ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

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DEFINING ENERGY INDICATORS FOR DETECTING SHORT CIRCUITS IN A DC ELECTRIC TRACTION SYSTEM (p. 6–14)

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It has been proposed to use power losses as an additional energy parameter to complement basic energy indicators in determining the short circuit mode in a traction power grid. Three techniques have been reported to determine the transitional characteristics of an electrical network, which are based on methods of approximation, discrete electrical engineering, and spectral analysis. The need to construct these methods is predetermined by the non-stationarity and nonlinearity of electrical parameters for traction networks, which could form uncertainty in the moment of a short circuit occurrence.

The input data to determine the energy characteristics and losses are the functions of transitional voltage and transitional current, measured at the clamps of the switchgear to which power conductors of the traction network are connected. Based on the experimental measurements and the reported methods, we have calculated basic energy parameters of the network, as well as losses, at different short circuits.

Results of our calculations show that during short circuits in a traction network the quantitative values of energy indicators and unproductive losses make it possible to unambiguously assess the mode of network operation. The obtained results also make it possible to determine the actual load on protective switching devices at short circuits in a traction network.

The proposed methods could be applied when developing computer models of traction networks in order to study them and perform engineering calculations. They could also be applied while designing new or reconstructing current DS traction networks, in order to more accurately substantiate design solutions. In addition, the proposed methods could be employed when constructing new or improving the existing samples of protective switching equipment.

Keywords: transitional process, short circuit, energy losses, energy indicators, spectral analysis.

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ANALYSIS OF THE INFLUENCE OF DRYDOCK MAIN PUMPS DRIVE ON ELECTRIC NETWORK (p. 15–35)

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The influence of unadjustable-speed AC drive and adjustable-speed DC drive of the drydock main pumps on the network of the Okean shipyard (Ukraine) is investigated in MatLab SimPowerSystems.

To accurately simulate deep-bar induction motors, the own method of determining the parameters of the T-shaped equivalent circuit and viscous friction coefficient of a virtual motor according to catalog data is used. This method is based on formulas that correspond to the T-shaped and refined L-shaped equivalent circuit. It is proposed to introduce the corrected values of the initial starting and critical torque ratio into the calculation. The rated power factor

is determined indirectly and compared with the catalog value. The dependences of rotor resistance are approximated by elementary functions, which provide almost constant values of these parameters at subcritical slip values.

As a result of the simulation, it became clear that even with the alternate starting of unregulated electric pump units, there is a significant voltage drop in the network.

The mathematical model of DC drives was built with a common dual-circuit automatic speed control system. A resonance filter is included at the input of each synchronized 6-pulse generator, thereby eliminating possible errors in operation.

The simulation results prove that during the operation of DC drives, there are switching voltage variations in the network, substantially non-sinusoidal current consumption and reactive power consumption. Given the stray capacitance of the cable line, high-frequency voltage fluctuations occur, which are dangerous for electric equipment.

Through the use of the harmonic filtering and reactive power control device, these negative phenomena can be eliminated, thus, the DC drive will surpass unadjustable-speed induction motor drive in many respects. To minimize reactive power consumption, an automatic control system with an integrated variable gain reactor power controller can be used.

Keywords: induction motor, catalog data, direct current, PI controller, specific capacity, harmonic filtering and reactive power control device.

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RESEARCH INTO ENERGY CHARACTERISTICS OF SINGLE-PHASE ACTIVE FOUR-QUADRANT RECTIFIERS WITH THE IMPROVED HYSTERESIS MODULATION (p. 36–44)

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The traction electric drives for electric rolling stock of alternating current employ the diode and thyristor rectifiers that predetermine a series of shortcomings. These include the significant emission of reactive power and higher harmonics of currents to the contact network, as well as the impossibility of implementing electricity recuperation to the contact network. In this regard, it is promising to use single-phase four-quadrant active rectifiers with a correction of power coefficient. The advantage of these converters is ensuring a power coefficient close to unity, the implementation of the sinusoidal input current, as well as the possibility of implementing electricity recuperation to the power network.

In the systems of control over active rectifiers quite common are the control systems with hysteresis modulation. However, hysteresis modulation predetermines the need to implement high and variable frequency for switching power keys, which negatively affects power losses in a transducer. Therefore, a control system with improved hysteresis modulation has been proposed. Due to the improved algorithm for switching power keys the proposed improved hysteresis control system makes it possible to reduce the number of switching power switches. That decreases the dynamic losses of power in an active rectifier, which makes it possible to improve the efficiency of electric rolling stock in general.

The simulation modeling conducted in the MATLAB 2017b software has confirmed effectiveness of the proposed modulation algorithm. In addition, during implementation of the proposed commutation algorithm there is an improvement in the harmonic composition of input current. The reduction in the amplitudes of higher harmonics of input current has been confirmed, as well as the improvement in the resultant coefficient of harmonic distortions.

