DEVELOPMENT OF THE METHOD FOR DETERMINING THE ASSOCIATED PARAMETERS OF THE MANIPULATOR WITH ROTATING LINKS BASED ON GENETIC ALGORITHMS

S.N. Medvedev, A.Yu. Yakovlev, O.G. Korol'kov

Abstract: the problem of choosing the optimal or close to optimal position of a four-link manipulator on a plane is considered. First, the inverse kinematics problem is formulated as a nonlinear optimization problem. Special attention in the mathematical model is given to the objective function. Next, to solve the problem, we propose a genetic algorithm for choosing the optimal position of a four-link manipulator on a plane. In accordance with the logic of genetic algorithms, original crossing and mutation operators were developed. Each of them is based on solving a geometric problem of intersection of two circles. The proposed operators are considered to represent the individual in the form of a set of coordinates of the vertices of the manipulator; however, instructions are also given to create such operators to represent the individual as a set of angles. To test the algorithm, a software package was developed, and a mini-manipulator was designed. The software package includes a software implementation for setting the algorithm parameters on a stationary computer and an implementation for a microcontroller with servo control of a real mini-manipulator. The article presents the results of a computational experiment for setting parameters, and also shows the operation of the algorithm on the microcontroller with the output of the results on the display. The construction of the optimal solution on a mini-manipulator is shown. Conclusions on work are made, and also possible further researches in the field are specified

Key words: inverse kinematics problem, Denavit – Hartenberg representation, genetic algorithm, crossing, mutation, manipulator, computational experiment, control, mechatronic devices

DEVELOPMENT OF THE AUTOMATED INFORMATION SYSTEM OF THE CONDITION EVALUATION, DAGNOSTICS AND SELECTION OF TACTICS FOR THE TREATMENT OF PATIENTS WITH CHRONIC DISEASES

K.O. Levenkov, E.N. Korovin

Abstract: the article presents the process of designing an automated medical information system for assessing the condition, diagnosis and tactics of treating patients with the pathology of the urogenital system based on statistical, simulation and neural network modeling. As input information for the construction of mathematical models for assessing the state and selection of a patient treatment scheme, data from 150 case histories of patients of the urology department of the Budgetary Healthcare Institution of the Voronezh Region of Voronezh City "Clinical Emergency Hospital No. 10" were used. To assess the significance of clinical signs we used correlation analysis and the method of a priori ranking of expert opinion. Assessment of the condition of patients with pathology of the excretory system was carried out using the construction of a "decision tree" and statistical modeling. The choice of treatment regimen for patients with chronic pyelonephritis and urolithiasis was carried out using neural network models and discriminant functions. A cluster analysis of data on the choice of therapy is given. A simulation model based on the Petri net was developed, which allows one to track the state of diagnosis and treatment of a patient with suspected pyelonephritis and/or urolithiasis and generate management options using imitation tools. The obtained neural network models, discriminant functions, statistical models and analysis results, the Petri net, as well as the digital processing module of the results of Doppler ultrasound are used in an automated medical information system, which contributes to an increase in the efficiency of diagnostic and patient assessment processes. Also, the medical information system allows one to improve the quality and reduce the time of selection of the scheme for treating patients with pathology of the genitourinary system

Key words: chronic pyelonephritis, urolithiasis, neural network modeling, discriminant functions, Petri network, Doppler ultrasound, module, simulation modeling

METHOD OF STRUCTURAL AND PARAMETRICAL SYNTHESIS OF MODELS OF ISOLATING RESPIRATORY DEVICES OF AUGMENTED REALITY

M.N. Krasnyanskiy, V.G. Matveykin, S.Yu. Alekseev, A. Yu. Zakharov

Abstract: training to use respiratory device and breathing in them is carried out by means of specialized exercise machines. Their basic element is the model of the respiratory device. Now the regenerative trainers are used as models, which are full analogues of respiratory devices, only with the reduced time of protective action. They accurately simulate the full range of apparatus effects on humans, but their use is associated with the need to dispose of the spent chemical regenerative product, the inability of the instructor to intervene in the process of the model and with a reduced, compared with the original apparatus, work time. The task of building models of breathing apparatus based on the technologies of mathematical and computer modelling, mechatronics, registration and assessment of the states of the human cardio and respiratory systems is considered. Compared with the regenerative models, they allow one to obtain additional information about the modes of operation of the device and the state of the user, so they can be considered as models of augmented reality. These models do not use a chemical regenerative product, allow one to simulate a wide range of modes of operation of the breathing apparatus, provide full control by the instructor over the factors affecting a person at any time. The result of solving the problem is the structure of the model of the breathing apparatus, in which the time to solve the problem of modelling is less than the time of one inhalation-exhalation cycle. The problem is solved with restrictions on the overall dimensions of the model, its mass, power consumption and appearance, which should correspond to the appearance of the breathing apparatus. In this case, the operation of the model can be provided by compact computing systems with low productivity and autonomous batteries. Building models that function as part of stationary training complexes, to which there are no restrictions on computing power and power consumption, is a special case of the problem

Key words: training complex, respiratory devices, structural and parametrical synthesis, complex system analyse

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RATIONALIZATION OF ARCHITECTURAL DESIGNING OF MULTI-AGENT SYSTEMS BASED ON MULTI-VARIANT INTEGRATION

