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SUMMARY and KEYWORDS

MECHANICAL AND THEORETICAL ENGINEERING

V. R. Vedruchenko, A. V. Shtib, I. I. Malakhov
Reduction of economic efficiency of marine diesel from pollution of elements and turbocharger cavity when using fuels of different composition

The detailed analysis of pollution of details and cavities of a gas turbocharger (GTN) of a ship diesel engine is done. The composition of contaminants and their impact on the operating conditions of the diesel engine is revealed, and an approximate assessment of the economic damage from contamination of parts of the GTN cavities is carried out.

Keywords: marine diesel, turbocharger, compressor, gas turbine, pollution, operating costs, economic efficiency.

D. S. Rechenko, R. U. Kamenov, D. G. Balova, A. K. Aubakirova, I. K. Chernykh
The influence of sharpness of cutting tool on processing of steel 07X16H4B

The quality of steel processing in industry is characterized by many parameters (for example, the presence of micro-outbursts, flakes and sagging, level of roughness, etc.). These parameters are influenced by such factors as cutting conditions (cutting speed, feed and depth), technological equipment parameters and characteristics of the cutting tool (geometry of the cutting part, hardening coating, sharpness of the blade). The purpose of the work is to study the treated surface of corrosion-resistant steel 07X16H4B with a tool sharpened by classical and high-speed methods. To achieve this goal, the following tasks are solved: the final carbide cutting tool is manufactured and sharpened, tests of the cutting tool on steel 07Kh16N4B are carried out; quality control of the treated surface is carried out. The results of experiments on blade cutting of stainless steel with a tool with different sharpness of the blade are presented. Based on these results, it is concluded that the best result of processing high-strength corrosion-resistant steel grade 07X16H4B is obtained by a tool sharpened by a highspeed method with a blade sharpness $\rho = 3 \ldots 5$ μm. The obtained results allow substantiating recommendations on the required sharpness of carbide cutting tools used in the processing of highstrength hard-to-work steels.

Keywords: processing of corrosion-resistant steel, sharpness of a blade, high-speed sharpening.

A. A. Krutko, D. A. Sedykh, A. A. Vorobev, A. R. Putintseva, Yu. O. Filippov
Study of stress-strain state of wheelset of freight car during braking

As a result of the study, a three-dimensional finite element model of a wheelset with rail sections is developed using a finite element of the ten-node tetrahedron type, and the maximum tangent stresses and maximum equivalent stresses are determined according to the theory of Mises and Dang Wang. It is shown that the maximum shear stresses are observed at a point located at a depth of 4,5–5,3 mm below the surface of the wheel. In case of emergency (short) braking, the maximum stresses take place on the surface of the wheel. With prolonged braking (the movement of the train on a long descent), maximum stresses occur at the point of transition from the disk to the rim on the inside of the wheel, and the value of these stresses is 2,5 times higher than in emergency braking mode. The finite element method is used to determine the stress-strain state of the wheelset of a freight car during braking.

Keywords: wheelset, wheel-rail system, finite element method, stress-strain state, braking.

ELECTRICAL ENGINEERING

V. N. Anosov, D. N. Belkova, V. M. Kaveshnikov
Application of maximum principle optimizing active current subharmonic filter

In this article, the structure and parameters of an optimal regulator for active filter current subharmonics (AFSC) are received based on the optimal control method L. S. Pontryagin. Such a regulator allows one to achieve complete suppression of the subsynchronous torsional vibrations of the rotors of gas turbine units (GTU) of an autonomous power plant at the stage of emergence and growth of resonance at one of the natural frequencies of GTU torsional vibrations and to prevent operation of vibration protection and emergency shutdown of the power plant. Such outages lead to large economic and technological losses.

Keywords: torsion subsynchronous vibrations, radial vibrations, active filter of current subharmonics, optimal regulator, mathematical modelling, autonomous electric power system with optimal AFSC.

