ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

CALCULATION OF ENERGY LOSSES IN RELATION TO ITS QUALITY IN FUZZY FORM IN RURAL DISTRIBUTION NETWORKS (p. 4–10)

Sergiy Tymchuk, Oleksandr Miroshnyk

The level of electricity loss indicates the efficiency level of electricity supply system. Precise calculation of electricity loss, especially in rural networks (0.38/0.22 kW), is not always possible. It is even more difficult to structure losses at changing PQI since there emerges a problem of reliability of the background information. We suggest solving the difficult problem by means of presenting electricity losses in fuzzy form, which allows to observe dynamic changes of losses at changing PQI as well as to compare the level of losses in the network with the norm. The emerging problem of uncertainty of the background information is solved with the help of fuzzy sets. Meanwhile, the rate of correspondence of PQI fuzzy values to vague standards of power quality should be estimated at their intersection. The intersection of fuzzy numbers can be evaluated due to the area of the figure created by the intersection membership function.

Instead of considering the existing determined dependencies of electricity losses, we suggest presenting losses in fuzzy form with regard to peculiarities of particular loads and elements of power network.

We have suggested expressions for the calculation of electricity losses for different loads, considered losses from asymmetry and nonsinusoidality for asynchronous engines and power transformers as well as presented graphs that distinctly show the range and dynamic changes of electricity losses depending on PQI.

The importance of the obtained findings consists in the new possibility of raising the informational content of the evaluated electricity losses when the background information is uncertain.

Keywords: electricity loss, voltage asymmetry, voltage nonsinusoidality, fuzzy sets.

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DEVELOPMENT OF THE MODEL OF VOLTAGE BALANCING IN THREE-PHASE NETWORKS (p. 11–14)

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Existing models of voltage balancing in electric networks were considered. It was found that such models are underinvestigated when using compensatory balancing installations. The proposed model of voltage balancing in electric networks is based on the Frieze theory. The model is suitable when using compensatory balancing installations, including capacitors.

The evaluation of the model compared with existing ones was performed. During the simulation of the voltage balancing process for one electric network unit, voltage asymmetry parameters were obtained, which were by 30 % lower than the voltage parameters, obtained using existing methods. During the simulation of the voltage balancing process for two network units, voltage asymmetry parameters were obtained, which were by 10–15 % lower than the voltage parameters, obtained using existing methods. These simulation results confirm that the obtained model provides a better voltage quality compared with existing voltage balancing models.

Keywords: reactive power compensation, voltage balancing, load balancing, Frieze theory, asymmetry.

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DEVELOPMENT OF THE SCHEME OF COMBINED HEATING SYSTEM USING SEASONAL STORAGE OF HEAT FROM SOLAR PLANTS (p.15–20)

Anton Mazurenko, Aleksandr Klimchuk, Stanislav Yurkovsky, Roman Omeko

Problems in the heat-power sector of the country force to actively introduce alternative heating systems. The most common heating systems based on renewable energy sources are solar systems and “air-water” heat pumps. Substantial unevenness of solar radiation intensity between summer and heating period requires the use of seasonal storage. A scheme for combined heating with seasonal storage of heat from the solar system was developed. The main heat storage materials, using the phase transition for the heat accumulation were presented. Climatic ranges for efficient use of various heat sources were defined. The simulation of the combined heating system was performed. Proportions of heat replacement in the combined heating system depending on heat energy sources were determined. The research data allow to significantly reduce the proportion of fossil fuels in heating systems of advanced-roofing and low-rise public buildings. The proposed scheme of combined heating allows to use different heat sources within the areas of effective application without reducing indoor comfort.

Keywords: seasonal storage, solar system, heat pump, combined heating systems, phase transition.