N.A. Ryndin, S.V. Sapegin

Abstract: the article discusses the features of the design problem of multi-agent systems architecture. The main and additional sets of models are identified within the framework of the general approach to their design, taking into account the life cycle of these systems and their components. A general form of the problem is formulated for a set of agents and components of multi-agent systems. Taking into account the fact that the task of synthesizing a rational architecture of multi-agent systems is quite laborious, and is associated with a large number of calculations and uncertainties, the solution of this problem is considered from the point of view of the multivariate integration apparatus. The process of finding rational variants on the basis of the formulated general structure of the multivariate optimization model is considered. As a basis for a numerical solution, we propose a scheme for restricting the diversity of sets in the framework of the multivariate integration process. The principles of decomposition of the general solution are proposed to reduce the complexity of the task of finding rational options. In addition to the stages of logical design, we give the technical stages of the design of multi-agent systems. The implementation of the architecture of the software subsystems of the information system in this paradigm is proposed based on the SOA methodology. The approach allows one to achieve increased efficiency in the framework of the applied design methods

Key words: distributed corporate information systems, intelligent design, construction of corporate information systems

MATHEMATICAL MODEL OF THE THERMOELECTRIC GENERATOR MODULE OF ANNULAR GEOMETRY

O.V. Kalyadin, K.G. Korolev

Abstract: a universal mathematical model was developed for determining the performance characteristics of thermoelectric generator modules with an arbitrary geometry of a annular thermopile. A thermoelectric module consisting of 7 generator thermopiles of the annular type was used as an object for modeling. As materials for branches of thermoelements, alloys with p-type conductivity ($Bi_{0.5}Sb_{1.5}Te_{3.2}$ with the addition of 0.06% (mass.) Pb) and with n-type conductivity ($Bi_2Se_{0.6}Te_{2.4}$ with the addition of 0,24% (mass.) Hg_2Cl_2), obtained by hot pressing, for which the temperature dependences of thermoEMF, thermal conductivity and electrical conductivity were known. For the mathematical description, a system is used that includes the balance equations of the module; equations that establish a relationship between heat flux, efficiency, electrical power generated by the current, voltage and resistance of an external load; expressions that determine the electrical resistance of the module and its full thermal conductivity between hot and cold junctions; heat conduction equations for all auxiliary layers of batteries. The simulation results are presented in the form of graphical dependencies of the influence of external load resistance on heat fluxes and junction temperatures on the hot and cold side, efficiency and generated electrical power, operating electric current and voltage. The current-voltage characteristic of the module and the dependence of the generated power on the operating current are presented

Key words: modeling, thermal emf, thermoelectric generator, thermobattery of annular geometry, stationary process

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ANALYSIS OF THERMAL PROCESSES WITHIN ELECTROTECHNICAL COMPLEXES WITH THE USE OF MATHEMATICAL MODELLING

A.I. Borisova, V.L. Burkovskiy

Abstract: the article discusses the results of the analysis of thermal processes to increase the resistance to special factors and the increase of resource of electrical systems designed for operation in open space as part of the equipment unsealed execution, as the basis for implementing interactive algorithms for topological and structural and modular design of this unit. At the same time it discusses the mathematical modeling of thermal processes of integrated structural elements with limited amounts of configuration in the facility environment with the optimization of mass transfer, heat flow and heat constructive ratios in its development. The article identifies the problem of specific features of thermal processes at heat fluxes in a distributed electrotechnical complexes of vacuum tube performance with digital control, aggression under high vacuum and zero gravity, when the pulse-width modulation at the carrier frequency in the loop "controller electronic converter - the executive electromechanical node - integrated structurte", given the fact that their reference kinematics for open space vacuum and solar radiation, limited heat transfer requires more sophisticated designs to the most complicated sections of the theory of " strength - friction" with the compromise category cooling, wear-resisting, strength of vibration qualities, etc. with the provision of resource characteristics and durability

Key words: thermal processes, resource, outer space, untight execution, integrated design

THE GENERATOR FOR VERTICAL WIND POWER INSTALLATION

A.Yu. Pisarevskiy, T.E. Chernykh, A.V. Tikunov

Abstract: the question of the development of alternative power generation in our country is a very urgent task. Due to the geographical features of the location, we have the conditions for the use of many technologies based on renewable energy sources (solar, small hydropower, wind power). One of the most promising in terms of energy indicators is wind power. However, today there are a number of problems in the Russian wind energy industry that impede its development. These problems are related to the fact that for many decades in our country the use of environmentally friendly renewable energy sources was considered to be economically inexpedient, and therefore at the beginning of 2000s we did not have any plant designs based on modern electrical devices, new types of wind wheel, etc. One of these problems is the lack of serial specialized generators for Russian-made wind power plants, which would have high reliability and energy performance, a long service life, a simple design at a low cost. To date, most of the generators that the developers of wind power plants are forced to use machines of general industrial purpose or ones of foreign production. In this regard, design of the generator is proposed, which can be used in a vertical-axial wind power installation

Key words: synchronous generator, permanent magnets, anchor winding, magnetic system

REACTIVE POWER COMPENSATION IN ELECTRIC DISTRIBUTION NETWORKS OF ALTERNATE CURRENT ON THE BASIS OF STATIC CAPACITORS BATTERIES

