ABSTRACT AND REFERENCES

ENERGY-SAVING TECHNOLOGIES AND EQUIPMENT

OPTIMAL CONTROL OF MUTUAL IMPACT OF ELECTRIC GRIDS FOR THE REDUCTION OF THEIR ELECTRIC ENERGY LOSSES (p. 4-11)

Petro Lezhniuk, Olexandr Rubanenko, Anton Kylymchuk

The subject of the research comprise the methods, aimed at determination of additional losses of active power, caused by forced displacement of transit transfers from high voltage (HV) into low voltage (LV) grids, which contain besides the transformers with tap-changing under load, also cross-transformers (CT).

The research for the first time performs the analysis of the impact of CT location and its angle on the losses of active power in the branches of LV grid and on general system losses, that takes into consideration the change of additional losses of active power at the expense of forced displacement of transit transfers from LV grids into HV grids and vice versa. The paper contains the algorithms and explanation of their operation, that enables to determine optimal branch and CT angle, as well as, in case of their implementation, allow to decrease power losses.

Results of research, considered in the paper are used in power industry, namely for calculation of normal modes and optimal parameters of control impacts vectors in order to degrease active power losses in electric grids.

The results obtained in the process of the research prove that application of CT with optimal phase angle in the branch, defined by the suggested method of CT determination of CT optimal place location allows to decrease, both losses of active power in LV grids and general system losses, the degree of mutual and transit power transfers impact on the level of active electric energy losses changes depending on autotransformers transformation ratios, value of CT phase-shifting angle, circuit parameters and electric grid loading mode; studies of additional losses of active power change, caused by the displacement of transit transfers of power from HV grids into LV grids shows that sometimes: uncoordinated usage of regulating devices of the transformers in HV and LV grids leads to growth of these additional power losses; usage of transformers tap-changing under load does not allow to decrease maximally losses of active power, greater decrease of these losses can be achieved by optimal usage of CT.

Keywords: control impacts vectors, additional losses of active power, cross-transformer, phase-shifting angle, mutual and transit power transfers.

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OPERATIVE OPTIMIZATION OF NORMAL MODES OF NON-UNIFORMITY ELECTRIC NETWORKS WITH LONG-DISTANCE POWER TRANSMISSIONS (p. 12-18)

Volodymyr Kulyk

An improved mathematical model of the non-uniformity of the electrical system (ES) with the long-distance AC power transmission was presented. A method of forming the control actions for the control devices of such system, the implementation of which allows to ensure maximum power transmission efficiency was proposed. The features of the hardware and software implementation of local management of ES control devices, which provides the benefits of centralized management were given.

Electrical systems are not optimal in terms of electricity consumption in its production, transportation and distribution. One of the main reasons for non-optimal states of the ES is their non-uniformity. Based on the above mathematical model of non-uniformity of electric networks taking into account the operation features of long-distance power transmission lines it was shown that for such networks because of the instability of the longitudinal and transverse parameters, their uniform state cannot be practically achieved. Thus, ensuring the optimality of their modes requires using appropriate automatic control systems.

To solve the problem of determining the optimal control laws of ES coupling transformers taking into account the features of their impact on the process of electricity transmission and distribution in electric networks with long-distance power transmissions, a mathematical model of optimal electromotive forces of imbalance, as well as the method of determining the optimal transformation ratios of control devices taking into account the wave properties of long-distance PTL, as well as the effect of unbalanced ratios of transformation of coupling transformers and voltage regulation in ES power centers, were proposed. This improvement allows to make better decisions in the optimal control of power flows and voltage in the ES.

Keywords: electrical system, long-distance power transmissions, non-uniformity, optimality conditions, optimal control.

