FUZZY REGULATION OF FEEDING HEATING STEAM IN THE FRAMEWORK OF AUTOMATED CONTROL SYSTEM OF TECHNOLOGICAL PROCESS OF AUTOMOBILE TIRES VOLCANIZATION

A.A. Mitrokhin, V.L. Burkovskiy

Abstract: in the article, the problems of control of the technological process of vulcanization of automobile tires from the position of a potentially dangerous process are considered. Control systems for potentially hazardous technological processes must be constantly developed and improved in connection with the undeniable importance of ensuring proper quality control, because potentially dangerous technological processes represent systems that are difficult to formalize and that operate in conditions of uncertainty, incompleteness of knowledge and unclear descriptions, both of the system itself, and the signals acting on it. In this connection, it is no longer sufficient to use classical methods of control theory to manage such systems, and new methods and approaches need to be developed. One of such approaches is based on the fuzzy set and fuzzy logic of L. Zade. In the paper, the expediency of using a fuzzy regulator for regulating the temperature in the external heating circuit of the car tire vulcanization process was analyzed, due to the change in the flow volume of the heating steam. The structure of the automated control system for the technological process of tire vulcanization based on the fuzzy logic apparatus was considered, and also the results of two-position control and proportional-integral-differential regulators used for temperature control in the external heating circuit of the car tire vulcanization were presented. Qualitative analysis of traditional regulators with respect to the adjustment of complex parameters control systems was carried out. The necessity and expediency of using a fuzzy regulator with regard to temperature control in the external heating circuit of the tire vulcanization process for improving the quality of the products were proved

Key words: fuzzy regulator, hazardous production, vulcanization

DEVELOPMENT OF THE MODEL OF OPERATION CENTER FUNCTIONING WITH THE APPLICATION OF THE FUZZY TIMED PETRI NETS

V.A. Mustafayev, M.N. Salmanova

Abstract: the modelling of dynamic interacting processes is examined in the article, which shows the operation of complex objects in the condition of uncertainty. Formalism intended for the development and analysis of models of complex parallel and distributed systems is proposed. It is based on the mathematical apparatus of the timed Petri nets (PN), representing generalized fuzzy timed PN of a special kind combining deterministic and non-deterministic character. The algorithm is developed for the functioning of fuzzy timed PN. The proposed algorithm provides a solution to the problem of solvability of triggering of transitions occurring in states of conflict, the imposition of a fuzzy structure on the network marking with fuzzy laws of composition that determine the values of the degrees of belonging of the input and output transition positions. The models of dynamic processes are presented in the form specific to fuzzy timed PN. An approach is proposed for modeling dynamic interacting processes based on the matrix theory of PN that provides an effective form of representation of the structure, dynamics of the model state, the space of achievable states, and the sequence of triggering transitions in the form of a set of vectors and matrices. On the example of the production model of mechanical processing, it is shown that the accepted rules of triggering transitions fully show the functioning process of fuzzy timed PN. A tree graph of accessibility in the form of a sequence of vectors was received as a result of the simulation

Key words: model, algorithm, trapezoidal fuzzy interval, fuzzy timed Petri Nets, mechanical processing module

SOFTWARE IMPLEMENTATION OF APPLICATION USING NEURAL NETWORK TO RESTORE IMAGES AFTER LOSSY COMPRESSION

V.F. Barabanov, N.I. Grebennikova, S.L. Kenin, D.A. Yurov

Abstract: the paper proposes a technology of image restoration, based on the use of neural network training. It allows to remove compression artifacts from the images processed by the JPEG codec that uses compression algorithms with losses. Neural networks are not programmed, unlike traditional software, they are trained. Learning capability is one of the main advantages of neural networks over traditional algorithms. Technically, training consists in finding the coefficients of connections between neurons. In the learning process, the neural network is able to identify complex relationships between input and output data, as well as perform generalization. This means that if the training is successful, the network will be able to return the correct result based on the data that was not in the training sample, as well as incomplete, partially distorted data. The structure and functions of the software tool for image restoration using deep neural networks are proposed. On the basis of the proposed structure, a library of methods and an application were developed to prepare the neural network for operation and to test it on non-synthetic copies of compressed images. Considerable attention is paid to the consideration of the most relevant architectures of neural networks for this task and libraries that simplify their implementation. The results of the application were obtained and analyzed