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DEVELOPMENT ASPECTS OF ASYNCHRONOUS ELECTROTECHNICAL COMPLEX FOR MINE PIN-STORAGE-BATTERY ELECTRIC LOCOMOTIVES (p. 21–26)

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Analysis of the condition of traction electrotechnical complexes of electric locomotives, used in domestic and foreign underground iron ore mining was performed in the paper. It was substantiated that creating new for domestic mines and safe in service type of electric locomotive – pin-storage-battery with mandatory application of energy efficient traction electromechanical complex: IGBT inverter - asynchronous traction electric motors is highly relevant for modern conditions of underground crude ore mining. Also, the necessity and possibility of obtaining soft electromechanical characteristics in the above structure of the traction complex, which eliminates the corresponding drawback of rigid characteristics of asynchronous electric motors as traction was proved. To this end, based on the optimal control law of the academician M. P. Kostenko, the author’s vision of the control algorithm structure was proposed.

Calculated characteristics and their comparison with the existing ones are given. It is shown that, when implementing the M. P. Kostenko’s law as proposed, an increase of traction parameters, including an increase of adhesion weight of electric locomotive is achieved.

Keywords: asynchronous electrotechnical complex, electric locomotives, electric energy efficiency, electromechanical characteristics, traction electric motors.

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INCREASE EFFECTIVENESS OF REVERSIBLE BRAKING MODE REALIZATION OF THE WOUND-ROTOR INDUCTION MOTOR (p. 27–30)

Michael Kotsur, Igor Kotsur, Aleksandr Bliznyakov

The aim of the work is to increase performance of the wound-rotor induction motor (WRIM) in reverse braking mode by modified pulse control system (PCS), at which the saving the value of the WRIM operating current at the reverse moment as well as energy efficiency of electric drive in the process of its braking are provided.

For the purpose to perform investigation of realizing reverse braking mode for WRIM with modified PCS, with the help of MatLAB software (structural tools of Simulink), the simulation model for the electromagnetic processes in the electric drive is developed. Using the modified PCS for the WRIM with insertion of series resistance in the circuit of rectified rotor current at the reverse moment will prevent rising stator and rotor currents of the WRIM up to its short-circuit value. The values of the phase currents save at the level of the operating values, which in turn will enable to avoid abrupt change of the WRIM torque at the reverse moment. The modified PCS for the WRIM provides recuperation of slip energy as static and dynamic characteristics form at simple enough implementation circuit that ensures its reliability.

Modified PCS for the WRIM can be recommended for the modernization of electric drives of crane-positioning mechanisms.

Keywords: regulation, motor, pulse, energy efficiency, braking, recuperation, slip.

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STABILITY INCREASING OF THE SYNCHRONOUS MACHINE BY IMPROVMENT OF THE EXCITATION SYSTEM (p. 31–36)

Vitaliy Khomenko, Viktor Nizimov, Sergiy Kolychev

The influence of capacitive energy storage in the circuit of a synchronous generator excitation on increasing the life activities of independent generating set has been researched. Control criteria of excitation circuit, which should be carried out not only as a function of voltage on the stator but also as a function of the derivative of the electromagnetic torque angle of a synchronous machine have been analyzed.

It has been proved that the limited capacity of existing thyristor exciters and devices of automatic excitation regulation can be significantly expanded. The most effective way to implement the given problem is excitation forcing with a capacitive compensation of excitation circuit inertia by discharging of a precharged capacitive energy storage in this circuit while supplying the forced voltage from thyristor converter. Intensive field discharge of synchronous machine is carried out by the insertion of the excitation circuit of the capacitive element. In this case, the control of synchronous machine excitation is achieved by changing the structure of power converter that provides relay control at high load areas. At low load areas the control of automatic regulation excitation devices is implemented.

We analyzed the influence of the electric energy storage capacities for the thyristor conducting interval included in the excitation circuit, on the transient processes in the rotor circuit, in particular on the change of current behavior in the excitation winding in the forcing mode and the magnetic field killing.

Developed devices with capacitive energy storage allow automatic regulation of the excitation of synchronous machines, providing high quality transient processes, and improvement of synchronous machines reliability at undervoltage on the stator or at supplying the consumers of considerable power.

Adequacy of forcing excitation processes in existing and developed circuits has been studied by proposed device that provides the modes of forcing or field discharge based on the synchronous machine mode. It has been proved that the performance of the forcing process of the excitation current and the magnetic field killing with energy storage is much higher in comparison with existing excitation systems.

Keywords: the capacitor store of energy, voltage speeding up, a magnetic field killing.