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PNEUMATIC POWER PLANT AS AN ALTERNATIVE SOURCE OF ECOLOGICALLY CLEAN DOMESTIC ENERGY (p. 18-22)

Valeriy Kvashnin, Vladislav Kvashnin

The solution of the problem of unstable parameters of the output voltage of wind power plants because of the inconstancy of wind flow, limiting the scope of their application based on the transition to the development of pneumatic power plant, containing energy accumulators in the form of high-pressure compressed air tanks in its structure is considered in the paper. Concrete design of low-capacity pneumatic power plant is proposed. The issue of calculating and selecting the sizes of energy accumulators in the form of high-pressure tanks, taking into account certain intervals of the wind flow is studied. Duration of continuous operation of the electrical load with power of up to 1 kW at various energy accumulator capacities is determined. The choice of power of the load consumed from the condition of its uninterruptible power supply with the presence of constraints on the sizes of the energy accumulators, their charging rate, installed capacity of the power generator, type size of the wind wheel, as well as constancy of the wind flow strength and speed are shown.

Keywords: wind power plant, pneumatic power plant, energy accumulator, compressed air, pressure, power, strength, volume, speed, time, capacity, electricity.

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CALCULATION OF PARAMETERS OF BALANCING DEVICES FOR TRACTION SUBSTATION OF ALTERNATIVE CURRENT WITH VISUAL SIMULATION (p. 23-28)

Valery Yagup, Kate Yagup

Traction substation with the star – delta connection of transformer windings is considered. Power supply of traction load is carried out from one side of the triangle on the second-

ary side of the transformer, which creates an unbalance in the power supply system. In turn, current and voltage unbalance reduces the power factor for power sources in each phase and increases losses in the transmission line. The study of electromagnetic processes, conducted using the developed visual model has confirmed the presence of a substantial unbalance in the system. With the help of the visual model and search engine optimization, parameters of balancing device, consisting of reactive elements are found. Herewith, currents in transformer lines and windings are balanced, and reactive power in the power supply system is fully compensated. Due to the perfect balancing and full compensation of reactive power, the losses in the system are minimized.

Keywords: balancing, reactive power, visual simulation, search engine optimization.

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PERFORMANCE EVALUATION OF TRANSMISSION OF ELECTRICITY IN THE SIP–LINES IN ELECTRIC DISTRIBUTION NETWORKS (p. 29-33)

Volodimir Romanovsky, Maxim Kachan

A method of performance evaluation of electricity transmission through modern electricity transmission SIP-lines of electric distribution networks in conditions of abruptly variable, nonlinear and asymmetric operation mode of electricity consumers was proposed in the paper. The specified operation mode of consumers meet modern operation conditions of the electrical network and is almost not considered in existing calculation methods of the actual electricity losses in the network that does not allow to adequately assess real energy efficiency of electric networks.

The proposed evaluation method of electricity losses is based on measuring the current THD and values of harmonic components of currents and voltages in the network that allows to use existing measuring instruments - electricity quality analyzers for evaluation. The relationship between the measured electricity quality parameters and the instantaneous voltage change rate allows to estimate the share of electricity losses, which is caused by abruptly variable, nonlinear and asymmetric operation mode of consumers.

Application of the developed method allows to assess the level of additional electricity losses in order to analyze the causes of the deterioration of electricity transmission efficiency, reduce these losses and increase energy efficiency of electricity transmission through the network. It was shown that in the modern electric distribution networks, additional electricity losses are almost 10 % due to the presence of higher harmonic components of currents and voltages in the electric network.

Keywords: energy efficiency, energy-saving, electricity losses, asymmetric and nonlinear power consumption modes, harmonics.

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ANTISURGE MANAGEMENT OF GAS PUMPING UNITS USING POLYVALENT CONTROLLERS (p. 34-39)

Georgiy Sementsov, Andriy Lagoyda

Based on the experimental data, the study of charts of change in productivity of centrifugal supercharger and change in gas pressure ratio, based on which the transfer function of the centrifugal supercharger of gas pumping unit was derived was conducted in the paper.