Key words: autoencoder, deep learning, convolutional neural network, Keras

DEVELOPMENT OF CONTROL SYSTEM OF BUILDING 3D PRINTER ON THE BASIS OF NEUROKONTROLLER

V.Zh. Bocharov, V.L. Burkovskiy

Abstract: the universal control system of the construction 3D printer, designed in a constructive manner on the basis of both the column architecture and the crane beam, is considered in the article. For the management system of such a device as a building 3D printer, it is extremely important to solve the control problem in conditions of both wind loads and various external disturbances, including changes in the composition of the applied building mixture. As part of solving these problems, the management system will require not only flexibility and reliability, but also the ability to self-learn as it operates. The solution in this case will be the previously discussed application of a hybrid parallel neural control system, which implies the use of two controllers at once: conventional and neural. The article presents a classical diagram illustrating a hybrid parallel neural control and an already revised scheme that is primitive for controlling a 3D construction printer. Neural networks of spatial layers of the neurocontroller are illustrated. The approach to the development of management systems for objects such as construction 3D printers described in the article makes it possible to significantly increase the overall efficiency of the control object and reduce the number of problems arising from the operation of such systems

Key words: neural control, building 3D printer, PLC, neural networks, optimization

PLUGGING CHART FOR PERFORMANCE OF PAIR OPERATIONS IN A RECONFIGURABLE PRODUCTION DEVICE

E.A. Titenko

Abstract: the paper describes the provision of parallel computations within the production paradigm. The goal of the study is to reduce the time required to provide parallel production calculations for the processing of character data. This goal is achieved by splitting the production system into independent subsets of products and setting the conditions for their initialization. The method of solution is based on the apparatus of constructive logic. The rules of decomposition are presented in the form of constructive disjunctions. Members of constructive disjunctions specify variants of intersection of pairs of special words. Special words are pairs of product samples or pairs of sample and product modifier. The basis of the decomposition consists of two commutation schemes. They combine the words into pairs in such a way that both adjacent and stepwise word combinations can be performed. The production system is represented by a bipartite graph. The left vertices of the bipartite graph correspond to the samples of the products. The right vertices of the bipartite graph correspond to the product modifiers. The alternation of commutation schemes allows to use the linearization property of the arrangement of pairs of samples and the property of two-dimensionality of the sample location and modifier in a pair. As a result, two commutation schemes provide a linear decoding time for the production system. A homogeneous array of blocks of search for intersections of word pairs with regular connections forms the basis of the reconfigurable production device. Connections set the commutation schemes. The alternation of commutation schemes and the uniformity of the composition of the device with regular connections constitute the content of the reconfiguration of the production device. The decomposition of the general structure into a homogeneous set of blocks of search for intersections of word pairs defines the universality of realization. It shows itself in the construction of the intersection search block based on pipeline, matrix, and associative principles

Key words: production system, reconfiguration, decomposition, plugging charts, intersection of words

SYNTHESIS OF FUZZY REGULATOR FOR MEDICAL ASPIRATION DEVICES

E.S. Sharapova, V.L. Burkovskiy

Abstract: the article considers the modeling of control processes of a medical aspiration device with a regulator based on fuzzy logic, basic methods of control of a medical device for aspiration providing such technical characteristics as: high power, accuracy of regulation, reliability and noiselessness. The article gives an example of a controller synthesis using fuzzy logic of a medical aspirator, using a traditional linear PID controller and based on fuzzy logic controller. Numerical characteristics of the control efficiency of the classical PID controller and controller with the use of fuzzy logic (for different types of devices), as well as the basic rules for controlling the fuzzy controller used to operate in this system, are given. A generalized fuzzy controller model for a dynamic object allows formally to describe a wide class of simply connected dynamic control objects

Key words: regulator, fuzzy logic, aspirator, electric motor

Energetics

USE OF SOLAR RADIATION AT APPLICATION ENERGY EFFICIENT FENCING CONSTRUCTIONS

R.A. Sheps, N.V. Portnova, T.V. Shchukina, I.I. Pereslavtseva

Abstract: the most common and renewable source available on the entire territory of the Russian Federation is the solar radiation successfully utilized for heating, hot water and electricity supply of buildings for many decades in the leading European countries. However, the positive European experience is often not applicable in the harsh climate of the Russian Federation. Given the difficult weather conditions of winter seasons, most of the territory of the Russian Federation, construction of fencing, utilizing the solar radiation should have not only the storage layer, but also high heat-shielding properties. This paper examines the issue of effective use of solar energy by designing energy efficient fencing structures. It is proposed to design the exterior walls to effectively utilize solar energy to reduce heating loads on the buildings. The feature of the technical solution is using heat isolation, separated from the storage layer by an air gap. This design allows to avoid overcooling of the premises in adverse weather conditions in cold seasons and overheating in warm ones. The obtained results show the unconditional prospect of the organization of passive solar heating systems with architectural and designing solutions, involving facade glazing. The proposed design solution will not only efficiently utilize the solar radiation, but also maintain the temperature in the premises through the use of thermal insulation