Keywords: active four-quadrant rectifier, hysteresis modulation, dynamic losses, energy efficiency, power coefficient.

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CONSTRUCTION OF MODELS FOR ESTIMATING THE TECHNICAL CONDITION OF A HYDROGENERATOR USING FUZZY DATA ON THE STATE OF ITS LOCAL NODES (p. 45–52)

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The task on estimating the technical condition of a hydrogenerator under conditions of fuzzy information has been resolved. To this end, a series of models have been constructed for the integrated estimation of the technical condition of a hydrogenerator based on data about the states of its local nodes. The technical states of local nodes are determined based on the earlier devised fuzzy models of the Mamdani type and represent the fuzzy values, which was taken into consideration in the model for estimating technical condition of a hydrogenerator.

The fuzzy methods by Mamdani, Sugeno, Zadeh, as well as the simplified fuzzy inference, were used to build the models. The fuzzy model by Mamdani has a qualitative base of rules only, which simplifies its construction by an expert. The models based on the fuzzy algorithm by Sugeno imply a rule base with weight coefficients, determined by the Saati method. The simplified method and the method by Zadeh require minimal expert participation when constructing a fuzzy model. Examples of estimating the technical condition of a hydrogenerator have been considered based on five devised fuzzy models; the sensitivity of models to the quality and reliability of input information has been tested.

It has been determined that the most reliable result from estimating the state of a hydrogenerator with an error of 1.5–2 % is produced by models built according to Zadeh method and the simplified fuzzy inference, since they have the least dependence on the uncertainty of input data on the states of local nodes, which themselves were obtained based on fuzzy models. High accuracy of these models and low dependence on the quality of incoming information are explained by the minimal participation of an expert during its configuration. The fuzzy models built using the algorithms by Mamdani and Sugeno yield a greater error of 3–4 %. Oure findings could be used to assess the remaining or spent resource of hydrogenerators, the probability of their failure over a time interval, and to execute the risk-oriented control over an electricity energy system and its subsystems.

Keywords: hydrogenerator, fuzzy logic, Mamdani model, Sugeno model, Zadeh method, simplified method.

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PERFORMANCE INVESTIGATION OF DUAL SHAFT HYBRID VERTICAL TURBINES USING DIRECTIONAL FINS (p. 53–58)

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The current direction of wind turbine development is more on horizontal wind turbine types because of its efficiency, which is better than vertical wind turbines. But there are some advantages of this vertical wind turbine in the kind of array turbines and small-sized turbines. In this paper, the research focuses on developing a vertical wind turbine between Savonius and Darrieus turbines and has a dual shaft on one wind energy generating unit.

Vertical turbine design with two turbine shafts placed close together is intended to increase turbine efficiency and increase power density. But this design also affects the omnidirectional nature of the vertical single shaft turbine.

This research investigates the change in the omnidirectional nature of the hybrid vertical turbine dual shaft design and the influence of models of a fin to restore the properties of the omnidirectional turbine. Then tests the performance between prototype using the directional fins and without using the directional fins.

Omnidirectional nature is one of the advantages in vertical turbines, but in the design with two axes, the omnidirectional nature changes and can affect the overall vertical turbine performance.

The experiment results show that the vertical shaft hybrid turbines still have omnidirectional properties, and the use of fins increases the TSR (Tips Speed ratio) value of wind speed, increases the Cp (Power coefficient) of the wind turbine and increases the mechanical power potential of the turbine.

Keywords: hybrid vertical wind turbine, directional fin, TSR, Cp, performance.

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DEVELOPMENT OF A RESOURCE-PROCESS APPROACH TO INCREASING THE EFFICIENCY OF ELECTRICAL EQUIPMENT FOR FOOD PRODUCTION (p. 59–65)

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Specific indicators of heat and electric power consumption per unit of food production have object-oriented properties, since they are determined on the basis of methods that are suitable only for a particular enterprise. It is shown that the system approach is the main approach to increasing the efficiency and reliability of electrical equipment.

The concept of increasing the efficiency of the use of electrotechnical equipment of food production by optimizing machine time is proposed. Methods for optimizing machine time for equipment utilization using a resource-process approach are developed. It is practically proved that by combining successive Gantt charts along the time axis from right to left, one can significantly reduce machine time for transferring raw materials. Thanks to the resource-process optimization, it became possible to significantly reduce the execution time of part of the technological task. Such a technique should be applied separately for all technological units that are consumers or sources of raw materials, followed by creating an integrated mathematical model and subsequent optimization.

As a result of testing the proposed method, energy saving was achieved by optimizing the time of use of the electrical equipment of the baking enterprise. It is found that due to reducing the significant total idle time of electric motors, inappropriate heating, cooling of furnaces and compressor operation, the efficiency of electricity use in food production is increased.

Keywords: electrical equipment, Gantt chart, resource-process approach, machine time, assortment tasks.

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