V.N. Krysanov, N.V. Sitnikov, N.I. Korolev, D.A. Mamontov, S.A. Goremykin

Abstract: the necessity of developing a technical complex for compensation of reactive power in three-phase electric networks with voltage of 6 (10) kV in relation to urban conditions is substantiated. The reactive power factor tg^{φ} in urban distribution networks is determined by a significant number of single-phase consumers, whose daily schedules, due to their obvious specifics, cannot be strictly predicted. In this regard, when finding solutions to the problem, statistical processing of daily load schedules of a significant number of metropolitan substations was used. Physically, the inevitability of transmitting reactive power over electric grids is justified by the need to create magnetic fields in asynchronous electric drives (60-65% of the total consumption of electrical power); transformers (20–25%) and the existence of magnetic fields in aerial electrical networks, reactors, converters, and a number of other electrical installations (about 15%). Reactive power, which is the exchange between the generator and the load and traditionally concomitant transfer of the active component of power, is not payable. At the same time, this power in the process of transportation over electric networks has the same effect on the loss of active power as the transport of an equal amount of active power. The article presents the motivation for the preparation of options for the implementation of automated complexes of compensating devices according to the number of stages and switching schedules, depending on the daily half-hour power schedules, in which excess reactive power was observed in excess of the established norms. The developed complex of software and hardware contains a method for statistical analysis of half-hour data on the consumption of active and reactive power at the main feeder feeders of the main substations of the Voronezh city electric grid. The results of the implementation of the pilot project of reactive power compensation at one distribution point in the city of Voronezh are presented

Key words: reactive power factor, thyristor voltage regulators, regulation of reactive power flows in a system

EVALUATION OF THE ASYMMETRY OF AN INDUCTION MACHINE BY THE METHOD OF SYMMETRIC COMPONENTS

E. S. Kinev, A. A. Tyapin, S. N. Efimov

Abstract: the article describes the features of the calculation and simulation of induction technological equipment intended for mixing liquid aluminum in furnaces and mixers. Instead of mechanical mixing in modern production, inductive magnetohydrodynamic (MHD) devices of longitudinal or transverse magnetic field are widely used. New furnaces are certainly equipped with MHD complexes consisting of an inductor and a power source. Furnaces of previous generations are subjected to modernization, during which they are equipped with MHD-agitators. The task of choosing the type of MHD machine is solved for each shop individually, based on the characteristics and price. The inductors of the longitudinal and transverse fields are different in design, efficiency, power supply modes, and cost. In addition, technological systems may differ in the type and characteristics of power sources. When creating induction machines, complex solutions are used to match the optimized electromagnetic system of the inductor and the power supply regime allowed in the power supply system. Power supply of inductors of a longitudinal magnetic field on furnaces with aluminum is provided with the help of three-phase IGBT inverters at a frequency of about 1 Hz. Acceptable reliability and sufficient control flexibility provide transistor frequency converters with single capacity of hundreds of kVA. For linear induction machines, the presence of an open magnetic circuit is characteristic; therefore, the power supply of multiphase windings turns out to be asymmetric. Asymmetry of the currents, as well as edge effects, can lead to a distortion of the traveling magnetic field and reduce the integral tractive force of the induction machine. The article shows that the evaluation of the asymmetry of the electromagnetic mode for different switching circuits of the windings of three-zone and four-zone MHD machines of the longitudinal magnetic field can be performed using the method of symmetrical components

Key words: asymmetry of the three-phase induction machine, electromagnetic inductor, traveling magnetic field, electromagnetic stirrer, power supply system of the induction machine, the method of symmetrical components, negative sequence currents, frequency inverter

VENTILATION SYSTEMS ENERGY EFFICIENCY INCREASING IN LIVING QUARTERS AND INDUSTRIAL PREMISES

A.V. Barakov, V.Yu. Dubanin, N.N. Kozhukhov, D.A. Prutskikh

Abstract: a significant amount of thermal energy is consumed by enterprises of various industries, as well as residential and public premises for the needs of ventilation and air conditioning. Designing modern thermal power plants can provide a significant economic effect during their operation. One of the main reserves of energy saving in the systems of ventilation and air conditioning in residential and industrial premises is the use of water evaporative air cooling. The greatest effect is achieved through the use of an air cooler with a "boiling" centrifugal layer. The nozzle for such a layer is represented by small particles of material that serve as a coolant for the regenerative transfer of thermal energy. Such technical and economic parameters as the cost of manufacture of the apparatus, corrosion resistance, wettability of the material, the specific surface area of the contact of the phases are key factors in determining the efficiency of the air cooler. On the basis of theoretical and experimental developments, an assessment was made of the fundamental possibility of operating a fluidized bed apparatus and calculating its thermal efficiency. The research results are presented by analytical and empirical equations. As a result of their solution, it was possible to obtain the values of the basic parameters of the air cooler. The results of the study confirmed the high efficiency of the device and can be used to calculate it

Key words: water-evaporative cooling, mathematical model, fluidized bed, experimental plant, coefficient of thermal efficiency

TO DETERMINATION OF THE RIBBING PARAMETERS IN THERMOSTATING OF THE SURFACE OF HEAT EXCHANGE IN CONDITIONS OF CONVECTIVE HEAT RELEASE