V. L. Kodkin, A. S. Anikin, A. A. Baldenkov, Huang Ji Chen
Modeling flux linkages of an induction motor in dynamic modes. Comparison of the effectiveness of various control algorithms

This article presents the results of studies that substantiated the effectiveness of the dynamic positive feedback on the stator current proposed by the authors in asynchronous frequencycontrolled electric drives. Experimental studies carried out over several years have shown that such a connection provides almost complete compensation for load surges in static modes, as well as minimal dynamic processes of parrying these loads (minimum transition time and minimum deviation from the steady-state value). During one of the discussions of the materials of these studies, it is suggested that the electromagnetic flux is stabilized in asynchronous electric drives with such a connection. This article confirms this hypothesis by the method of mathematical modeling. Modeling convincingly shows that in a system with positive feedback on the stator current with dynamic load surge, rotor flux linkages stabilize much more precisely, than with known methods of controlling asynchronous motors at all drive speeds. The article also provides modeling of similar modes for vector and scalar control. The simulation, thus, confirmed the effectiveness of the proposed structural correction, while earlier experiments showed significantly better dynamics and energy of the drive with such correction (dynamic positive feedback on the stator current).

Keywords: asynchronous electric drive, mathematical modeling, vector control, scalar control, positive feedback.

O. A. Lysenko, A. A. Okhotnikov, V. A. Zakharenko, V. Yu. Kobenko
The study of five-level inverters with various PWM

The energy indicators of multilevel voltage converters are analyzed. The relevance of the research is indicated by the increasing demands of technological processes for the economic use of electric energy, the reduction in power consumed by semiconductor converters, and also to the level of regulated reactive power. The converter considered is a five-level voltage inverter. As the topology of the converter, the structure of the inverter on H-bridges is considered. The article presents twostage three-phase circuits with the connection of inverter cells to wye. Possible states of

electronic keys and their corresponding operating modes are described. The voltage of constant voltage sources is 535 V. In the article algorithms for the formation of pulse-width modulation (PWM) are considered: Phase Opposition Disposition, Alternative Phase Opposition Disposition and Hybrid methods with zero sequence sinusoidal shape of the modulate voltage or with triangular shape of the modulate voltage. As a criterion for evaluating the quality of the inverter's output voltage, total harmonic distortion and line-to-line voltage are adopted. A harmonic voltage spectrum is developed for various control methods of the converter. Possible ways of reducing the harmonic coefficient, as well as increasing the amplitude modulation factor, are shown, by using various methods of forming the pulse-width modulation.

Keywords: Bridge circuits, Inverters, Multilevel Converters, Pulse width modulation, Three-phase electric power, Total harmonic distortion.

A. A. Tatevosyan, E. G. Andreeva
Method of formation of numerical projection-grid algorithm on basis of «three-dimensional regular element» for calculation of 3D-models of magnetic field in cylindrical coordinate system for synchronous magnetoelectric machines as part of high-tech electrotechnical complexes

The paper proposes a method of forming a numerical projectiongrid algorithm on a regular triangulation network for the calculation of three-dimensional models of the magnetic field of synchronous magnetoelectric machines with excitation from permanent magnets (SMEM PM) using recurrent expressions obtained on the basis of a «three-dimensional regular element» for a cylindrical coordinate system. The use of the «three-dimensional regular element» makes it possible to automate the process of forming a global system of linear algebraic equations in the projection-grid Galerkin method in combination with the finite element method bypassing the stage of constructing elemental systems of equations. When solving the problem of optimization of designs of low-speed synchronous magnetoelectric machines in the electrical complex, the Central place in the refinement of the solution is occupied by the calculation of the magnetic field. According to the known distribution of the magnetic field in the regions occupied by the winding current are calculated inductance of the winding, back-EMF, the performance of SMEM PM in the high-tech electrical complex (HTEC).

Keywords: three-dimensional regular element, finite element method, magnetic field, magnetic system, low-speed synchronous magnetoelectric machines in HTEC.

A. A. Tatevosyan, A. V. Bubnov
Development of general approach to optimal design of high-tech energy-efficient electrical systems based on low-speed synchronous magnetoelectric machines

The paper suggests a general approach to creating high-tech energy-efficient electrical systems based on low-speed synchronous magnetoelectric machines. The task is to optimize the magnetic system according to the criterion of specific net power while ensuring a minimum mass of the active materials used. The optimal mass-dimensional relations for the magnetic system of a linear magnetoelectric drive are given, which determine the maximum developed electromagnetic force. In addition, the paper presents a classification of starting and operational characteristics of synchronous magnetoelectric machines as part of electrical complexes.

