

MECHANICAL AND THEORETICAL ENGINEERING

I. V. Boyarkina, V. N. Tarasov

Analytical justification of parameters and norms of ply pneumatic tires for land vehicles

In the article, it is proposed to determine the load capacity of a pneumatic tire as a function of the generalized geometric parameter DB , equal to the product of the outer diameter D and the width of the profile of the bus B . The ply layer norm is an even number $n_c = 2, 4, 6 \dots$ is a complex parameter that characterizes load capacity, tire structure, technological features, air pressure in the tire. For the first time, the dependences of the load capacity of the tire Q on the generalized parameter DB for different stratification rates $n_c = 4, \dots, 12$ for diagonal and radial tires were obtained. The dependences of the contact area of the tire A_k on the generalized geometric parameter DB for different layers of diagonal and radial pneumatic tires are obtained.

Keywords: tire frame, contact area, nominal load capacity.

Yu. I. Matyash, Yu. M. Sosnovsky, A. A. Razhkovsky, E. M. Kondrikov

Changes of physical and chemical properties of steel nodes and details of railway transport as method of determining residual resources

The thermodynamic processes occurring in metallic alloys as they cool from melting temperature to normal ambient temperature are considered. It is shown that the most acceptable method for predicting the residual life of railway rolling stock parts should be based on the use of semi-empirical calculated dependencies connecting the change in the energy parameters of metal products with a change in their structural friability. The existence of an inflection point on the dependence of the change in the strength properties of a metal on structural friability is substantiated.

Keywords: engineering of technical details, residual resource, structural friability, energy barrier, thermodynamic processes.

V. N. Tarasov, I. V. Boyarkina

Investigation of the effect of layering on the parameters and characteristics of pneumatic tires

The article proposes to determine the load capacity of diagonal and radial pneumatic tires as a function of the generalized geometric parameter (DB/n_c) , equal to the product of the outer diameter D , the width of the profile B , divided by the layering norm n_c . The carrying capacity of the tire Q depends on the geometric parameters, the tire pressure, the ply norm and the strength of the tire. Graphic dependencies are obtained that simplify the procedure for selecting the parameters of the pneumatic tire for the given operating conditions. It is suggested that the mass of the tire m_k be modeled as a function of the generalized geometric parameter (DBH) , which is the product of the outer diameter D , the profile width B , and the profile height H for each layer norm of the pneumatic tire.

Keywords: load-carrying capacity, tire mass, ply norm.

V. A. Shepetkov, E. S. Anikin, A. V. Zubarev, A. O. Zvonov

Cord thread tilt to meridian on the assembly drum and on the surface equator of manufactured rubber-cord flexible element

The main tire geometry equation which includes the cord thread tilt at any point of the automobile tire with predetermined profile and the cord thread tilt on the tire equator is given. Based on this equation, three sine multiplication formulas, which further disclose the interconnection between the thread angles on the assembly drum and on the tire surface are obtained. The described equations are suitable for analysis of pneumatic shock absorbers based on rubber-cord flexible elements.

Keywords: tire analysis, cord carcass geometry, cord thread angles.

E. N. Eremin, A. S. Losev, A. E. Matalasova, S. A. Borodikhin, I. A. Ponomarev

Effect of boron carbide on the properties of the deposited metal on the basis of dispersion-hardening chromium-nickel steel

The advantages and disadvantages of chromium-nickel steels used for surfacing coatings of sealing surfaces of shut-off pipeline valves are analyzed. On the basis of this, a new composition of the flux-cored wire is proposed, which provides after the deposition of the metal the Cr-Ni-Mo-Mn-Si-Nb-Ti-B alloying system. The structure and properties of such a metal are presented. It is established that the proposed flux-cored wire provides a complex hardening of the deposited carbide and intermetallic phases of the deposited coating matrix, which makes it possible to significantly improve the operability and reliability of the valves that work on abrasion in contact with corrosive media.

Keywords: valves, chromium-nickel steel, boron carbide, surfacing, flux-cored wire, structure, hardness, wear resistance.

