ABSTRACT AND REFERENCES

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PARAMETRIC IDENTIFICATION OF FUZZY MODEL FOR POWER TRANSFORMER BASED ON REAL OPERATION DATA (p. 4-10)

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The research is devoted to the development of a fuzzy model for assessing the technical condition of power oil transformers based on the DGA. The parametric identification of optimal values of membership functions of fuzzy terms for linguistic variables is carried out to increase the reliability and objectivity of fault identification. For this purpose, it is proposed to use the theory of fuzzy sets, the nonlinear optimization method. A comparative analysis of the fuzzy simulation results for the technical condition with the fault diagnostic results on existing power transformers has confirmed high efficiency. The diagnostic accuracy of the adapted fuzzy model for the technical condition assessment of power transformers is 97 %, which is acceptable in the power transformers diagnostic. The developed model will be used for further research on the development of an algorithm for making effective decisions regarding the operation strategy of power transformers and preventive control of the subsystem operation of electric power systems. The obtained results of the fuzzy simulation for the technical condition assessment of power transformers give grounds to assert regarding the possibility of implementation in software of operation risk analysis of electric power systems for power supply companies.

Keywords: power transformer, dissolved gas analysis (DGA), technical condition assessment, fuzzy model, membership function.

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DETERMINING ENERGY-EFFICIENT OPERATION MODES OF THE PROPULSION ELECTRICAL MOTOR OF AN AUTONOMOUS SWIMMING APPARATUS (p. 11-16)

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Ensuring the maximum possible navigation range and duration of autonomous functioning of an unmanned swimming apparatus for special purposes was solved by minimizing energy consumption of the electromotive system. In order to achieve it, we proposed a procedure for the estimation of power losses at different static loads and power voltage of the asynchronous baro-unloaded motor of an autonomous swimming device. Special features of the procedure include determining an essentially descending character, loading characteristics of a baro-unloaded asynchronous motor of low capacity; determining the values for magnetic flux of the induction motor, at which under steady operational modes and a partial load, the total power losses are minimal; establishing dependences of performance efficiency and the stator current when controlling voltage at different loads.

Employing the proposed procedure in the control algorithm over electromotive system of the device made it possible to enable an energy-efficient change in power voltage at a constant frequency and partial loads.

Keywords: autonomous swimming apparatus, control algorithms, power losses, baro-unloaded propulsion asynchronous electrical motor.

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ANALYSIS OF THE POSSIBILITY TO CONTROL THE INERTIA OF THE THERMOELECTRIC COOLER (p. 17-24)

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We examined a model of transient processes for the thermoelectric cooler and performed its analysis when the device operated under a non-stationary mode. It is shown that the consideration of various factors influencing the transition process of a thermoelectric cooler comes down to the control over temperature of a thermoelement junction and to the variation of a heat load. The developed model connects thermophysical and structural parameters of the thermoelement, external load and operating current. The model employs the constraints: branches of thermoelements possess identical thermophysical parameters, side surfaces of the cooler are thermally insulated.

An analysis of the model revealed the influence of working current density on the temperature difference and the inertia of thermoelements. We determined conditions under which, by changing the magnitude of operating current, it is possible to minimize the time of transition of temperature difference of the thermoelement to the stationary state, typical of the systems for ensuring heat regimes of thermally-loaded components. The results obtained could serve as a basis for the creation of control system over dynamic characteristics of the thermoelectric cooler.

Keywords: thermoelectric cooler, non-stationary mode, temperature difference, control over inertia.

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ESTIMATION OF GAS LOSSES BASED ON THE CHARACTERISTIC OF THE STATE OF WELLS OF DASHAVA STORAGE (p. 25-32)

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In the present research, it is proposed to use the methods of mathematical modeling of filtering flow taking into account a special type of boundary conditions, characteristic for underground storages, peculiarities of geometry and variable characteristics of permeability of the medium, viscosity and density of fluid.

The specified models found numerical implementation using the over-relaxation method for the Dirichlet problem with a special type of boundary conditions.

As a result of the performed calculations, it was found that regardless of the model of filtering flow and the number of zones of fluid penetration through the boundary zone, the impact of existence of these zones is tangible only in the vicinity of these zones, i. e. existence of outflows on the height of the well's area almost does not affect parameters of the stream at the bottom of this area, the difference in the calculation results is less than 0.5 %. This makes it possible to conclude that detection of the outflow coordinate, as well as of the fact of its existence, is impossible within the Darcy and Forchheimer models.

Keywords: underground storage, modeling of processes, development wells, gas cross-flow, filtering process.

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DEVELOPMENT OF AN IMPROVED DEVICE TO CONTROL FLAME BRIGHTNESS IN COMBUSTION CHAMBERS OF STEAM BOILERS (p. 33-39)

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The study has helped create a device by developing the design of a sensor to control the fire brightness of a coal burner as well as by using the electronic circuit of an information processing unit. The proposed optical fiber transformer design provides a comparison of the brightness of adjacent areas and the total area of a separate torch, and it increases the viewing angle of the sensor up to 20 degrees. A third channel has been introduced to correct measurements, taking into account the radiation of combustion products that hinder the accuracy of the measurement. The study has determined the radiation spectrum of combustion products in the furnace and their dependence on the temperature of the flame.

It has been revealed that the developed optical fiber sensor increases the area of the controlled flame, which increases the accuracy of control. The presence of a "window" in the logic source block will help adapt the device to the temperature and location of burners in the furnace.