S.V. Dakhin

Abstract: an option of temperature control of a heat exchange surface during convective heat transfer is considered. The heat exchange surface is divided into areas with a given heat flow. In each section, the condition of constancy of the wall temperature is supposed to be realized by controlling the thermal resistance by applying ribs of variable height, changing their number and the conditions of heat transfer on the ribbed surface. The increase in heat transfer can be carried out in any suitable way through the use of intensifiers of various types. At the same time, the condition of equality of wall temperature in the cross section of the flow between the temperature under the rib and in the middle of the intercostal space due to the change in the distance between the ribs and their thickness should be satisfied. Thus, the temperature of the wall within the considered section is regulated in the longitudinal (downstream) and in the transverse directions, taking into account the temperature discrepancy that is specified for the technological process. An assessment was made of the effect of the parameters on the change in the ratio of the dimensionless temperature of the ribbed wall, which showed that the edge thickness and the Biot number had the maximum effect, and the rib height was minimal. Increasing the distance between the ribs leads to a decrease in this ratio at a small rate

Key words: rib of variable height, thermoresistance, thermostabilization

OPTIMIZATION MODELS OF POWER FLOW DYNAMICS CONTROL IN ELECTRIC POWER SYSTEMS

A.L. Rutskov, A.V. Burkovskiy, O.G. Yaskevich

Abstract: one of the urgent problems of the development of dispatch control systems is associated with the development of tools for optimizing electric power systems based on models for controlling the dynamics of the flow of energy resources. The goal is to minimize the loss of active power. A comparative analysis of two alternative methods for solving the problem of optimization of electric power systems by the criterion of the minimum of active power losses was carried out. A generalized algorithm for the implementation of the Lagrange method under independent initial conditions is described, as well as an algorithm for optimizing an electric power system using the modified Newton–Raphson method, supplemented by a fuzzy neural network. Due to the use of fuzzy neural networks, weakly formalized factors are taken into account, due to the unevenness of the consumer's load and affecting the distribution of energy in the power system. The results of numerical simulation with the aim of optimizing the node of the electric power system of the Voronezh energy zone based on the two algorithms described. It is shown that the use of fuzzy neural networks to control the power flow dynamics within an optimization model can significantly reduce its error

Key words: electric power systems, minimization of active power loss, power flow dynamics, control, optimization model

Radio engineering and communication

LINEAR VOLTAGE STABILIZER WITH MINUTE VOLTAGE FALL

A.S. Shaikin, I.A. Surov, E.D. Alperin

Abstract: the development of the concept of a linear voltage regulator with a voltage drop of 200 mV (Ultra LDO) and a load current of 100 mA is considered. Its structural scheme was proposed, which includes three main blocks: a reference voltage source (RVS), an error signal amplifier (ESA), and a regulating element (RE). As an error signal amplifier, an operational amplifier with Miller's compensation with a capacitor in the feedback circuit is used, made in MOS technology. The bandgap core is selected as the reference voltage source, the voltage at the output of which is determined by the width of the forbidden zone of the semiconductor used. A stable current is required for ESA and RVS operation. For its implementation, a thermally stable current source is used, the output current of which remains stable over a wide range of temperatures. As a regulating element of the voltage regulator, a p-channel MOS transistor is used, the resistance of which is changed so that the output voltage level remains almost constant, compensating for the fluctuations of the load current and the input voltage. Using the simulation methods in the Cadence Virtuoso Schematic system, the performance of the voltage regulator is checked, its temperature instability, instability on the supply voltage, the minimum voltage drop, and the ripple suppression factor are investigated. The research results indicate the possibility of using this stabilizer in power sources for processors and EPLD

Key words: stable voltage, reference voltage source, thermally stable current source, error signal amplifier, minimum voltage drop

REALIZATION OF A STOCHASTIC LDPC DECODER ON A FPGA

A.V. Bashkirov, I.V. Sviridova

Abstract: this article considers LDPC codes for the following communication standards: 10GBASE-T, DVB-S2 and IEEE 802.16 (WiMAX). A review of a new class of stochastic iterative decoding architectures is presented. The proposed architecture makes completely parallel decoding of (long) modern LDPC codes working on FPGAs. Stochastic decoders represent probabilistic messages on the frequency of units in a binary stream. This leads to a simple mapping of the factor graph of the code in silicon. The implementation on the FPGA of the LDPC decoder with 8 information bits and 8 encoded bits is described. On the Altera Cyclone FPGA, the bandwidth is 5 Mbit / s when clocked at 100 MHz and is expected to increase almost linearly with the code length. Modeling of the decoder on the FPGA Altera Stratix at a demanding capacity of 8 Mbit/s was carried out. The article describes the hardware implementation of the stochastic decoder for the LDPC code. Next, we'll look at the basics of iterative decoding of LDPC codes. The concept of stochastic decoding is described below. An overview of the hardware architecture of the stochastic LDPC decoder is presented. The results of the FPGA implementation and summary are given in the conclusion of this article