E. N. Eremin, A. S. Losev, S. A. Borodikhin, K. E. Ivlev, A. E. Matalasova, I. A. Ponomarev

Nitride-boride hardening of martensitic steel

Separate use of nitrogen and boron for alloying corrosion-resistant steels has been analyzed. A complex joint application of nitrogen and boron compounds for hardening of chromium steel with a martensite matrix is proposed. A new composition of a high-chromium flux-cored wire with a complex of boride compounds (BN, TiB₂, ZrB₂) is developed, which ensures the production of welded metal of composite type. The results of studies of the structure, properties, and phase composition of such a metal are presented. It has been established that the formation in such a metal of a martensitic matrix with a reduced average size of the structure fragments resulting from the separation of dispersed nitride-boride phases determines the high hardness and wear resistance of coatings deposited with a new flux-cored wire.

Keywords: chromium steel, martensitic structure, borides, hardening, surfacing, flux-cored wire, hardness.

ELECTRICAL ENGINEERING. POWER ENGINEERING

A. V. Bubnov, S. V. Birukov, A. N. Chetverik

Features of the construction of a synchronous-inphase electric drive based on a multifunctional logic comparison device with an indirect determination of the angular velocity error

The synchronously-inphase electric drive, built on the basis of electric drive with phase synchronization, widely used in thermal imaging and laser scanning systems due to the high accuracy and dynamic characteristics in a wide range of adjustment of the angular velocity. The aim of the article is to analyze the possibilities of improving the dynamic characteristics of the electric phase-locked and synchronously-inphase electric drive based on the use of methods of indirect determination of the angular velocity error realized on the basis of a multifunctional logical comparison device. Classifications of methods for indirect error determination by angular velocity (variants for constructing a block for determining the frequency deviation of the compared pulse sequences) and methods for organizing the control of the electric drive using a block for determining the frequency deviation of the compared pulse sequences are proposed.

Keywords: the electric drive with phase synchronization, synchronously-inphase electric drive, logical comparison device, discriminator.

V. R. Vedruchenko, A. L. Ivanov, V. A. Borisov, P. V. Litvinov

The analysis of formation ways of harmful substances in exhaust gases of piston engines

In this article we are produce the detailed analysis of the ways of formation of nitrogen oxides, carbon monoxide, hydrocarbons, aldehydes, soot and solid particles in exhaust gases of reciprocating engines. The influence of these substances on the state of the environment and man is considered. The review of data on environmental pollution is presented and the results of search and elimination of harmful substances in the exhaust gases of reciprocating engines are presented to increase energy efficiency.

Keywords: piston engines, exhaust gases, combustion process, nitrogen oxides, carbon oxides, hydrocarbons, solid particles.

S. S. Busarov, V. K. Vasiliev, I. S. Busarov, B. S. Sagin, Yu. N. Panin

Parametric analysis of working processes of low-speed long-stroke lubricating piston compressor stages on the basis of verified calculation technique

The calculation and parametric analysis of the efficiency of the working process of an airless, low-speed, long-stroke stage of a medium-pressure compressor unit is based on a verified calculation technique. The article considers the influence on the discharge temperature, the indicator efficiency and the feed rate of the main design and operating parameters of the stage. Calculations have shown that parameters such as cycle time, cylinder diameter and stroke have a significant influence on the economy of the work process and the temperature regime of the stage and can be parameters of optimization in the development of a piston stage of this type.

Keywords: low-speed reciprocating compressor; Work processes; heat exchange; Discharge temperature, indicator diagram, temperature diagram, mathematical modeling, average pressure.

S. V. Glukhov, M. V. Glukhova, S. V. Chicherin

A way to generate renewable energy from municipal solid waste for Omsk district heat

The objective of this study is to examine the current situation of the waste problem related to heat-only boiler plant and to present the technical and economic aspects of applying 3 Waste-to-Energy (WTE) facilities located in Omsk. These facilities were chosen because of their location in the northeastern region, where energy prices and population density are relatively high and encourage such a project. The study presents the advantages and disadvantages of WTE to Omsk region. Hence, a preliminary evaluation was conducted of district heating application at these three facilities. In

conclusion, retrofitting a WTE plant to co-generate heat and electricity is always technically possible but it is necessary to consider some aspects such as: the ratio between the value of electricity and the value of heat, the ratio between the reduction of electrical output and the thermal output, and the capital and operational costs. Data appear in this document was calculated and compiled with provided calculation method. The method developed and used may help reader to understand the basis for waste incineration facility planning.