The method of determining the settings of PID and PIDD2 controller through the parameters of the object transfer function is given. Based on the calculated values, simulation of the process with PID, PIDD2, PIDD2D3, PDD2, PDPD controllers was performed in the Matlab software product, and their optimal settings were determined.

During the study of the system using polyvalent controllers it was found that the system performance will increase at: PIDD2 controller by 4.44 %, PIDD2D3 controller by 22.67 %, PDD2 controller by 89.33 %, and PDPD controller by 98.22 % compared to PID controller.

Keywords: centrifugal supercharger, controller, setting, transfer function, performance, simulation, surge, management.

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BASIC THROTTLING SCHEMES OF GAS MIXTURE SYNTHESIS SYSTEMS (p. 39-45)

Ihor Dilay, Zenoviy Teplukh, Yuriy Vashkurak

Gas dynamic synthesizers (GDS) are one of the most promising means of preparing complex mixtures of given composition, in particular for checking the gas analysis equipment. This is caused by both versatility (the ability to synthesize a wide range of mixtures) of GDS and their potentially high precision of setting and maintaining concentrations of the components of the synthesized mixtures. Providing high metrological and performance characteristics of synthesizers is possible due to the optimal combination of basic throttling schemes in the developed principal schemes of GDS.

Information on the throttling schemes that can be used in GDS – connection by the scheme of flow summarizer, flow divider, parallel and sequential, as well as combined connection of pressure and flow dividers was presented in the paper. The mathematical description of basic throttling schemes provides efficient modeling of the developed gas-dynamic devices, including GDS was given.

An example of using the studied basic connections of throttles is developing the principal scheme of GDS of gas mixtures with microconcentrations of components. In the synthesizer, due to a combination of features of the flow summarizer with packages of line dosing capillaries, fixed in channels and cascade connection of line pressure dividers for setting and maintaining the pressure drops in the dosing capillaries, preparing complex gas mixtures with microconcentrations of components at the same stage (without the loss of pure components and intermediate gas mixtures) and accuracy of maintaining the given concentration of components, higher than in the known synthesis means was provided.

Keywords: basic throttling scheme, gas-dynamic system, gas mixture synthesis, capillary.

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ANODE EFFECT AND MHD-INSTABILITY IN ALUMINIUM ELECTROLYZER. CONTROL OF PARAMETERS FOR THEIR PROGNOSIS (p. 46-50)

Gennagy Shcherbbanj, Ivan Chervony

The results of studying the interaction of the complex of process parameters on the occurrence and course of the "anode effect", using which will allow to significantly improve the electrolysis process and increase the electrolyzer efficiency were presented. With the appearance of the "anode effect", the current density on the free surface greatly is increased, the anode potential becomes more positive and is passivated to the potential, sufficient for the discharge of fluorine ions, fluorine ions with oxygen ions at the anode start to be discharged, the concentration of perfluorocarbons increases up to 30 %. Interaction of the magnetic field with the current appears not only in the misalignment of the molten metal surface. The studies of magnetohydrodynamic processes in the electrolyzer have shown that the molten metal surface is in a state of continuous agitation and herewith the wave height can reach 45 mm. Thus, the wave height is comparable to the interpolar distance, which causes local short-circuiting.

To minimize the number of process abnormalities on the electrolyzer, the necessity of constant monitoring of a number of parameters that characterize the current state and development of abnormalities in the bath: temperature of the electrolyte and its overheating; concentration of alumina; composition of the anode gas and the ratio of CF_4, CO, CO_2 in flue gases; back EMF and the specific resistivity of the electrolyte; interpolar distance, height of the metal and electrolyte; ratio of the melt densities of the electrolyte and aluminum; thickness of the ledge; effective current density and its distribution under the anode face; distribution of current intensity and magnetic field in hearth; change in the shape of the working space was established.

Keywords: aluminum electrolyzer, current, electrolyte, voltage, anode effect, MHD instability.

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