Key words: stochastic decoder, LDPC code, stochastic calculations

METHOD OF DESIGNING THE FREQUENCY SYNTHESIZER OF DIRECT DIGITAL SYNTHESIS ON FPGA

A.A. Pirogov, E.A. Bocharov, E.V. Syemka, O.Yu. Makarov

Abstract: an integral element of most radio devices are systems for synthesizing frequencies and signals. Most of the known circuits use analog elements, which are characterized by changing parameters to one degree or another under the influence of external factors. However, with the advent and development of digital technology, which uses purely mathematical calculations and logical functions that are resistant to changes in external factors, a new way of generating signals has emerged - direct digital synthesis. One of the main types of frequency synthesizers is digital computational synthesizers (DCS). High resolution in frequency and phase, the most rapid transition to another frequency without interrupting the phase, the ability to control the frequency, phase, and amplitude of the digital interface are constantly expanding the scope of digital signaling systems in various fields of technology, such as satellite communications, radar, radio navigation, measuring instruments, etc. Direct digital synthesis is a method of creating a signal of the required frequency and shape using digital resources. Thanks to the digital solution, the generated signal has the inherent accuracy of digital systems. The frequency, amplitude and phase of the signal at any given time are known and controlled. Thanks to these advantages, direct digital synthesis is increasingly crowding out analog solutions. The work is relevant because of the lack of domestic analogues of frequency synthesizer chips, implemented on a modern element base. The technique of designing a direct digital synthesizer (DDS) with a quarter-wave converter (QWC) based on FPGA is described

Key words: arithmetic logic device, programmable logic integrated circuit, design, verification, modeling

ESTIMATION METHODOLOGY OF VIBROACOUSTIC SIGNALS OF THE ROLLER BEARING OF THE RAILWAY CARRIAGE WHEEL PAIR

D.V. Zhuravlyev, T.S. Glotova, V.V. Glotov

Abstract: monitoring equipment status in a broad sense means reading information signals from various sensors, collecting data, processing signals and analyzing them for extracting and evaluating fault information. The purpose of the monitoring is to prevent the unplanned shutdown of production processes due to malfunction of individual units and catastrophic equipment failures during the operation of rail cars. Monitoring of the state is absolutely necessary on transport, where safety considerations have a high priority. Smooth monitoring is necessary to achieve the most beneficial economic effect, as the installation of malfunctions will take place in the early stages of development. Vibration signals are carriers of information for both the machine as a whole and its parts, each of which has its own spectrum of vibration frequencies. In order to provide effective preventive detection of damages in complex mechanisms containing multiple nodes, these methods of signal processing and analysis are required that make it possible to extract partial information about the state of each specific component of the complete vibroacoustic (VA) signal. This article describes the results of an experimental study of the statistical characteristics of VA signals of a roller bearing a wheel pair of a railway car

Key words: vibro-acoustic signals, roller bearing, freight car, statistical characteristics

RESEARCH OF THE FRESNEL LENS INFLUENCE ON PARAMETERS OF THE TEM-HORN

L.N. Korotkov, A.S. Samodurov, D.S. Pogrebnoy

Abstract: the influence of the Fresnel lens on the input parameters of the horn antenna is studied when different versions of the Fresnel lens are installed. It is established that the use of the Fresnel lens on the opening of the horn antenna in most cases leads to an improvement in a number of parameters, of which the most important are the standing wave voltage coefficient, the gain factor, the active and reactive input resistance. In the course of a numerical experiment, it was found that the direction of installation of the lens is very important; this is clearly shown on the graphs of research. So, for example, the inverted lens differs from the directed one in that the horn antenna has better gain factor (one of the main parameters for the antennas) without narrowing the angle of the radiation pattern. This is achieved due to a different shift of coherent waves in phase, due to which the maxima of the waves from different zones coincide, and this, in turn, causes amplification of the signal with an unchanged radiation angle. An analysis of the results obtained as a result of simulation showed that it was the inverted Fresnel lens that provided the improvement of the horn antenna parameter set in several frequency bands. For additional verification of the results, a three-dimensional radiation pattern of the antenna was compiled, which made it possible to establish that there was no negative effect on the directionality of the antenna, the angle of cut of the teeth in the Fresnel zones was set correctly

Key words: TEM-horn, dielectric lens, Fresnel lens, horn antenna

CONTROLLABLE TWO-CASCADE GENERATORS ON SAW-FILTERS

M.I. Bocharov, S.G. Nekrasov, A.E. Akin'shin

Abstract: raised standarts are required for the linearity of the modulation characteristics, the magnitude of the frequency deviation, the level of noise emission and frequency stability of controlled oscillators of high-frequency oscillations used at high frequencies and microwave frequencies. These contradictory requirements can be fulfilled using generators made on two-cascade amplifiers and filters on surface acoustic waves (SAW). Based on the analysis of the basic structures of two-cascade amplifiers (cascode circuits), a justification was made for implementing a controlled generator on SAW bandpass filters using two-cascade amplifiers common base - common collector with current control of the generator frequency by the barrier capacitance of the varactor. For the implementation of controlled generators with optimal characteristics, a method of their calculation is proposed, based on the matrix method and the use of Y-parameters, which allows for an optimal energy mode of operation with minimal nonlinear distortions. To assess the reliability of the results obtained, modeling and experimental verification of the static modulation characteristic (SMC), dynamic modulation characteristic (DMC), the level of noise radiation and nonlinear distortion were carried out. It was found that the tuning range of the SAW generator frequency is about 0.9% with a frequency deviation of 230 kHz, a noise level of about -155 dB/Hz when offset from the center frequency by 100 kHz and mode instability of the frequency $1.8\ 10^{-5}$ when the supply voltage changes to ± 5%

Key words: SAW filter, two-cascade amplifier, matrix method, modulation characteristics, simulation and experimental studies