Keywords: district heating, Waste-to-Energy, municipal solid wastes, plant, tariff, fuel.

S. V. Glukhov, D. A. Churikov

The new approach to small localities' heat supply systems management

The article considers main groups of small localities' district heating systems and also defines general development scenarios of each group depending on external factors. A list of typical energy saving means to simplify selection of the optimum modernization direction is suggested. Necessity of new municipal department responsible for working-out of heat supply schemes, technical tasks for investment programs and energy efficiency increasing programs is justified.

Keywords: district heating system, energy efficiency, heat supply scheme, resource-saving, energy management.

N. M. Zaytseva

Solution of some electroenergetic problems using artificial intelligence methods

The article examines the problems of searching a power- efficient operation mode and prediction of power consumption for one power-intensive continuous production process characterized by non-linearity, inertance and closure. Deterministic simulation of the technological production process using fuzzy logic is suggested for their solution. A genetic algorithm is used to solve the optimization task of searching a power-efficient operation mode, which allows obtaining values of technological control parameters ensuring decrease of production power inputs. A dynamic model to predict power consumption is suggested, making it possible to determine power consumption of the production process in any technological mode without retrospective data.

Keywords: energy efficiency, modeling, genetic algorithm, power-consuming industry, energy saving technological decisions.

D. S. Osipov, D. V. Kovalenko, L. A. Faifer, B. Yu. Kisselyov, N. N. Dolgikh

Development of conductive parts power losses calculation method in case of interharmonics

The algorithm is proposed that calculates power losses in current-carrying parts of power supply systems operating in non-sinusoidal non-stationary modes and containing interharmonics. Interharmonics are fluctuations in voltage (current), which are not multiples of the main frequency of the supply network. The proposed algorithm is based on the application of packet wavelet transform, which allows analyzing signals not only in the frequency, but also temporal domain. The use of packet wavelet transform has made it possible to get rid of the main disadvantage of the Fourier transform – the «spectrum leakade» effect. In carrying out the experiment, the role of the nonlinear load in power supply system was performed by a 6-pulse converter. The calculation of power losses in the presence of interharmonics in the network is made using the presented algorithm.

Keywords: wavelet transform in the electric power industry, higher harmonics in power supply systems, quality of electrical energy, power losses in the presence of interharmonics.

D. A. Polyakov

Mathematical model for calculation of cables XLPE-insulation residual life

An urgent task in the field of improving the reliability of power supply is to reduce the number of short circuits. In this regard, monitoring the insulation of power cables is necessary throughout its life. However many methods of the insulation condition monitoring allow predicting insulation breakdowns and time to its complete deterioration. In this regard, the research directed on the development of methods for calculating the remaining life of insulation becomes more relevant. The paper considers mathematical modeling of insulation aging process using elements of mathematical statistics. The technique calculating the remaining life of cable insulation is proposed. The results obtained indicate the need to improve the statistical elements of the mathematical model. Using the methods of exponential extrapolation allow to predict the time when the insulation is completely deteriorated.

Keywords: XLPE-insulated cable, mathematical modeling of insulation aging, cable insulation residual life, insulation condition monitoring

D. A. Polyakov, V. N. Pugach, K. I. Nikitin, D. A. Yurchuk

Data acquisition system for the monitoring of power cables XLPE-insulation condition

Cable insulation monitoring is an urgent problem of the electric power industry. One of the most frequent reasons of short circuits is insulation breakdown. When solving the task of the insulation condition monitoring, the key factors are the determination of the pre-breakdown state of insulation and the calculation of its residual life. It is proposed to determine the pre-breakdown condition using the partial discharges characteristics monitoring, which are known to have a certain dynamics of change before breakdown. To determine the remaining life, it is also necessary to monitor the supply voltage and the cable insulation temperature. The paper proposes the implementation of a data acquisition system that includes monitoring of all the effects taken into account during the determination of insulation pre-breakdown state and its residual life. It is supposed to calculate the insulation residual life and analyze the partial discharges characteristics online using the mathematical models and the data obtained.