Key words: energy saving, solar energy, building structures

EXPERIMENTAL COMPARISON OF THE WATER COOLER WITH NOZZLE CENTRIFUGAL BED AND COOLING TOWER

Yu.N. Agapov, D.A. Davydov

Abstract: the article presents the results of an experimental comparison of a water cooler with centrifugal fluidized bed and a cooling tower. In particular, the dependences of the specific cooling capacity and thermal-hydraulic index on the initial temperature of the fluid are shown. The experiments were carried out on a test bench designed to study the hydrodynamic and thermal characteristics of a three-phase fluidized bed. In this case, prototype models were used as working elements. The main tasks of the research were: testing the performance of devices, determining their heating capacity (cooling capacity) and the thermo-hydraulic index. An experimental comparison of the water cooler with a centrifugal three-phase fluidized bed and a cooling tower showed that the device is twice as effective as the cooling tower for specific cooling capacity, and 1.5 times for the thermo-hydraulic index. The results of the experiment make it possible to recommend a fluidized bed as a nozzle in cooling towers to ensure the optimal technological mode of cooling of circulating water via the air flow

Key words: fluidized bed, interphase heat exchange, nozzle, cooling tower

OBTAINING HIGH THERMAL CONDUCTIVITY ADHESIVE JOINTS BY COMBINED EFFECT OF THE ELECTRIC AND VIBRATION FIELDS

N.V. Mozgovoy, V.M. Popov, D.V. Popov

Abstract: the problem of increasing the thermophysical characteristics of materials based on adhesive compounds is considered. When operating heat-stressed units of technical systems, including glued joints, an increased thermal conductivity of the adhesive layers is required. To solve this problem, a method for increasing the thermal conductivity of glued interlayers of compounds based on the effect of combined action of electric and vibro-wave fields on adhesive layers formed on the basis of epoxy glue with a metal filler is proposed and tested experimentally. When magnetic or electric fields are applied to glued interlayers, the increase in their thermal conductivity is explained by the formation of heat-conducting chain structures from metal filler particles. However, according to the results of X-ray diffraction analysis, in this case the packing density of the filler particles is imperfect. This circumstance shows the need to investigate the complex effect of heterogeneous physical fields on the thermal conductivity of interlayers of adhesive joints. As a result, it was shown that the thermal conductivity of the adhesive composition is influenced by the nature of the filler and its concentration, the electric field strength and the frequency of mechanical vibrations. Moreover, the greatest effect is observed when the electric field intensity is varied

Key words: adhesive joint, coefficient of thermal conductivity, electric field strength, vibration frequency

CALCULATION OF NONUNIFORMITY OF THE DISTRIBUTION OF THE COMPONENT ALONG THE COOLING CHANNELS OF A LIQUID ROCKET ENGINE CHAMBER BASED ON MODELING IN ANSYS CFX

A.V. Kretinin, D.N. Galdin, E.E. Spitsyina, A.N. Popkov

Abstract: the article deals with the flowing part of the regenerative cooling system of the liquid rocket engine chamber. The estimation of the uneven distribution of the coolant in the cooling channels was made at deviation of the geometry from the design one as a result of the features of the manufacturing technology of the brazed two-layer construction of the cooling jacket. The geometric model of the flow section of the cooling path of the combustion chamber consisted of 101 channels of the external cooling system in combination with the collectors of the coolant supply and collection. The resulting grid model contained 8 million elements. ANSYS Workbench was used for modeling. As a model of turbulence, we used the standard k-ε model. The simulation was performed in a stationary setting. The main results of calculations were the values of flow through separate channels of the cooling path. During the modeling, the angle of inclination relative to the perpendicular axis of the inlet and outlet nozzle was changed. It was established that the effect of the supply fitting affects about 10% of all channels of the system, causing lower flow rates through the remaining 90% of the channels, additionally non-perpendicular execution of the coolant inlet and outlet chutes lead to a change in the flow through the channels by a maximum of 4-5%

Key words: liquid rocket engine, cooling channels, hydrodynamic modeling

ISSUES OF INCREASING THE LEVEL OF ENERGY SAVING OF AUTOMATED ELECTRIC DRIVES OF PUMPING EQUIPMENT BASED ON COMPENSATION OF REACTIVE POWER