Mechanical engineering and science of machines

EXPERIMENTAL DETERMINATION OF FRICTION COEFFITIENT BY STRETCH-FORMING METHOD

V.V. Eliseev, L.V. Khlivnenko, A.M. Gol'tsev, S.S. Oding

Abstract: the article shows the calculation and experimental methods for determining the friction coefficients between the sheet blank and the form-block by the stretch forming method. The determination of the coefficient of friction is made on the basis of the solution of the problem of the equilibrium of the workpiece element, loaded according to the bending scheme with stretching taking into account friction according to the Coulomb law. The experimental coefficient of friction was found from the distribution of the longitudinal strains of the sample after stretch forming. To carry out the research, preliminary tests were performed to determine the mechanical properties of various materials used for stretch forming of the parts from aluminum alloys and steels. When determining the coefficients of friction, a simple stretch forming device was used. The effect of influence of various punch, blank and lubricant materials on the coefficient of friction was studied. The effect of friction on the limit strains of the workpiece was established. The results of the studies are used in modeling various operations of sheet punching with the help of CAD of technological processes

Key words: coefficient of friction, workpiece, lubrication, limit strain, stretch forming

INFLUENCE OF ULTRADISPERSED MODIFICATORS OF FLUIDS ON POWER CHARACTERISTICS OF THE PROCESS OF CUTTING CONSTRUCTION MATERIALS

Yu.A. Tsekhanov, I.V. Kharchenko, R.M. Dzhemalyadinov, V.V. Skakun

Abstract: one of the current areas in the field of improving the performance properties of lubricant agents (LCA) is the modification of liquids with ultrafine powders. Directly coagulation (aggregation) is the main problem when using ultra-fine powders, as there are difficulties in their dispersion, stabilization and uniform distribution in the volume of lubricant. The most effective means of eliminating these disadvantages is the intensive dispersion of metal particles with the introduction of a polymer (surfactant), which in turn actively covers the surface with a protective sheath, which prevents their further aggregation. Intensive dispersion breaks the coagulation bond, and the polymer in turn creates a solvation shell around the particle. As a result of the active dispersing effect in the presence of a polymer, it is possible to achieve stabilization of the modifier in a dispersed form and prevent its coagulation. The results of the influence of stabilized LCA with ultrafine aluminum and molybdenum modifiers on wear and the power characteristics of the process of turning metals with various chemical activities are presented. It can be seen from the histograms that the use of stabilized ultrafine modifiers contributes to reducing cutting forces and reducing tool wear on the front surface by reducing the specific pressure and changing the chip shear angle. The use of minimal lubrication technology contributes to the economic viability

Key words: ultrafine modifiers, lubricant cooling agents, ultrasonic treatment, minimal lubrication technique, surfactants, cutting forces, coagulation, wear

ELECTROCHEMICAL TREATMENT OF TITANIUM ALLOYS WIYH WIRE WITH AXIAL ELECTROLYTE FLOW

E.V. Smolentsev, V.G. Gritsyuk, O.G. Shipilova, D.E. Krokhin

Abstract: electrochemical wire processing is mainly used for cutting machined parts with a wide range of thicknesses. It has a great advantage in comparison with the non-profiled electrode in the electroerosion method, as it avoids the zone of thermal influence in the processing area. In addition, the wire electrode in the electrochemical processing can be reused, as it does not wear out. Titanium and alloys are widely used in the aerospace industry, as parts of rocket and aircraft engines, as well as the fuselage due to a good combination of high specific strength and corrosion and heat resistance. Titanium and its alloys are considered to be difficult to process due to a number of properties of these materials, such as poor thermal conductivity, chemical reactivity, and low modulus of elasticity. The article deals with the axial supply of electrolyte for the removal of electrolysis products. The axial flow of electrolyte to remove electrolysis products in the processing of titanium, the optimization of processing parameters such as feed rate, operating voltage, electrolyte concentration, etc. are considered. Experimental results show that electrochemical machining with axial electrolyte flow is a promising technique for machining titanium alloy OT4. The article also discusses the possibility of multielectrode electrochemical processing to improve processing performance

Key words: electrochemical processing, titanium, electrode wire

APPLICATION OF INTEGRATED HYDRA METALS FOR THE CUTTING TOOL MANUFACTURING

L.S. Pechenkina, O.I. Popova, M.I. Popova

Abstract: the article considers the use of complex alloys for manufacturing cutting tools. One of the indicators affecting the quality parameters of the machined part, which should be taken into account when machining large-sized parts, is the indicator of the toughness of the tool material and the cutting tool operation time. The use of optimized compositions of wear-resistant alloys and methods for their preparation allows one to increase the wear resistance and resistance of the cutting tool to shock load. For the manufacture of the cast tool from the new complex alloys, two fundamentally different technological schemes were used: 1) annealing of cast workpieces, mechanical processing, high-temperature hardening, tempering for secondary hardness, and finishing by grinding; 2) obtaining precise castings, stripping and finishing them. A rational chemical composition of complex alloys (base - iron) was established, including: from 1.3% to 1.9% carbon, 3.6-5.3% molybdenum, 3.4-6.1% vanadium, 4.0-5.5% chromium, up to 1.3% silicon with a limited content of manganese (up to 1.2%), aluminum and rare-earth elements (up to 0.15%). The use of new cast complex alloys as a tool material provides the cutting tool with high durability and resistance to shock load, leads to a reduction in cost, makes it possible to produce cutting tools operating at high shock loads, for machining large-sized parts, gears and other blanks