Keywords: XLPE-insulated cable, cable insulation pre-breakdown condition, cable insulation residual life, insulation condition monitoring.

V. Yu. Miroshnik, D. A. Lyubeznykh, E. V. Pomogalova, D. V. Batulko, E. G. Andreeva

Determination of the faulty connection at various types of circuit in the distribution networks 6–35 kV using emergency mode parameters

The review and the analysis of the existing methods in defining of the fault connection in distribution 6–35 kV network with the emergency mode settings was done. The description of the algorithms used in modern digital protective devices were included. Simulation model for determining the faulty feeder lines and the type of the fault was constructed based on the review. The principle of the operation algorithm for determining the fault connection are described. The description of auxiliary blocks is given.

Keywords: distribution network, circuit in power system, determination of the faulty connection, digital protective device.

**INSTRUMENT ENGINEERING, METROLOGY
AND INFORMATION MEASURING EQUIPMENT AND SYSTEMS**

V. L. Hazan, A. N. Kalinin

Transmission of discrete messages on a short-wave communication channel using time-frequency matrices

The article describes a new modem with frequency-temporal coding and frequency diversity of a signal for transmitting messages over a short-wave radio channel. The proposed modem has increased noise immunity in comparison with known modems under conditions of selective fading of the signal in the presence of additive interference as concentrated in the spectrum (station interference) and time-concentrated (impulse noise). An estimation of the energy gain of the described modem in relation to the existing ones is made.

Keywords: time-frequency matrix, interference immunity, multiway signal, impulse noise, radiostation interference, multipath fading.

A. E. Karelin, A. V. Maystrenko, A. A. Svetlakov, S. A. Kharitonov

Synthesis method of automatic control of processes based on the concept of inverse problems of dynamics

In article proposes a new approach to the synthesis of automatic control methods of objects based on the use of the concept of inverse problems of dynamics. The essence of the PID-control facilities and the reasons for the need to find methods of automatic control, PID is an alternative – regulation, and is described, named above approach to the synthesis of automatic control methods on objects.

Keywords: automatic controller, PID-control, the inverse problem of dynamics, the derivative.

E. V. Leun

A lathe cutter with integrated active control devices the temperature of the cutting zone, dimensions of the detail and the shape of its surface

The article presents a lathe cutter with three active control devices (ACD). In the first ACD the temperature of the cutting zone t_{cut} it is directed jet of cutting fluid (coolant) optionally used also for the transmission of IR radiation $\lambda_1(t_{cut})$ how «liquid fiber» from the cutting zone to the pyrometer for temperature measurement. Also in the jet are formed with a period Δ_{jet} running thickening, growing by the end of the jet to drop with a diameter of up to 2 diameters of the jet that hit the «shot» produced chips for her break-up with increasing pressure power jet to $\approx 2,7$ times.

The second ACD is measured by the dimension of detail by working together with low- and high-coherence a measure of the displacement, respectively, for small $\Delta/1$ and large $\Delta/2$ ranges. In the third ACD method is implemented shadow section for measuring the shape of its surface.

Keywords: the lathe cutter, the liquid jet, the active control, drop, the breaking of the chips.

V. V. Tomilov, O. S. Tomilova

Experimental researches of water ultraviolet sterilizers effectiveness

Experimental time control of water irradiating in ultraviolet sterilizers allows to assess their effectiveness and to propose ways to improve the structures. Proposed solutions allow to increase the effectiveness of disinfection by providing a more uniform irradiating of water flows. Aligning UV dose provided by tangential swirls at inlet and outlet of the housing and by screw in disinfection camera. Sterilizers research results are for typical flow range of passenger cars of railway transport.

Keywords: test bench, ultraviolet sterilizer, irradiating time, irradiating dose, tangential swirl, passenger car.

