ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

MEASURING EQUIPMENT SYNCRONISATION PROBLEMS WHILE POWER QUALITY CONFORMITY ASSESSMENT (p. 4–9)

Oleg Gryb, Dmitry Gapon, Roman Zhdanov, Tetyana Ierusalimova

The paper considers the shortcomings of the existing regulations, governing the construction of the measuring equipment for the power quality conformity assessment by such parameter as the levels of the higher harmonic components. Providing the necessary power quality parameters is a prerequisite for the normal operation of a significant number of power consumers and the power supply system as a whole. The key element that allows to effectively regulate the relationships between the consumer and the supplier of power at the legislative level is a regulatory framework. One of the most important quality indicators are levels of higher harmonics in the current and voltage signals. The method, based on the discrete Fourier transform should be used as the main method for measuring the levels of the harmonic components of the current and voltage signals. The experimental data and their analysis, indicating the impossibility of A class assessment with a literal fulfillment of the standards were also given.

Keywords: higher harmonics, synchronization, quality, power, frequency, power system, consumer.

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STUDY OF THE EFFICIENCY OF THE ELECTRIC ENERGY RECOVERY PROCESS IN THE SUBWAY (p. 9–13)

Oleg Sablin

Experimental research of qualitative efficiency indicators of the electric energy recovery process in the subway was carried out in the paper. It was found that in Dnipropetrovsk Metro there is a significant untapped reserve of energy-saving from the electric energy recovery in the range of 15...50 % of energy expenditure for train operation. However, train traffic volumes, strongly variable nature of tractive electric energy consumption and lack of regenerative braking system in subway trains do not allow to realize this potential today. The prospect of buying new and upgrading existing cars requires prior research of efficiency indicators of regenerative energy from braking of trains in the subway. As a result of the study, it was found that the energy, generated by electric trains while electric braking has intermittent nature (8...20 seconds) with decreasing power and contains a considerable variable component (30...50 %). Taking into account these indicators is relevant when selecting measures for the effective use of excess regenerative energy in subway trains since the return of unstabilized energy with such parameters to the primary energy system may make significant distortions and negatively affect operation of nontractive consumers.

Keywords: subway, power consumption, electric braking, recovery, electric energy, excess, efficiency indicators, energy saving.

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THE SINGLE SHAFT GT D045 MATHEMATICAL MODEL ADAPTATION TO THE OPTIMUM OPTIMIZATION SYSTEM (p. 14–18)

Volodymyr Chobenko, Anatoly Tarelin, Alexander Lyutikov, Iryna Annopolska

The need to identify the main controlled parameters (characteristics) of the engine, determined in experimental studies, which depend on a large number of parameters, uncontrolled during the experiment has caused the need to apply software identification tools that allow to reduce the complexity of these works.

The paper presents the results of GT D045 mathematical model adaptation to the Optimum software system for optimization and identification of parameters and characteristics of power plants, developed in IPMash NAS of Ukraine, allowing to calculate the identification criteria, parameters and characteristics of the studied object using the same equations as in the design. The choice of variable and controlled parameters, as well as the range of their changes is described. The principles of further improvement of the methodology for setting the ranges of change of variable and controlled parameters, based on direct measurements of the material part and the experience of the researcher-developer are given.

The results of solving a test identification problem demonstrate the possibility and feasibility of using the Optimum system for the identification of the mathematical model of GT D045 during its fine-tuning.

Keywords: mathematical model, identification, GT, variable parameters, controlled parameters, objective function.

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RATIONALE FOR BLOWDOWN WATER CONDITIONING CIRCUITS OF ZERO-DISCHARGE RECIRCULATING COOLING SYSTEMS AT NPP (p. 19–25)

Victor Kishnevskiy, Vadim Chichenin, Iryna Shuliak

The calculation results of physicochemical parameters of water by processing stages of the blowdown water of the recirculating cooling system after the devices of hybrid water treatment plants using water preparation before the reverse osmosis plant by the methods of liming, soda-liming, ion exchange are given. The possibility of controlling the quality of the concentrate and permeate of the reverse osmosis plant by changing the physicochemical composition to the membrane processing is shown. The principle of constructing the circuits of zero-discharge multi-purpose hybrid water treatment plants for the production of feed water with different quality for the NPP cycles from the blowdown water of recirculating cooling systems is substantiated. Separation of the mass-salt flow of the blowdown water into two allows to bring the quality of treated water to the standards, imposed on the feed water of the NPP cycles. This can significantly reduce the station discharges into the environment.