Key words: cutting tool, impact load, complex-alloyed alloys, wear resistance

FEATURES OF CALCULATION OF A COMBINED ELECTRODE-TOOL FOR ELECTRICAL METHODS FOR TREATMENT MANUFACTURED BASED ON ADDITIVE TECHNOLOGIES

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Abstract: the relevance of the research is justified by the need to modernize the technology of designing and manufacturing an electrode tool for electrical processing methods in order to reduce costs in the conditions of experimental design and individual production. In this regard, the article is aimed at disclosing the possibilities of using modern computer-aided design tools and rapid prototyping technology for the manufacture of a complex profile tool for a single and pilot production. As an approach to the study of this problem, the geometry of the profile of the working surface of the combined complex-profile electrode-tool for electrical processing methods is used, taking into account its implementation based on additive technologies made of dielectric materials with subsequent application of a conductive coating. The article presents the methods for calculating the geometry of electrode tools, both for electrochemical and electroerosive processing methods, which are produced on the basis of additive technologies from dielectric materials with the subsequent application of a conductive coating, which served as the basis for identifying the basic laws governing the determination of the thickness of the conductive coating, which directly depends on the modes of use of the electrode tool. The materials of the article are of practical value for the enterprises of the machine-building complex in connection with the modernization of the manufacturing process of the electrode-tool for electrical processing methods, reducing its cost and increasing the variability of its manufacture

Key words: electrode-tool, electrochemical processing, additive technologies

Physics

THERMOELECTRIC MATERIAL BASED ON CHALCOGENIDES OF BISMUTH AND THE N-TYPE CONDUCTIVITY WITH NANOSCALE OXIDE PHASE

Yu.V. Panin, Yu.E. Kalinin

Abstract: the paper deals with the issues of improving the thermoelectric quality factor of thermoelectric materials used in practice. A significant breakthrough in the improvement of thermoelectric Q (ZT) was made in the 1950s, thanks to the implementation of the concept of solid solutions based on Bi2Te3-Sb2Te3, put forward by the A. F. Ioffe, which was later implemented in practice. In recent years, there has been a new breakthrough in increasing the ZT of thermoelectric materials, based on the concept of creating nanostructured thermoelectric materials. Taking into account the latest trends of thermoelectric q-factor increase, thermoelectric characteristics of the composite material based on solid solutions of Bi2Te3-Se2Te3 n-type conductivity containing nanoscale oxide phase of the main semiconductor material are investigated. Samples for research were synthesized by ceramic technology with a concentration of nanoscale oxide filler 0.1-0.12 mass. %. It was found that the introduction of oxide nanoscale filler leads to an increase in the ratio of electrical conductivity to the thermal conductivity of the material and the growth of thermal e.m.f.. It is shown that the thermoelectric quality factor of the obtained composites reaches a maximum value of ZT = 1 in the temperature range of 500-600 K

Key words: nanocomposites, thermal e.m.f., resistivity, thermal conductivity coefficient

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INFLUENCE OF PRESSURE AND HOLDING TIME AT HOT PRESSING ON THERMOELECTRIC PROPERTIES OF BISMUTH TELLURID

A.A. Grebennikov, A.I. Bocharov, V.V. Bavykin, I.V. Izvekova

Abstract: the influence of the hot-pressing regimes (pressure and holding time under pressure) on the thermoelectric properties of bismuth telluride $Bi_2Te_{2.4}Se_{0.6}$ n-type conduction doped with calomel Hg_2Cl_2 was investigated. Four samples were obtained at the "RIF Corporation", using a two-stage technology that includes synthesis followed by hot pressing. It was established that a change in the hot-pressing modes has little effect on the thermo-emf coefficient – the numerical values almost coincide at the temperatures higher than 200 ^oC and differ by less than 3% at the temperatures less than 200 ^oC. The conductivity of the samples does not depend on the pressure and holding time. The temperature dependences of conductivity practically coincide up to the temperature of 200 ^oC; the difference in conductivity does not exceed 5% at a higher temperature. Changing the hot pressing mode affects primarily on the thermal conductivity. Both an increase in the pressure and an increase in the holding time under pressure leads to a decrease in the thermal conductivity of the material. Thus, increasing the pressure, holding time under pressure, or both parameters can increase the thermoelectric figure of merit of bismuth telluride. The growth of thermoelectric figure of merit in the investigated samples was 15%

Key words: thermoelectricity, bismuth telluride, electrical conductivity, thermal conductivity, thermal electromotive force

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DAMPING DECREMENT AND INTERNAL FRICTION OF THE FILAMENT

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Abstract: the connection between the equation of internal friction of the filament material and the natural frequency of its oscillations is shown; the method of damping of the string vibrations is applied to find the level of internal friction. The resonant frequency of the main bending mode of oscillations is close to the resonant frequency of the second string mode of the oscillations of the filament, which allows one to perform controlled damping of the filament. An analytical calculation of the damping properties of a tensioned filament with a known value of internal friction of the material from which it is made is carried out. Taking into account the energy losses in the filament and not limiting by any particular mechanism of energy dissipation, we can say that in order to preserve the generality of reasoning, the amount of internal friction of the filament material will characterize the phase angle between stress and strain. The Bogolyubov method is used to solve the wave equation. When determining the value of the damping factor proportional to the true level of internal friction, it should always be remembered that the coefficient of proportionality, depending on the loading conditions of the string, can vary within wide limits. Therefore, the method of damping the oscillations of the string should be applied to find the level of internal friction with great care, each time determining the voltage value

