MECHANICAL AND THEORETICAL ENGINEERING

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Changes in structural-phase state and physicochemical properties of tungsten-free TIC-TiNi hard alloys after various types of ion-beam treatment

Using experimental methods of analysis, the morphology, elemental composition and chemical state of hard alloys of the «TiC-TiNi» system in the initial state and after various types of ion-beam treatment have been investigated. It is found that the effect of a continuous ion beam leads to an increase in the microhardness of the investigated alloys by 10–12 %. When samples are irradiated with a pulsed ion beam, as a result of destruction of surface layers, the microhardness value decreases by 20 %, as a result of which this type of modification is not preferable for alloys of the TiC-TiNi system.

K. S. Akhverdiev, E. A. Bolgova, E. O. Lagunova, S. V. Kumanin

Hydrodynamic calculation of wedge-shaped system «slider-guide» operating on compressible lubricant in presence of melt on surface of guide

In the article on the basis of the equation of motion of the compressible lubricant for the «thin layer», continuity, state, and the equation describing the profile of the molten contour taking into account the formula of mechanical energy dissipation the asymptotic and self-similar solution is found for the extreme (when the speed tends to infinity) and non-extreme case. As a result of solving the problem, a refined mathematical calculation model of a wedge- shaped sliding support with a low-melting metal coating on a movable contact surface is obtained, which compensates for an emergency lack of lubricant and provides a stable hydrodynamic lubrication mode.

V. P. Kuzmenko, S. V. Solyony

Exploration of influence of led spotlights on quality of electric energy

The results of the study and assessment of the quality of electrical energy measured at a separate phase in the existing electrical installation of the building, with a load in the form of LED floodlights are presented. The problem of the negative impact on the quality of electrical energy of switching power supplies of electronic devices, typical for this type of electrical load, is considered.

Keywords: LED load, quality of electrical energy, high- frequency current harmonics, electrical measurements.

S. V. Pashukevich

Investigation of performance properties of rubber with metal fillers

The work conducts laboratory tests on the rubber of the first group of GOST 8752-70 with the introduction of the metal components. The filler is introduced into the rubber mixture on laboratory rollers. Fine powders of copper (Cu), tin (Sn) and lead (Pb) are used as fillers. The dependences of the temperature in the contact zone of the sample and the body of revolution on the concentration of the filler and the dependence of wear on the concentration of the filler for the same loads and sliding speeds are obtained, the fillers that give the rubber the greatest wear resistance are revealed, and the rational amount of the filler is determined. The positive results of laboratory tests give grounds to recommend various equipment including aerospace equipment for use in sealing devices of hydraulic systems, rubber products with metal fillers in the indicated concentrations, which will extend their service life and increase their reliability.

Keywords: rubber compound, metal fillers, the performance properties of rubber, fine powders, hydraulic systems, wear resistance.

S. V. Kartashev, Yu. V. Kozhukhov

Improving the quality of design calculations of viscous flow in low-flow centrifugal compressor stages by methods of computational fluid dynamics through reasonable application of different turbulence models

The paper considers the issue of improving the quality of the numerical experiment in the calculation of viscous gas in the flowing part of a low-flow centrifugal compressor stage. The choice of turbulence model in creating a calculation model for calculations by methods of computational fluid dynamics is substantiated. As object of research is chosen low-flow stage with conditional flow coefficient $\Phi=0{,}008$ and relative width at impeller outlet $b2/D2=0{,}0133$. The issue of qualitative modeling of friction losses in low-flow stages is of fundamental importance and is directly related to the choice of turbulence model. It is shown that the choice of low-Reynolds turbulence models in the case of unloaded and discontinuous low-flow stages can be made from the main common models (Spalart- Allmaras, SST, k-ω) based on the economy of calculations, speed of convergence, solution stability and adequacy of the obtained results. For models with wall functions, the quality of the mesh model and the observance of the dimensionless distance to the wall $y+$ throughout the calculation domain are particularly important. For high- Reynolds turbulence models, at values of $y+=25...50$ on all friction surfaces of the computational domain in the optimal mode of operation, the grid independence of the solution for the entire gas-dynamic characteristic is ensured. It is unacceptable for $y+$ to fall into the transition region of 4...15 between the viscous sublayer and the region of the logarithmic velocity profile.

Keywords: Improving modeling quality, centrifugal compressor, low-flow stage, computational fluid dynamics, turbulence model, near-wall function, dimensionless, $y+$, Numeca Fine/Turbo.