The design of the optical fiber transformer and some nodes of the electronic unit can be used in the development of serial combustion control devices for coal burners. The use of CCD matrices will help achieve future two-coordinate control of the burner flame and increase the selectivity and performance of the device.

Keywords: torch, burner, optical control, combustion products, pulverized fuel, spectrum, furnace.

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FRACTAL DIAGNOSTICS OF THE DEGREE OF FUEL ATOMIZATION BY DIESEL ENGINE INJECTORS (p. 40-46)

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The work deals with the research related to finding the relationship between the wear rate of diesel engine injector nozzles and the fractal characteristics of spots of fuel atomized by such injectors.

At present, the processes of diagnosing the degree of fuel atomization by injectors are carried out either using too complicated and expensive methods, or at a basic, visual level with conclusions about the injector efficiency. Based on the analysis of the methods of diagnostics of diesel engine injectors, the method of fractal diagnostics, which does not require the verification of elements either on a working engine, or with the use of complex and expensive devices is proposed.

The research has shown the effectiveness of the proposed quantitative fractal diagnostics to assess the wear rate of diesel engine injector nozzles. The proposed method of fractal diagnostics of the degree of fuel atomization by injectors can be divided into the following stages: getting an image of the spot of fuel atomized by an injector, allocation of the area for the fractal analysis and dimensioning, image segmentation, generation of features and comparison with the reference image.

The experimental research using the method of fractal diagnostics of the degree of fuel atomization by diesel engine injectors is carried out. On the basis of experimental data, the fractal dimension of the spot of fuel atomized by the diagnosed injector allows drawing conclusions about the readiness of injector operation on an engine or about the need for repairing such an injector.

Keywords: fractal diagnostics, degree of fuel atomization, injector, fractal modeling, computer model support.

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STUDY INTO EFFECTS OF A MICROWAVE FIELD ON THE PLANT TISSUE (p. 47-54)

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We report results of experimental research into effects of heat treatment of different plant materials in a microwave field. The effects of seed bio-stimulation are investigated, as well as features of drying and the influence of thermal treatment on the properties of moistened straw. A procedure is proposed for calculating a threshold time of seed exposure to a microwave field, compiled on the basis of hypothesis on the emergence of a bio-stimulation effect. We identified a cascade pressure growth in a container with humid grain when the layer's temperature exceeds 70 °C. The moisturizing effect of the lower layer of grain was established during its drying in MW field under conditions of a leakproof bottom. It is shown that at an initial moisture content in grain of 20 %, after 14 minutes of drying, the moisture content of the upper layer reached 15.5 %, of the middle layer – 14.5 %, of the lower layer – 21.6 %.

It was established that performance efficiency of a microwave chamber substantially depends on the loading volume, material's type, and moisture content. The chamber's performance efficiency while heating water can reach 90 %, the chamber's performance efficiency when loaded with grain does not exceed 67 %. To estimate energy effectiveness of using microwave energy, a dependence is proposed, which includes power output of the magnetron, load volume, and the value of performance efficiency. Dependences for the calculation of performance efficiency when loading a material are proposed to be established experimentally.

Keywords: microwave energy, heating, plant tissue, bio-stimulation, drying, performance efficiency.

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INFLUENCE OF IMPURITIES IN PROPANE COOLANT ON THE PROCESS OF OBTAINING ARTIFICIAL COLD (p. 55-62)

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The study of the influence of propane quality on the total pressure of vapors of the coolant in condensation and vaporization processes and on operation of refrigeration equipment was carried out.

Research was carried out in the refrigeration department of the industrial combined unit of deparaffination of raffinates and oil removal from gatch. In the experiment, technical propane with the content of the main component of 91–96 % by weight was used as the coolant, the rest was made up by hydrocarbon impurities. To determine the composition of the coolant, chromatographic method for separation of hydrocarbons was used.

The impact of propane quality on total pressure of coolant vapor in the refrigeration cycle was determined. Impurities were found to contribute to an increase in total pressure and temperature in evaporation and condensation processes.

A decrease in propane content in the coolant from 95 % by weight to 89 % by weight leads to an increase in pressure in condensers from 57 to 86 kPa, in condensers – from 1,385 to 1,524 kPa. At the same time, there is an increase in temperature of evaporation and condensation by 4–5 °C.

Contribution of each separate impurity to total pressure of saturated vapors of the coolant in evaporators and condensers was determined. The most harmful impurities are ethane and butane. Ethane and methane under conditions of cold production are in gaseous state and increase total pressure in the refrigeration cycle. The content of methane in the raw material mixture does not exceed 0.03 % by weight, which is why its impact on total pressure is negligible.

Butanes form a liquid film on the surface of the equipment, worsen heat exchange processes, and contribute to an increase in the total pressure.

Propylene behaves in the system as a coolant and its impact on total pressure is insignificant.

The impact of hydrocarbon impurities on operation of refrigeration department was established. The impurities differently affect operation of the equipment, however, on the whole, this impact is negative.

An increase in amount of impurities in the coolant contributes to an increase in power consumption of the compressor, worsens compression process and increases consumption of electricity.

A decrease in propane content in the raw material mixture from 97 % to 95 % leads to an increase in total thermal loading on the condenser and the refrigerator by 1.7 %. This causes additional material and energy consumption in the course of cold production.

Keywords: refrigeration unit, refrigeration equipment, propane coolant, hydrocarbon impurities, vapor pressure.

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