Key words: internal friction, phase shift, tension, deformation

THERMOELECTRIC PROPERTIES PbTe THIN FILMS PREPARED BY ION-BEAM SPUTTERING

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Abstract: the effect of silver and carbon doping on the electrical properties of PbTe thin films, prepared by ion-beam sputtering was studied. The structure of the films is characterized by a PbTe phase with a cubic lattice of the NaCl type, with a strong texture with an axis <100> perpendicular to the substrate plane. It was established that doping of 2,7-2,8 at. % Ag and 9,7-11 at. % C leads to increasing of the charge carriers concentration and mobility of PbTe thin films. At concentrations more than 2,8 at. % for Ag and 11 at. % for C the formation of two-phase composites PbTe-C and PbTe-Ag_2Te occurs and it leads to decrease in carriers' concentration and mobility with increasing in content of the doping element. The maximum values of the thermoelectric power factor for thin PbTe-C and PbTe-Ag films obtained in this investigation were 0,768 $mW \cdot m^{-1} \cdot K^{-2}$ and 1 $mW \cdot m^{-1} \cdot K^{-2}$, respectively. This is twice as high as value for pure PbTe films prepared at the same sputtering conditions (0,584 $mW \cdot m^{-1} \cdot K^{-2}$)

Key words: lead telluride, resistivity, thin films, thermos emf, Hall effect

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MODULE OF SUPER-CONDUCTING FREQUENCY CONVERTER WITH CASCADE OF THERMOELECTRIC COOLER

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Abstract: the design of a frequency converter based on a high-temperature superconductor of the Bi(Pb)-Sr-Ca-Cu-O system was proposed. As a cooling device, it was proposed to use a microcryogenic system operating on the reverse Stirling cycle. The device of the microcryogenic system was described. Such a system is able to provide thermal stabilization of an object at the temperature level of T = 80 ÷ 120K with the accuracy of ± 0.5 K, which is insufficient for a frequency converter based on Bi-HTSC. To improve the accuracy of thermal stabilization and reduce the inertia of the system, a thermoelectric refrigeration module was used in the design. Additional stabilization of the temperature of the frequency converter was provided by a thermoelectric refrigeration module, which is based on the Peltier effect. As materials for a thermoelectric refrigeration module operating at cryogenic temperatures, it waqs proposed to use Bi-Sb alloy for the n-branch and Bi_2Te_3 - for the p-branch. According to estimates, the thermoelectric refrigeration module in the proposed design is capable of providing the object with thermal stabilization at the level of 0.05 K. The design and operation principle of the frequency converter was described. The paper substantiates the possibility of using bismuth-based superconducting materials as a nonlinear converter. The technology of obtaining materials by the method of solid-phase synthesis was described. The precursors for the final material are given. The results of microstructure research and the results of X-ray structural analysis are shown

Key words: high-temperature superconductor, thermoelectric refrigeration module, frequency converter, micro-cryogenic system, nonlinear medium, microstructure

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STRUCTURE AND MECHANICAL PROPERTIES OF COMPACTED SEMICONDUCTORS ON THE BASIS OF Bi_2Te_3-Sb_2Te_3 SOLID SOLUTION, OBTAINED IN THE PROCESS OF HOT PRESSING AND FURTHER SURFACE TREATMENT

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Abstract: the efficiency of thermoelectric generator batteries is determined by both the bulk properties of a semiconductor (first of all, thermoelectric Q factor) and the contact properties of the semiconductor-switching layer interface (contact resistance, adhesion). The first depend on the method of manufacturing the material, the second - on the method of processing the surface of the material before the formation of the switch layers. The purpose of this work is to establish patterns of formation of the structure and phase composition of p-type semiconductor materials based on Bi_2Te_3-Sb_2Te_3 solid solution as a result of hot pressing, as well as result of various technological options for treating the surface of the material. X-ray diffractometry (XRD), scanning probe microscopy (SPM), scanning electron microscopy (SEM), and nanoindentation were used to study the phase composition, structure and mechanical properties (hardness, elastic modulus) of samples of compact semiconductor materials of p-type conductivity based on solid solution Bi_2Te_3-Sb_2Te_3, obtained in the process of hot pressing, before and after different options for surface preparation (mechanical polishing, electrochemical polishing, pulsed photon processing). It was found that in the process of hot pressing in the volume of a semiconductor material based on the Bi_2Te_3-Sb_2Te_3 solid solution a texture is formed with the axis of the <001> $Bi_{0.4}$ $Sb_{1.5}Te_3$ zone parallel to the pressing axis; for the near-surface region (at a depth of up to 200 μm), a texture is characteristic with the axis of the <001> $Bi_{0.5}Sb_{1.5}Te_3$ zone, a normal surface. Mechanical polishing and pulsed photon processing of material samples cause substructural changes in it, associated with an increase in the fraction of grain boundaries and an increase in the dispersity of the grain structure. It was established that mechanical polishing of material samples strengthens the surface layer up to 2 microns thick, photon treatment leads to hardening of the deeper layers of material, and electrochemical polishing leads to a decrease in hardness and elastic modulus

Key words: thermoelectricity, bismuth telluride, hot pressing, texture, hardness

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