ELECTRICAL ENGINEERING

V. N. Anosov, V. M. Kaveshnikov, S. A. Saidov

Synthesis of neuroregulator of power in system of sensorless traction electric drive

In this paper we solve the problem of synthesizing a power regulator in a traction electric drive system using artificial neural networks.To control the vehicle and obtain the desired quality of transients, neural network observers have been developed that allow the measurement of indirect parameters to determine the immutable coordinates of the system. For this purpose, this paper uses dynamic neural networks. When developing the neural network observer, experimental data obtained by the authors on an operating vehicle in real operating conditions are used.To test the effectiveness of using the created artificial neural network, an object is simulated with a random nature of the supply voltage change. A comparative analysis of transients in a system with a power neuroregulator and classical regulators in a subordinate control system shows a fairly high convergence of the results.

V. V. Kharlamov, Yu. V. Moskalev, S. N. Naiden

Methodology for determining permissible operating modes of DC traction motor of quarry dump truck to ensure satisfactory commutation

The article considers an approach to determining the permissible ranges of changes in the armature voltage, armature current and the excitation coefficient of the DC traction motor of a mining dump truck to ensure satisfactory commutation. When the DC motor is running in the specified modes, the probability of sparking in the collector-brush unit with a degree of 2 points will be minimal. A method for determining the permissible operating modes of a mining dump truck traction motor to ensure satisfactory commutation is proposed. The method allows, based on the analysis of experimental data, to determine the permissible ranges of changes in voltage, armature current and excitation coefficient, at which the degree of sparking does not exceed 1S points.

Yu. V. Plotnikov

The method of calculating power supply for monitoring and metering devices of DC traction network based on serial chain of voltage converters

For organization of power supply of devices for monitoring and accounting of electric energy for railway traction networks of direct current, the topology of the power source based on a serial chain of voltage converters can be used. The paper considers the development of a methodology for the electrical calculation of such sources. For this purpose, lists of initial data and calculation resultsare formed. A substitution scheme of ideal elements is proposed. The operation of the substitution scheme is analyzed using the «equivalent source» method. It also provides formulas and recommendations for selecting and determining the required parameters. The adequacy of the proposed method is confirmed by a full-scale experiment.

A. V. Simakov, V. V. Kharlamov, V. I. Skorokhodov

The overcurrent protection characteristics testing digital substation intelligent electric devices

The electric power industry digital transformation features and the intelligent electronic devices (IEDs) introduction in the low-voltage circuits of power stations and substations are considered. The analysis of normative documents and standards is carried out. The features of scheduled maintenance of relay protection and automation devices are determined, the possibilities and prospects of organizing condition-based maintenance are considered. The mandatory steps required for any type of maintenance are defined. A method for checking the electrical and time characteristics of the overcurrent protection of an intelligent electronic device is proposed. The device is designed in accordance with the IEC-61850 standard and operates in the local area network of a digital substation of architecture III.

INSTRUMENT ENGINEERING, METROLOGY AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS

E. V. Leun

Features of circuitry of acousto-optic laser measuring systems for controlling three-coordinate (3D) movements of products and equipment elements. Part 2

The article discusses the noise, dynamic and accuracy parameters of acousto-optical (AO) laser measuring systems (LMS) for high-precision control of three-coordinate (3D) displacements of products. It is shown that now when using modern high-speed low-noise photodetectors makes it possible to achieve the resolution of AO LMS without special technical techniques $\approx \dfrac{\lambda}{1800}$ and $\approx \dfrac{\Lambda_{aom}}{900}$ for longitudinal Δl_x and transverse Δl_y, Δl_z displacements, respectively, where λ and Λ_{aom} are the wavelength of light and sound in the AO modulator. The features of using PLL systems in AO LMS are discussed. The possibilities of increasing the resolution when measuring displacements using two photodetectors for one input optical signal: high-speed and low-noise, as well as by controlling the bandwidth of the PLL system are considered.

P. V. Sak

Integrated estimation of parameters of radio transmitter power amplifier with automatic mode adjustment by two-frequency test signal

Comparative estimation of energy parameters of power amplifiers of single-band radio transmitters using automatic mode adjustment using a deterministic two-frequency test signal instead of a random single-band signal modulated by speech is investigated in the work. Relationships are found that allow judging the power consumption of the terminal stage of the power amplifier with automatic mode adjustment under various types of modulation based on the results of measurements obtained during tests.

The ratios between the power consumption of the output stage when amplifying the random speech signal and amplifying the deterministic two-frequency test signal are obtained both without taking into account losses in the controlled power supply and taking into account such losses.Method is proposed for calculation of energy gain and efficiency factor (efficiency) when applying automatic control of supply voltage of output cascades of shortwave transmitters intended for modulation with speech signals. The loss in the regulated power supply has been estimated. The advantage of power amplifier circuits with automatic mode adjustment is justified.