V.N. Krysanov, K.V. Ivanov

Abstract: the article considers one of the options for increasing the energy saving level of pumping and compressor units by using reactive power compensation devices (RPCD). A method for estimating the energy efficiency of measures for reactive power compensation based on the criterion of minimum averaged costs is considered. Formulas are given for calculating the economic effect due to the optimization of the power system modes, as well as the formula for the initial costs and objective function. The practical implementation of the automated calculation of costs is described depending on the mode of the power system and the configuration of RPCD. The results of the calculation of the optimal operating modes of the load nodes for various customer types are presented, according to the load graphs, with the use of RPCD in the form of three-dimensional graphical dependences of the costs on the voltage in the main and the type of the thyristor capacitor installation. Conclusions are made about the possibility of the effective use of RPC devices for turbomechanisms, as well as the possibility of obtaining an informative picture of the optimal modes of load nodes using the developed algorithm

Key words: energy efficiency, reactive power compensation, optimization

EXPERIMENTAL STUDIES OF ENERGY EFFICIENCY OF CLIMATE SYSTEMS WORK IN THE OFFICE SPACE

D.V. Lobanov, R.A. Sheps, N.V. Portnova

Abstract: the analysis of the efficiency of microclimate maintenance systems in the office premises, which are the main consumers of thermal energy in the building, is performed. According to GOST 30494-2011 “Residential and public buildings. Microclimate parameters for indoor enclosures”, the room under examination belongs to the 2nd category (mental work rooms) for which the regulatory documents set the parameters of the internal microclimate and determine the quality of the air. For the room, experimental studies were carried out to determine the distribution and the time variations in the main parameters of the microclimate and the concentration of carbon dioxide for different periods of the year in the room. The measurements were carried out every working day for two calendar years. The following operating modes of microclimate systems were investigated: the first mode - air conditioning and mechanical ventilation are switched off, the natural ventilation system works (windows are wide open); the second mode - mechanical and natural ventilation systems are switched off, the air conditioning system is switched on; the third mode - natural ventilation does not work, air conditioning systems and mechanical ventilation work; the fourth mode - air conditioning and natural ventilation systems do not work, mechanical ventilation works; fifth mode - ventilation and air conditioning systems are disabled. It was established that none of the regimes considered was capable of providing simultaneous temperature and gas comfort in the room. The consequence is huge capital (equipment, materials, etc.) and current (thermal and electrical energy) wastage for microclimate systems that do not provide the expected effect

Key words: ventilation of office premises, microclimate maintenance systems, operating modes of ventilation systems, personal ventilation, analysis of the operation of ventilation systems

INFLUENCE OF HEAT EXCHANGE CONDITIONS ON DURATION OF THE NON-STATIONARY THERMAL MODES OF THE SUPERFICIAL HEAT EXCHANGER

S.V. Dakhin, V.I. Ryazhskikh

Abstract: an analytical solution was obtained that makes it possible to analyze the effect of heat exchange conditions on the duration of the unsteady thermal conditions of a surface heat exchanger. The final formula is written with thermal resistance of heat transfer and water equivalents, which simplifies such analysis at any stage of development, design or industrial operation of heating equipment. It is shown that, depending on the specific numerical values of the thermoresistance, water equivalents and initial wall temperature, it is theoretically possible to create conditions for the minimum duration of the unsteady thermal conditions of the heat exchanger. An expression is obtained that determines the set of heat transfer parameters to minimize the time to reach the stationary mode. The solutions given are valid for a straight-through or countercurrent flow of heat transfer media, but can be extended to more complex circuits, for example, for cross current. With a significant change in the thermophysical properties of coolants or consideration of more complex flow patterns, it is possible to adapt the solution obtained to the interval-iterative calculation

Key words: non-stationary mode, heat exchange, heat exchanger, time

NUMERICAL MODELING OF HEAT EXCHANGE IN LIQUID CHANNELS OF THERMOELECTRIC COOLING UNIT

A.V. Kretinin, D.N. Galdin, E.E. Spitsyna, A.N. Popkov

Abstract: to simulate the heat and mass transfer in the liquid channels of the thermoelectric cooling unit, a grid model of the flow section was generated using the ANSYS Meshing module. The mathematical model of computer dynamics of a liquid was synthesized with the connected energy equation in the module ANSYS CFX. The grid model of the thermoelectric module was constructed in the ANSYS ThermalElectric module. Models of the Response Surface type of thermoelectric analysis for thermoelectric modules and heat and mass transfer for liquid channels of the cooling unit were constructed. The results of the simulation showed that, firstly, a significant part of the liquid channels operates in the field of non-stabilized fluid flow both at the inlet and outlet. Secondly, the developed (uneven) heat exchange surface from the side of the liquid leaves open the question of the prevailing mechanism (molar or molecular) heat transfer from the coolant to the thermoelectric cooling unit's wall. Thirdly, the transfer of heat was carried out into a thermoelectric material at different values of the electrical energy supplied to the thermoelectric power. In this case, heat is transferred from cold to hot junction, i.e. the thermoelectric mechanism of heat transfer is involved at essential influence of the thermal processes passing according to laws of Fourier and Joule. The conducted experimental studies showed a significant influence of thermoelectric nature of heat absorption on the cold junction on the intensity of heat exchange between the coolant and thermoelectric cooling unit's wall. The identified dependence of the law of heat exchange on the wall of the liquid-bone channel bordering the thermoelectric module was obtained