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MODELS OF OPERATING ASYNCHRONOUS ENGINES AT POOR-QUALITY ELECTRICITY (p. 37–42)

Vitaliy Kuznetsov, Anatoliy Nikolenko

The paper considers operation of asynchronous squirrel-cage engines in conditions of poor-quality electricity since even slight deviations in the quality of voltage supply lead to negative consequences. We presume that solution of the problem requires a unified mathematical model. The model would facilitate analysis of energy efficiency for asynchronous squirrel-cage engines in the established conditions and with different quality indices for the network electricity. We have formulated requirements to the type, functionality, characteristics, and composition of input values that an asynchronous engine model would meet. We have analyzed the existing mathematical models of asynchronous engines operating in the above mentioned conditions. The revealed models reflect the impact of particular indices of voltage supply quality upon the operation of the electromechanical transducer.

On the basis of the analyzed mathematical analogues of asynchronous squirrel-cage engines, we presume that there is no unified model to evaluate energy efficiency of an electric machine operating in conditions of poor-quality electricity. Nevertheless, there exist models that reflect the impact of particular indices of voltage supply quality upon the operation of the electromechanical transducer. Solution of the existing problems requires devising an imitation model of an asynchronous squirrel-cage engine. Meanwhile, the elements of the considered models, whose connection permits simultaneous accounting of all electricity quality indices, should be used as computational units.

Keywords: mathematical model, asynchronous engine, electricity quality, electromechanical transducer, voltage.

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HEAT TRANSFER OF STAGGERED BUNDLES OF FLAT OVAL TUBES IN TRANSVERSE FLOW (p. 43–48)

Vadim Kondratyuk, Alexandr Terekh, Alexandr Baranyuk, Evgen Pis'mennyi

The paper deals with investigating convective heat transfer for virtually unstudied staggered bundles of flat-oval tubes at their transverse air flow around. Experiments were conducted in an open-circuit wind tunnel with rectangular cross-section in the range of Reynolds numbers change from 2000 to 30000. In the course of experiments, the average convective heat transfer coefficients were determined. When processing and analyzing experimental data and dependencies of Nusselt numbers on Reynolds numbers of bundles of flat-oval tubes, much attention was paid to factors, which may affect the heat transfer intensity. During the experiments, several of these factors: operation factor – flow rate W, geometrical factors: back pitch between tubes S_1, long pitch S_2, the ratio of longitudinal to transverse tube size (profile elongation) d_2/d_1 were identified.

Keywords: tube, profile, flat-oval, oval, round, flow, heat transfer, intensity, staggered, transverse.

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DEVELOPMENT OF PHYSICO-MATHEMATICAL MODEL AND JUSTIFICATION OF PARAMETERS OF DEVICE FOR AIR COOLING BY DROPPING WATER (p. 48–54)

Roman Tishin, Ihor Tolkunov

The paper deals with solving actual scientific and technical task to ensure safe working conditions for personnel in workplaces of industries with high temperatures (over 300 °C), such as deep mine workings, blast furnace shops, etc., which lies in a local air cooling without using special conditioners, where the greatest effect is achieved in the processes of hydrodynamic irrigation of warm air by dropping water.

It is shown that the measures, aimed at reducing the air temperature of working areas in mine workings involve air cooling by forced ventilation and air conditioning systems, which do not fully meet the required quality parameters. This has a negative effect on the overall condition of personnel and enterprise efficiency as a whole, and causes the risk of diseases from overheating respiratory organs and dehydration. Solving the problem of physico-mathematical modeling of the dispersed water impact on the air and heat exchange occurring between droplets and air is urgent for improving the irrigation-based mine air cooling effect.

The design of the device for the hydrodynamic air cooling by dropping water based on diffuser-confuser pipe was developed, and relations that allow to determine the structural and operational parameters were defined. The analytical relations, the appropriateness of which was experimentally confirmed reveal the mechanism of cooling action of water droplets on the air, enable the analytical determination of the thermodynamic characteristics of the flow, which affect the heat transfer efficiency, and justification of means, required for this process.

Using the developed device in workplaces of industries with high temperatures will ensure the implementation of labor protection requirements on air quality in working areas, as well as high efficiency of air cooling measures, which is caused by the possibility of engineering calculations when designing the proposed devices.