Keywords: recirculating cooling system, recirculation, circulating water, blowdown water, concentration, ion exchange.

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THE HURST METHOD IN ANALYZING THE TECHNICAL CONDITION AND FUEL ECONOMY OF A LOCOMOTIVE (p. 25–28)

Vladimir Drobaha, Alexey Trihleb

The paper considers a possibility of using the Hurst method for analyzing time series. At present, improvement of locomotive efficiency monitoring methods allows expansion of the possibilities for analyzing and predicting the considered dimensions. The devised methods of prediction are based on the nonlinear dynamics, the theory of fractals, and mathematical statistics to determine the current technical condition of a diesel and generator set of locomotives, to correct the time between overhauls, and to introduce respective corrections in the planned dependencies for calculating the operational fuel consumption. We have specified the fundamentals for estimating the Hurst fractal index and analyzing its nature for different conditions of the time series components. It is determined that the time series analysis is preconditioned by the length of the series and the number of the studied intervals rather than the number of observations.

The calculation and assessment of the Hurst index for the time series of locomotive fuel consumption served as the basis for the suggested monitoring of the technical condition as well as the devised method for calculating the ultimate resource of the fuel equipment, which facilitates planning and implementing its adjustments and repairs.

Keywords: analysis, deviation, dependency, interval, method, index, expansion, fractal, time series.

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PHYSICAL AND MATHEMATICAL MODEL OF RAW MIXTURE AGGLOMERATION PROCESS USING LOCAL FUELS (p. 29–34)

Boris Lesun

Within the work, carried out in the Republic of Belarus on the implementation of the state program «Peat», physico-mathematical model of the raw mixture agglomeration using local fuels was developed, the directions necessary to implement the plan of increasing the peat use for energy purposes were identified. Physico-mechanical properties of raw materials and fuel briquettes, the elemental composition of the peat, the main technical parameters of the peat crusher were presented. Fractional composition of fuel based on fuel briquettes after the first and second crushing was determined. The mathematical models for determining the hydraulic conductivity coefficient were developed, and the influence of different contents of loam, fragmented peat and coal in a mixture on the aggloporite strength was determined. The dependences of aggloporite strength on its density when adding crushed briquettes and sawdust in the obtained experimental batch were defined. Application of the above techniques has allowed to get the economic effect at the MCMP of more than 100 million BYR (approx. 10 000 USD) at the release of the experimental batch of aggloporite.

Keywords: peat briquettes, agglomeration, averaging, enrichment, model, aggloporite, waste energy.

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DEVELOPMENT OF ENERGY EFFICIENT METHODOLOGY OF CARBON MATERIALS DRYING AND FRAGMENTATION (p. 35–40)

Vladimir Kutovoy, Iosif Mysak

The development of heat power engineering in the modern conditions requires high-quality fuel with low sulfur content. Unlike liquid and gaseous fuels, brown coal has a high ash content and humidity. In order to improve the efficiency of thermal power plants, it is necessary to modernize the brown coal preparation process to lower sulfur content and reduce harmful emissions into the atmosphere during combustion. Therefore, the development and introduction of new energy-saving heat technological installations for drying and fragmentation of carbon materials is an important scientific-technical problem which is solved in the framework of the scientific area - industrial heat power engineering.

In the paper, new energy-saving methodology, allowing highly efficient continuous drying and simultaneous fragmentation of dispersed materials was developed at the newly created highly productive thermal vacuum installation.

During the research on thermal vacuum drying of dispersed materials, analytical and experimental methods for determining

moisture withdrawal from the investigated objects depending on the regime parameters of the thermal vacuum installation were used.

Based on the results of scientific and technical research it was found that brown coal with the initial humidity of 40 % and size of up to 8 mm is converted into a fine powder with a humidity of less than 1.0 % for 14 seconds during drying in the thermal vacuum installation. The temperature of the dried brown coal at the heating element outlet did not exceed 76 °C at the heater temperature of 250 °C. Brown coal drying proceeds uniformly, the color changes from brown to black. This suggests that the sulfur content in the brown coal reduces. In our case, the sulfur amount in the dried brown coal has decreased by more than twice from 4.8 % to 2.2 %.