Key words: numerical simulation, heat transfer, thermoelectric element

Acknowledgements: The work was carried out with the financial support of the Ministry of Education and Science of the Russian Federation within the framework of the Federal Target Program (Agreement No. 14.577.21.0202, unique identifier RFMEFI57715X0202)

DETERMINATION OF OPTIMIZATION APPROACHES IN THE DESIGNING OF THE COOLING SYSTEM OF THE GAS THERMOELECTRIC GENERATOR MODULE

K.V. Kruzhaev, D.P. Shmatov, K.V. Zubarev, I.G. Perevezentsev

Abstract: this article highlights the most important tasks in the field of creating a modern gas thermoelectric generator module, which, as part of an autonomous thermoelectric power source, is designed to convert the heat energy released from the combustion of natural gas into electrical energy. Some physical processes occurring in a vertical thermosiphon with respect to the thermosiphon cooling system are considered. Based on the simulation results, using ANSYS Fluent instrumentation, in which temperature distributions, liquid and vapor phase distributions, the distribution of volumetric fractions of phases and pressures were calculated and analyzed, optimization approaches were determined for the design of the cooling system for the gas thermoelectric generator module in the ANSYS Fluent environment. The formulated optimization approaches make it possible to find the determination coefficient for the calculation error function, thereby confirming that the change in the temperature of the internal heat-conducting surface is determined by changing of the variables under consideration, as well as the sensitivity analysis graph showing that the magnitude of the calculation error is influenced by all factors, and the type of coolant. As a result, the requirements for the cooling system, the conceptual design and the scheme of the cooling system based on thermosiphon are formed and directions for further research are also determined

Key words: optimization approaches, thermoelectric generator module, thermosiphon, ANSYS

Acknowledgements: the work was financially supported by the Ministry of education and science of the Russian Federation within the framework of the Government of the Russian Federation dated April 9, 2010 no. 218 (Contract number 03.G25.31.0246)

Radio engineering and communication

AN AREA-EFFICIENT FPGA-BASED ARCHITECTURE FOR FULLY-PARALLEL STOCHASTIC LDPC DECODING

A.V. Bashkirov, I.V. Sviridova, D.S. Andreeva

Abstract: stochastic decoding is a new alternative method of low complexity decoding of error correcting codes. This paper presents a variant of the hardware architecture for stochastic decoding low band codes. This architecture allows for full parallel decoding using the latest technologies when working with algorithms with LDPC, working on a field-programmable gate array (FPGA). The architecture of the parallel stochastic decoder is implemented on LDPC in device Xilinx Virtex - 4 XC4VLX200 with a bandwidth of 706 Mbit / s, at a bit error rate of about 10-6, with a loss of performance of about 0.1 dB.

A survey of stochastic computing and stochastic decoding methods is also presented. The problem of hardware implementation and architecture of stochastic decoders are described. The results of the synthesis and decoding for the (1024,512) LDPC-codes with low density parity check decoder are presented. It is shown that the architectural features present in many programmable logic integrated circuits, can be used for area-efficient implementation of stochastic LDPC decoders

Key words: iterative decoding, low-density parity-check (LDPC) codes, stochastic decoding, FPGA, external memory

ANALYSIS OF STATISTICAL METHODS OF TESTS AND OPTIMIZATION OF CALCULATION OF RELIABILITY AT THE PRODUCTION OF ELECTRONIC DEVICES

A.C. Kostyukov, I.S. Bobylkin, L.N. Nikitin, A.A. Pirogov

Abstract: testing products for reliability is one of the most important stages in the production of any equipment. Without this characteristic, it is impossible to have a complete idea about the correctness of the product manufacture. During production, incorrect technical actions are possible which have a negative effect on the device. To identify such actions, tests for reliability are performed. At present, there are several ways to determine the reliability that are used massively in production. The most common are the a priori and a posteriori reliability analysis, as well as the method of boundary and matrix tests. The last method of analysis should be considered separately and explained in more detail. This is due to the fact that the method of determining reliability by means of boundary and matrix tests is of little use due to their laboriousness. The method itself consists of two tests, namely the boundary and matrix tests, the initial data for both tests are the same, but the characteristics obtained during the calculation for these tests differ. The features of each of the methods for determining reliability are briefly described, the advantages and disadvantages of the methods of analysis are revealed. The following is a comparison of these methods, from which it can be concluded which method of determining reliability is most relevant, accurate and sufficient under certain conditions for determining reliability