Keywords: air cooling, water droplets, ejector, diffuser, confuser, air-droplet flow.

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PARAMETRIC ANALYSIS OF THE INFLUENCE OF VARIOUS FACTORS ON THE THERMAL POWER OF THE U-SHAPED PIPE RADIATOR (p. 55–60)

Oleksandra Iakovlieva

Shortcomings of existing methods for calculating the U-shaped “dark” pipe radiators were identified. The features of radiant heat transfer in the radiating system with the symmetric arrangement of the burner and the outgoing branches were formulated. A specified method for calculating “dark” pipe radiators based on their geometric dimensions and optical properties was given. Alternative calculations for different input data were made. The analysis of the influence of the geometric dimensions and optical properties of the U-shaped “dark” pipe radiator on its energy efficiency was performed. It was found that in the studied ranges, the thermal power of the “dark” pipe radiator can be greatly improved by increasing the burner branch temperature and diameter. The need to decrease the negative impact of the outgoing branch was revealed. This can be achieved by reducing its diameter or placing outside the reflector housing in a separate compartment. Moreover, increasing the radiant heat power of the radiator can be achieved by increasing the absorption coefficient of the reflector housing surface and the floor surface. This will reduce the material cost of manufacturing the reflector housing through replacing expensive stainless steel sheet metal or aluminum sheet by sheet metal from conventional carbon steels. The findings can be used when designing U-shaped “dark” pipe radiators.

Keywords: radiator, absorption coefficient, U-shaped radiator, energy efficiency, reflector

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CONTROL OF HEAT SUPPLY OF BUILDING BASED ON THE USE OF INDIVIDUAL HEAT POINT OF ORIGINAL DESIGN (p. 61–67)

Oksana Lysenko, Liliya Kuzhel, Igor Bozhko

The literature states that the transition from central heat points to individual heat points with the installation of appropriate automation allows to achieve a heat energy saving of more than 20 %, but reliable experimental data, substantiating this position are not found today. Therefore, long-term experimental studies of heat supply of administrative building based on the individual heat point of original design to determine the real heat energy saving in actual practice taking into account environmental factors were conducted.

Based on the experimental data, graphical dependencies of consumption of the heat carrier, heat energy and heat carrier temperature on the ambient temperature for two operation modes of the individual heat point with the calculated heat energy saving were constructed. The effectiveness of introducing the individual heat point was also determined. As a result of experimental studies, it was found that the higher the ambient temperature, the more unreasonable heat energy consumption with centralized unregulated heat supply, especially at the beginning and end of the heating season.

Therefore, introducing individual heat points is one way to increase energy efficiency during new construction and modernization of existing buildings, which enhances the heat supply quality and efficiency thus providing consumers with comfort. Long-term experimental studies of heat supply of administrative building based on the individual heat point have shown the possibility of heat energy saving of up to 15 %. The experimental data are important for providing recommendations on mass introduction of individual heat points of different capacities for housing and communal services.

Keywords: energy saving, individual heat point, heat supply, heating system.

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DETERMINATION OF THE REQUIRED SEGREGATION OF FRACTIONS OF SINTER CHARGE FOR STABILIZING THE THERMAL CONDITIONS OF SINTERING (p. 68–73)

Anton Mnyh, Oleksandr Yeromin, Irina Mnyh

A methodology that allows a continuous real-time estimation of the fractional composition of the charge by the horizons of the layer, prepared for sintering is proposed in the paper. The concept of the coefficient, characterizing the change in the average diameter of the groups of fractions by the layer height was introduced, its values for the sintering machines of individual metallurgical plants were calculated.

The adequacy of the developed method for sintering plants of different enterprises was verified. It was found that the method can be considered suitable for identifying the fractional composition of granular material, loaded on pallets.

The required distribution of fractions of a polydisperse sinter charge that stabilizes the thermal conditions of the sintering process. The latter is caused by the optimal distribution of the solid fuel and the chemical components of the charge and creates prerequisites for selecting the feeder, capable of providing the desired fractions material segregation.

Keywords: segregation, sintering , model adequacy, thermal conditions, layer horizon, charge.

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