The developed process of thermal vacuum drying and simultaneous fragmentation of brown coal allows to reduce energy costs per unit of the dried product, accelerate the drying process, obtain a fine powder of the dried coal with low sulfur content, which leads to reducing harmful emissions into the environment during combustion.

Keywords: thermal vacuum installation, brown coal, ecology, energy saving, drying, fragmentation, pressure, sulfur.

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DEVELOPMENT OF ENERGY SAVING TECHNOLOGY OF TWO-STAGE BIOMASS GASIFICATION FOR COGENERATION PLANTS (p. 40–47)

Katerina Kremneva

A two-stage fine biomass gasification process for the low - power generation plants based on ICE, providing the tar content in the producer gas of no more than 7.1 mg/m^{3}n that meets the requirements of the ICE producers was developed. Based on the results of experimental studies of the two-stage fine biomass gasification process, the effective process regimes were determined. The optimal range of the specific air flow, which provides a stable process of oxidative biomass pyrolysis in a dense layer at the pyrolysis temperature not exceeding 800°C is 25.0 ÷ 55.0 m^3/(m^2 h).

Efficiency of the oxidative pyrolysis process reaches 98.0 % taking into account the disposal of all heat flows. Efficiency of the coke residue gasification process without the use of sensible heat of the producer gas is on average 78.0 %. Using the sensible heat of the producer gas allows to improve gasification process efficiency to an average of 96.4 %.

Numerical and theoretical studies of gas ICE operation have shown that the gas ICE operation on the producer gas with a calorific value of 7.6 MJ/m^3 is optimum. In this case, the fall of ICE effective power is 16.0%, and the cost of electric power generation is 0.39 UAH/(kW·h). The results of studies have also shown that increasing the natural gas proportion in a mixture of more than 40.0 % is not desirable, since it leads to higher cost of electric power generation up to 1.04 UAH/ (kW·h) that corresponds to the cost of electric power from the external power system.

Exergy analysis of a cogeneration plant has shown a high value of total exergy efficiency of 45 %, while exergy efficiency of individual circuit elements, such as a pyrolyzer and gasifier reaches 96 %, and the "ICE-generator" unit – 91 %. Such values of efficiency are caused by deep disposal of all heat flows in the circuit.

Keywords: biomass, two-stage gasification, cogeneration plant, internal combustion engine, exergy analysis.

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INVESTIGATION OF EMERGENCY AUTOMATION FAILURES INFLUENCE ON THE POWER SYSTEM ACCIDENT RISK (p. 47–56)

Volodymyr Litvinov

To improve the power system reliability, it is necessary to organize efficient management. Effective management requires an integrated approach which takes into account the probabilistic nature of failures, stochasticity of modes, possible scenarios of the accident and its consequences. Technical risk most fully covers all the factors.

The paper presents the fuzzy-statistical method for assessing the accident probability and risk in the power system. The proposed method takes into account the operation of system emergency automation devices and their operable or inoperable condition. Modeling of the 14-node test circuit of the power system was performed using the developed method. Probability of dynamic stability loss on the time interval was estimated for this circuit. The results have confirmed the adequacy of the developed fuzzy-statistical method and shown the need to consider the operation and condition of system emergency automation to obtain reliable results.

Keywords: risk, probability, failure, system fault, system automation, probabilistic-statistical method, technical condition, dynamic stability.

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ENERGY APPROACH TO THE PROBLEM OF THE GAS PIPELINE HYDRAULIC EFFICIENCY (p. 56–62)

Vladimir Grudz, Yaroslav Grudz, Nikolay Iakymiv

The problem of energy dissipation in the main gas transportation on linear regions of pipelines and its impact on the hydraulic efficiency factor reduction is considered in the paper. The results of analytical studies of the potential and kinetic energy conversion into internal energy are presented. The primary objective of the research is to determine the effect of energy dissipation in the pipeline throughout the entire route on the hydraulic efficiency of the gas transportation system as a whole, and consequently on the hydraulic efficiency factor reduction in particular. In the paper, the above analytical studies are given and compared with experimental data. Positive convergence of predicted and actual results and their impact on the hydraulic efficiency factor was revealed. These findings are important to take into account for the operating gas transportation companies. The results allow to increase the capacity of main gas pipelines and thereby increase the hydraulic efficiency factor. The principle of implementation of the task and use of its results is demonstrated.

Keywords: hydraulic efficiency and its change over time, energy dissipation, internal energy, efficiency factor.

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