Key words: boundary tests, matrix tests, test matrix

PROTOTYPES MODELING A SYSTEM OF DISCRETE INFORMATION TRANSMISSION AND INTERFERENCE BY PHASE-COMPENSATING METHOD

I.V. Ostroumov, M.A. Romashchenko, T.D. Izhokina

Abstract: this article presents the device of formation and reception of a useful signal of a system. The prototype of transmission of discrete information by means of phase-manipulated signals is considered, where the receiver demodulator is based on the use of consistent filtering, which is most opposed to the effects of white noises. The code in the prototype of a complex signal is used either periodically repeating M-sequences with a period of up to 1023 bits, or initially given an information logical regularity, such as Barker code or a chaotic series of binary characters with a number of up to 4096 bits. In the illustrative example, diagrams of demodulator signals were presented: PM-2, PM-4, SPM-4, MMS. The synchronization of the receiver and a detailed description of its operation are considered. To solve the task of determining the protective ratio of signal/noise, a prototype was developed, simulating the effect of interference on the transmission line of discrete information by phase-manipulated signals. The main function of the prototype is the separate consideration of the passage of various useful and interfering signals along the receiving path, and also the construction of histograms. During the development of the model, a calculation was made for the further introduction of new elements and procedures for the generation of signals as new unintentional radio interference was investigated. Based on the value of the resulting signal at the output of the matched filter in the time interval, histograms of the response to the useful signal and unintentional radio interference were formed in the model. The developed model allows to determine the influence of the parameters of the URI on the probability of a failure

Key words: phase-shift keyed signal, discrete information, prototype, signal modulator

COMPARISON OF DIFFICULTY OF HARDWARE IMPLEMENTATION AND CORRECTIVE CAPACITY OF STOCHASTIC DECODERS WITH TFM AND EM MEMORY

I.V. Sviridova

Abstract: this article presents the hardware architecture of stochastic decoding of LDPC codes on factor graphs. The proposed architecture makes completely parallel decoding of (long) modern LDPC codes working on FPGAs. This article also discusses the impact of the TFM approach on the overall hardware complexity and decoding of stochastic decoders in ASIC. The article shows the process of comparing decoding and ASIC applications in TFM decoders and two EM decoders. It is suggested to replace TFM by EM in stochastic ASIC decoders. Various hardware architectures for implementing TFM in ASIC and their impact on the complexity of stochastic information nodes are described. Examples of stochastic ASIC decoders that decode (1056 528) LDPC code selected from the IEEE 802.16 (WiMAX) standard are also given. As a result, it was shown that TFMs can provide similar or better decoding performance compared to EM, with significantly less hardware complexity. TFM significantly reduces the overall application surface of ASIC circuits for stochastic LDPC decoders. The silicon surface of this ASIC TFM (1056,528) LDPC decoder is 40% and 65% smaller than the surface area of the ASIC EM LDPC decoder with 32-bit and 64-bit EM, respectively

Key words: stochastic decoder, TFM decoder, EM decoder

MODEL OF PRINTED BOARDS SUSCEPTIBILITY TO EXTERNAL ELECTROMAGNETIC EXPOSURE

V.V. Glotov

Abstract: solving the issues of electromagnetic compatibility is now becoming an integral part of the activities of enterprises - developers and manufacturers of technical equipment, the basis of which, as a rule, are printed nodes. The article considers a complex approach in the design of radioelectronic facilities taking into account the provision of electromagnetic compatibility parameters. The use of the criterial approach in the design of radio-electronic facilities is proposed taking into account the provision of noise immunity and noise stability. The proposed approach in the design allows to solve the problems of applying optimal circuit and design solutions in the design of noise-free radioelectronic facilities. However, in radio engineering, optimization problems in practice have been studied very little, mainly for the reason two very weighty arguments. The first reason is the constant change of the element base and the related desire to solve all the problems in this regard. The second reason is rapid development of the theory and expansion of the fields of application of radio electronic means, which is accompanied by a multiple change in the principles of action and design. The article gives a brief description of the tasks of optimizing radio-electronic means with regard to electromagnetic compatibility. The same method is described - the optimization of a radio receiver as a multidimensional filter

Key words: design of radioelectronic devices, noise immunity, noise stability, electromagnetic compatibility, design methods, optimization

