, the method, proposed in the paper provides a higher accuracy in calculating the temperature rise in the structure of power semiconductor devices since all layers of these devices are taken into account. Also, calculation by this method takes into account the dependence of physical properties of materials of the thyristor components on the change in their temperature. Solving the system of heat conduction equations, set up for the model that adequately reflects the thyristor design, was performed by finite difference method using the implicit scheme.

When calculating the transient thermal resistance using the real model for different types of thyristors, difference in its value reaches 5–16 % compared with the calculation using the simplified models. Thus, calculation of the temperature rise in the structure of power semiconductor devices is appropriate to carry out using the proposed method based on a model that adequately reflects the design of these devices.

The described calculation method can be used for the rational choice of a power semiconductor device as a basic

element of hybrid and non-contact semiconductor apparatuses in systems of their computer-aided design.

The paper presents examples of calculating the thermal mode of semiconductor devices for the most common types of semiconductor apparatuses.

Keywords: temperature rise, current load, thermophysical model, semiconductor switch, semiconductor apparatus.

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