R. R. Fakhrutdinov, S. A. Zavyalov

The quadrature phase error influence modeling of the LO on the intermediation products suppression in cartesian loop

The modern radio transmission systems using amplitude and amplitude-phase modulation, and form RF signal having a complicate spectrum. Linearize the power amplifier, while maintaining low consumption allows when cartesian loop are using. Many factors affect the linearization efficiency, in particular the LO quadrature phase error. The article considers the Matlab model of the cartesian loop, and simulates the influence of LO quadrature phase error on the third order intermodulation products level. It is established that the phase error does not lead to efficiency decreasing of their suppression. In this case, the cartesian loop reduces the level of the upper sideband by 10 dB.

Keywords: cartesian loop, power amplifiers, predistortion, phase error, nonlinear distortions, simulation.

INFORMATION TECHNOLOGY**A. A. Kolokolov, I. A. Ziegler**

Solving of some target groups formation problems with logical restrictions

The paper considers the formation of production groups with logical restrictions taking into account both agreement and disagreement relationships. For this purpose, model of integer linear programming is constructed and solution algorithms based on the branch and bound method and the cutting-plane method are proposed. Computational experiment was performed with these algorithms and the commercial package CPLEX, showing classes of instances on which some algorithms have an advantage over the others.

Keywords: discrete optimization, target groups formation problems, integer programming, branch and bound, cutting-plane method.

V. I. Potapov

Numerical-analytical solution of the game problem warfare hardware-redundant dynamic system with the enemy, acting in conditions of incomplete information about the behavior of players in the game

The mathematical model of a game task in which conflicting parties act and make decisions in conditions of incomplete information about the behavior of participants in the game. The attacked side has a hardware-redundant dynamic system, which is not only resource of protection from enemy attacks, but also the resources of the active influence on the probability of finding an attacker in the

appropriate States of the attack. It is believed that the behavior of warring parties approximately Markov process. The solution of the considered differential game is reduced to a multi-step matrix game and its sequential solution at intervals of discretization with constant average probabilities of finding the attacker on these intervals. When solving a problem use numerical and analytical methods.

Keywords: game problem, mathematical model, dynamic system, numerical-analytic method, information, probabilistic process, confrontation.

V. I. Potapov, M. L. Ralovets

Information criteria for the assessment of dynamic technical systems involved in a conflict situation

The article provides a rationale for the use of informational criteria used in information theory for the information condition assessment of dynamic technical systems involved in a conflict situation, and the effectiveness of its system of test control and management remediating the failed functional modules of the system in the process of conflict as a result of enemy attacks. Provides information criteria for assessing the state of rebuilding after the failures in the process of conflict functional modules of a technical system. Given the information evaluation of the effectiveness of the test control system and manage the failover process of the conflict dynamic of the technical system.

Keywords: dynamic technical system, conflict situation, information theory, test control, system failure, restoring health.

O. T. Danilova, S. O. Savchenko, N. V. Kapchuk

Algorithm for constructing an intruder model using the example of an information security system with the help of game theory and graph theory

To effectively ensure the security of the information security system from various types of attacks and to more thoroughly describe the offender, it is advisable to consider the protection process as a one-way matrix non-cooperative game with perfect information and zero sum. There are two players with a finite set of strategies that know everything about each other's actions and Win only at the expense of the opponent, not being able to co-operate. In this paper, we describe the use of elements of game theory, probability theory, and graph theory to develop an algorithm for constructing an intruder model in an information security system.

Keywords: intruder model, game theory, information security, modeling, graphs.

D. A. Elizarov

Design the system of recognition of road objects

The paper has description of the developed system of recognition of road objects (signs, pedestrians and other participants of traffic). The paper has been described the algorithms used in the modules of «Preprocessing of image» and «Object detection and recognition». This system is aimed to reducing the number of road traffic accidents caused by an incorrect assessment of the road situation by drivers. In comparison with similar systems, the developed system will be different on quality of road sign recognition and be capable to analyze a larger number of the objects encountered in road traffic.

Keywords: active computer vision, detection of objects, preprocessing of the image, recognition of images, traffic safety.

V. A. Badryzlov

Classification of random graphs with preferential attachment

The review of generation principles for different types of random graphs, which are building under rules of preferential attachment is executed. The variety of the offered approaches to creation of the random graphs significantly expanding the basic idea of preferential attachment is shown. The most essential classification criterions which allow to construct classification system of random graphs are selected.

Keywords: random graph, preferential attachment, criterions of classification.