DEVELOPMENT OF THE MODELS OF PHASE-SHIFT KEYED PULSES FORMATION

I.V. Ostroumov, M.A. Romashchenko, D.S. Andreeva

Abstract: a complex approach to the process of the effect of the parameters of phase-shifted signals on the EMC RED is considered, and a structure for solving the modeling and optimization problems of the corresponding model and the methodology for creating a model for generating signals in a radio transmitter are proposed. The object is a model using FFT that produces a representation of a sample of the values of a constant pulse on the time axis. It simulates step-by-step following of the signal created in the modulator through a power amplifier and a bandpass filter at the output of the transmitter. Bandwidth filters of different orders are considered as bandpass filters in the model for the formation of phase-manipulated signals. The method of increasing the efficiency of the amplifying path is considered. Various mechanisms for the generation of envelopes of variations and their effect on the spectral characteristics of the signal, and, consequently, on the characteristics of the RED for EMC are described. For systematic representation of rectangular pulses of different polarity, the possibility of sinusoidal smoothing of intersymbol transitions is taken into account. The structural scheme of the model of the phase-impulse pulse imposition in the radio transmitter is considered, the graphs of the complex representation of phase-shifted signals are presented, as well as the signal modulator circuit. An imitation of the process of formation of coded discrete pulses was taken into account, the effect of amplitude-phase conversion was analyzed

Key words: phase-manipulated impulses, radio transmitter, signal modulator

Mechanical engineering and science of machines

INCREASING THE RESOURCE CHARACTERISTICS OF THE TECHNICAL TITAN BY OPTIMIZING THE PARAMETERS OF THE GAS-SATURATED LAYERS

A.B. Kolomenskiy, S.V. Shakhov, B.A. Kolomenskiy, I.V. Zubarev

Abstract: the technology for the production of sheet semi-finished products from titanium alloys (sheets, tapes and foils) with the thickness up to 3.0 mm includes a number of operations, including hot rolling in the temperature range 650-850 °C, as well as etching to remove gas-saturated layers. Along with the negative effect of gas-saturated layers, there are indications that when they are incompletely removed, the effect of a significant increase in the cyclic durability of titanium sheets appears. This effect can also be used to reduce the irreversible loss of such an expensive material. Annealing is a mandatory operation to remove residual stresses in titanium structures after welding, stamping, straightening operations. The article studies the combined influence of gas-saturated layers of various hardness and length and oxide films formed in the process of low-temperature air annealing on the dynamic and short-term mechanical characteristics of technical titanium VT1-0, widely used in the manufacture of parts and components of aviation equipment. It is shown that regulated gas-saturated layers can enhance the service mechanical characteristics of sheet structures subjected to annealing to relieve stresses. Oxide films formed in the process of low-temperature air annealing can have a useful effect on the durability of sheets under repeated static loading, and also increase their impact toughness

Key words: technical titanium, gas-saturated layer, low-temperature air annealing, resource characteristics

ON THE FEATURES OF THE IMPACT OF THE NEAR-LECTRODE LAYER TEMPERATURE ON THE PROCESSES OF OBTAINING ELECTROLYTIC METALS AND ALLOYS

Yu.N. Shalimov, A.V. Zvyagintseva, D.L. Shalimov, A.V. Russu

Abstract: the article considers peculiarities of the methodology of studying electrochemical processes. The constraints are shown for a detailed study of systems based on the averaged parameter - temperature and a hypothesis is made about the true value of the temperature in a double electric layer. The results of determining the temperature of the near-electrode layer in chromium electrolytes are presented and it is shown that the main parameter determining the temperature rise relative to its average value in the electrolyte volume is the current density (anodic or cathodic), as well as the chemical composition of the electrolyte and the duration of the electrolysis. The possibility of determining the current in the near-electrode zone by the method of analytical calculation using the linearization dependences of individual parameters (current density and duration of electrolysis) is presented. The analysis of the nature of the change in the near-cathode temperature showed the maximum growth of this parameter at the initial moment. The method of internal friction establishes the relationship between the hydrogen content in electrolytic coatings under conditions of pulsed and continuous electrolysis for sulfuric acid electrolytes of chrome plating. It is established that the probability of formation of metal hydrides is the highest in structures formed by the electrolytic method from aqueous solutions of electrolytes. The temperature dependence of the internal friction makes it possible simultaneously to estimate the amount of adsorbed hydrogen, as well as the hydrogen-metal bond energy

Key words: near-electrode layer temperature, fine structure of electrolytic metals, internal friction, electrolysis of aqueous solutions, metal hydrides