Keywords: energy efficiency, magnetic system, optimization, magnetoelectric machines, electrical complexes, permanent magnets, winding.

B. A. Kosarev, V. K. Fedorov
Elimination of voltage and frequency deviations, suppression of chaotic oscillations in power system with distributed generation

The article proposes an algorithm for eliminating voltage and frequency deviations, suppressing chaotic oscillations in a power system with distributed generation. The operation of the algorithm by modeling in a SymPowerSystems (MatLab) software package is shown. Chaotic and pre-chaotic modes of operation are detected by the algorithm in the same way. If it is impossible to suppress the prechaotic and chaotic regimes of the same type of control action, it is proposed to supplement the algorithm with the calculation and evaluation of stability indicators. Existing algorithms for detecting and suppressing chaos do not take into account the requirements for indicators of the quality of electric energy; for their implementation, expensive measuring equipment is required. Therefore, the aim of the work is to develop an algorithm for detecting and suppressing chaotic oscillations in a power system with distributed generation taking into account the requirements for the quality indicators of electric energy and implemented by simple circuitry solutions.

Keywords: distributed generation, chaotic oscillations, indicators of the quality of electric energy, steady-state voltage deviation, steady-state frequency deviation, s-model.

G. A. Koshuk, B. A. Kosarev, V. K. Fedorov, A. A. Okhotnikov
The possibility of occurrence of chaotic modes of operation of electrical system with distributed generation

Possibility of origin of chaotic vibrations is in-process shown in the electrical engineering system with the up-diffused generation. Chaotic vibrations are malfunction of functioning of the electrosystems. Thus, from the point of view of the up-diffused generation the question of origin of chaotic office hours appears is worked out not enough. Therefore, the aim hired is consideration of possibility of origin of chaotic vibrations in the system with the up-diffused generation. The aim is arrived at by description of types of the set modes of operations of the system with the updiffused generation, reasons of origin and methods of stabilizing of chaotic vibrations.

Keywords: distributed generation, chaotic oscillations, beats, Lyapunov indicators, attractor, dynamic model.

I. V. Prisukhina, D. V. Borisenko
Improved machine classification algorithm for electric rail circuits in train warning systems

There are known algorithms that implement the classification of code signals in an electric rail circuit. These algorithms, however, have some disadvantages in the form of either relatively complex implementation or reduced accuracy in the presence of noise in a code signal. In this article, we present an improved classification algorithm, which combines the simplicity of implementation and accuracy. The algorithm is based on a neural network trained with cyclically shifted learning examples. We explore the optimal size of the neural network for this type of training set. At the cost of the increased size of the neural network we streamline the classification process and preserve its accuracy.

Keywords: rail electric system, cab signaling, neural network, numeric coding, cloud computing.

V. N. Pugach, D. A. Polyakov, K. I. Nikitin, N. A. Tereshchenko, I. V. Komarov
Research of temperature destruction effect on cables insulation operation life

Technological interruptions reduce in power supply companies is an important problem of electrical power engineering. The service life of power cables is one of the parameters that significantly affects the occurrence of breakdowns in cable insulation. The article describes the thermal aging of insulating materials of low-voltage cables and its effect on their service life. The wellknown mathematical models of insulation aging dependence on temperature are considered. Low-voltage cables are slightly affected by the electric field due to the large margin of electric strength. Therefore, it is assumed that such cables are being aged mainly due to their thermal operating conditions. Experimental studies of cable insulation temperature monitoring have been carried out. Seven weeks of the experiment show an insignificant temperature change. The article also evaluates the effect of insulation temperature on its service life. The results show a significant reduction in service life even with a slight increase in temperature, which shows a significant effect of thermal destruction of the insulating material.

Keywords: insulation ageing model, insulation degradation mechanism, insulation thermal destruction, power low voltage cable.

INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS

A. A. Novikov, A. R. Putintseva, D. A. Sedykh, V. Yu. Putintsev, D. D. Sidorenko
Experimental study of erosive possibility of ultrasound exposure in rehabilitation of nephrostomy catheters

This article assesses the effectiveness of invasive acoustic treatment in the drainage of external urological catheter (nephrostoma). The description of the developed research stand is given, the results of scanning electron microscopy on the device «JCM–5700» are given, the percentage of remote obstruction is determined by the results of weighing samples before and after ultrasonic exposure. It is shown that a short ULTRASONIC effect on the liquid medium in the encrusted catheter allows to remove up to 60 % of contaminants.

Keywords: ultrasonic waveguide-instrument, urological catheter (nephrostoma), ultrasonic sanitation, erosive possibility of ultrasonic influence, piezoceramic emitter, amplitude-modulated signal.

A. I. Blesman, R. B. Burlakov
Vacuum vaporizer for fabrication of thin films of material by sublimations

The offered vacuum vaporizer can be used under the vacuum fabrication of films from Cr, Mg, Mn, SiO, GeO, MoO_3, WO_3, ZnS, ZnSe, CdS, CdSe, CdTe by sublimations. Vacuum vaporizer containing tubular element with tightly closed by flat end areas, executed from Ta (or Mo) foil by the thickness (0,05–0,1) mm with the high temperature of melting and evaporations and is kept a central region of the radial cross-section with the hole in the manner of the oval situated between flat end areas having variable area of the current section, which decreases toward from the centre of the tubular element to its ends. The offered vaporizer has broader field-performance and technological possibilities, since for the fabrication of the vaporizer use a metallic foil that allows under its fabrication to change amounts of the vaporizer. Herewith the vaporizer possible to use for fabrication of films repeatedly executing its recurrent boot without removing from the vacuum camera.

Keywords: vacuum vaporizer, fabrication of thin films, method sublimation.

O. V. Krivozubov, Yu. G. Kryazhev, I. V. Anikeeva, N. A. Davletkildeev, D. V. Sokolov, O. N. Semenova

Formation on quartz substrate and study of properties of nanostructured layers from polyvinylen obtained by dehydrochlorination of polyvinyl chloride with modifying additive — iron nitrate

The work is devoted to solving the urgent task of developing simple ways of applying nanostructured layers of polymers to different substrates with a pairing system with properties of organic semiconductors. To obtain such polymers used dehydrochlorination of polyvinyl chloride under the influence of anilin in the solution dimethylsulfoxide. Iron nitrate is used as a metal-containing modifying supplement. The nanostructured layers of polyvinylen (polymer with the system of conjugated double bonds) are obtained by forming on the plates of monocrystalline quartz by the Langmur-Blodgett. The ASM method shows that in the absence of metal-containing additives, layers of polyvinylens are formed thick ~100 nm. Metal addition leads to significant changes in the morphology of the layers. There is a formation of conglomerates of rounded particles measuring ~30…50 nm. The iron content in these layers is 0,04 % atomic. The study of ultraviolet spectrums shows that iron dopation causes a multiple increase in optical density in the entire range of wavelengths studied. The resulting data can be used to create an elemental base of molecular electronics.

Keywords: conjugated polymer, thin films, polyvinyl chloride, dehydrochlorinated, atomic force microscopy, conductivity.

E. V. Leun, L. G. Varepo, A. E. Shakhanov, A. V. Nickel

On construction of jet-drop optical measuring systems: analysis of optical, dynamic and metrological parameters in visualization of surface of product

The article is devoted to the use of jet-drop optical measuring systems for measuring shape deviations, including surface roughness of products during processing. The issues of image transmission, focal length control due to the merger of several drops of one or more hydraulic streams are considered. The issues of image transmission by moving and falling drops on the surface of the processed product are discussed. The paper presents a method for calculating the performance requirements for registering a microscope image together with a moving droplet, depending on its size, the liquid used and the speed of its movement. The developed method of calculating the positioning error of moving droplets for one – and two-axis control of the trajectory of the droplet flow is considered.

Keywords: jet-drop optical measuring system, electro drop-jet device, controlled drip flow, droplet fusion, droplet positioning, forced capillary jet decay, drip microscope.