INFLUENCE OF GAS ADDITIVES Ar, N_2 AND N_2O ON THE KINETICS OF ETCHING OF LITHIUM TANTALATE IN FLUORINATED PLASMA

I.V. Konyaev, L.N. Vladimirova, E.N. Bormontov, V.A. Buslov, I.I. Borodkin

Abstract: the influence of controlled gas additives Ar, N_2 and N_2O in the mixture with working gas (SF_6) on kinetic features of the etching process of polished single-crystal $LiTaO_3$ samples in low-temperature fluorinated plasma is analyzed in the article. Experiments were performed on a Corial D250 with a diode-type reaction chamber. In contrast to the typical plasma-chemical etching of $LiTaO_3$ in SF_6 plasma, the addition of inert argon, as well as nitrogen and nitrous oxide, lead to the formation of a significant ionic component, thereby making the etch mechanism different. Data on the etching rate make it possible to quantify the activation processes reactive ion plasma etching of the investigated material. Comparing the data, we can make the conclusion about the most significant contribution of argon. The presence of a maximum at a volume fraction of argon about 40-50% is observed. This addition led to an increase of etching rate by 30%. The addition of nitrogen also has a maximum with a volume fraction 30% leading to an increase of etching rate by 15-20%. The etching mechanism is analogous to the argon addition. The addition of nitrous oxide led to a decrease in the etching rate. Increase in addition by more than 50% vol. led to a decrease in etching rate in mixtures with argon and nitrogen caused by a change limiting process due to a decrease in the concentration of the working gas (SF_6) and, as a consequence, a decrease in the concentration of fluorine radicals, the main component of chemical etching

Key words: plasma chemistry, *lithium tantalite, activation process, gas addition, fluorinated plasma*

THE USE OF THE MAGNETIC FIELD GRADIENT MEASUREMENTS FOR NAVIGATION AND DETECTION PROBLEMS

E.A. Nikitina, I.M. Golev, A.V. Sergeev

Abstract: the perspectives of using gradient measurement schemes in navigation and detection systems using the characteristics of the anomalous magnetic field of the Earth and the magnetic field of artificial objects are discussed. An analysis of the measured characteristics of the magnetic field is given. It is shown that the measurement of the gradient of the modulus of the magnetic induction vector increases the accuracy of the region. The measurement of the second derivatives in the direction of maximum field variation allows to separate the anomalous magnetic field of the Earth and the magnetic field of a nearby object, which can be used to reduce the indeterminacy of the magnetometer readings introduced by the magnetic field of the object itself, which makes it possible to improve the accuracy of determining the position of the mobile object. The features of spatial selectivity of various components of the measured magnetic field are considered. Specific features of measuring the magnetic field on a moving object are discussed, methods are given for describing the intrinsic magnetic field of a mobile object that introduces deviations in the readings of a magnetometer measuring the characteristics of the anomalous field. The relationship of operating modes of a mobile object with a change in the characteristics of an intrinsic magnetic field is determined. Methods for reducing the deviation of a magnetometer are considered. The effectiveness of the use of gradient magnetic field measurement schemes in problems of detecting objects having an intrinsic magnetic field

Key words: magnetometry, gradiometer, anomalous field, navigation by geophysical fields

ELECTROCHEMICAL TECHNOLOGIES OF IMPLEMENTATION OF SYSTEMS FOR SAFE STORAGE OF HYDROGEN

Yu.N. Shalimov, A.V. Zvyagintseva, A.V. Pomiguev, A.V. Russu

Abstract: the article is devoted to the study and creation of mobile units based on the electrochemical principles of energy conversion and storage for aircraft maintenance. It is shown that the most affordable material for the production of energy storage is aluminum. The advantage of metallohydride method of hydrogen accumulation is shown. The questions connected with methods of development of a surface of the storage device for increasing the capacity of accumulation are considered. The analysis of planar and volumetric storage of hydrogen is presented. It is shown that aluminum is the main and most affordable material for the production of highly effective energy storage devices. The article also considers the main problems that arise when creating systems for the safe storage of hydrogen in the form of aluminum hydrides. The peculiarity of the interaction of aluminum oxide with hydrogen in an aqueous solution, taking into account the effect of Sore, is shown. The mechanism of formation of metal structures (electrodes) for electrochemical production of aluminum hydrides is considered. It is shown that the formation of aluminum hydrides is most likely due to defects in the structure of metals. The hydrogen is pumped into the accumulator by electrochemical discharge of the hydrogen proton on the cathode with the formation of atomic hydrogen, which subsequently forms hydride compounds with the metal atom

Key words: new aviation technologies, maintenance of flying machines, electrochemical technologies, hydrogen power engineering, energy accumulation, hydrogen storage, aluminum hydride, defect of the metal structure, destruction of the metal crystal lattice