ORIGINAL APPROACH TO GENERATION OF APPROXIMATION FUNCTIONS FOR HIGH-PERFORMANCE SHELL STRUCTURES SIMULATION

Yu.N. Zgoda

Abstract: computer simulation of the stress-strain state of thin-walled shell structures using the Rayleigh-Ritz method requires selecting of approximation functions to substitute into the total potential deformation energy functional. This step transforms the variational problem to a multidimensional minimization problem. However, in contemporary shell modeling researches the choice of approximation functions is frequently approached casually. Meanwhile, employing specific methods for constructing approximation functions can significantly improve both the accuracy and performance of calculations. The purpose of this work is to develop original high-performance approaches to the generation of approximation functions in the context of thin-walled shell structures modeling using the Rayleigh-Ritz method. As part of the implementing this goal, two novel approaches to constructing approximation functions were proposed. The first approach is to sequentially increase the number of terms in the approximation functions. This offers researcher a more flexible tool for determining the accuracy and duration of the simulation. The second approach is to use a different number of approximation terms for different components of shell's stress-strain state. Both approaches were included into the author's high-performance shell modeling software, OptiShellX, and were tested on various calculation problems. The results of computational experiments have shown that these approaches can significantly reduce the duration of simulation without significant loss in accuracy. Also they allow to simplify the results' validation. The purposed methods are universal and can be implemented in almost any mathematical package or programming language

Key words: shells, approximation functions, Rayleigh-Ritz method, functional, variational problem, Julia

ALGORITHMIZATION OF TECHNOLOGICAL PROCESSES MANAGEMENT OF ASPHALT CONCRETE MIXTURES PRODUCTION

I.N. Volkov, V.L. Burkovsky

Abstract: highways are an important part of the country's industrial infrastructure, so the development of the construction industry in this area is a priority. It should be noted that the introduction of automation tools into the technological processes of building roads can significantly improve their quality and service life. The article deals with the problems of algorithmization of the control of the technological process for the production of asphalt concrete mixtures, one of the most important in the road construction industry, as well as the structure of the control system. The technology for the production of asphalt concrete mixtures includes the following stages: preparatory, main and final, within the framework of each of which processes are carried out that are interconnected. This requires high-precision provision of the quantity of such mixture components as sand, crushed stone, mineral powder, bitumen, as well as various chemical additives. Depending on the values of various quantitative characteristics of the constituent components, an asphalt concrete mixture is formed that is different in terms of technological, general physical, chemical, thermophysical, mechanical and operational properties. All this must be taken into account when creating an effective structure for the control system for the production of asphalt concrete mixtures within the framework of algorithmic support. The material presented in the article can be useful for creating intelligent means of controlling technological processes in the production of asphalt concrete mixtures

Key words: asphalt concrete mixture, algorithmization of technological processes, control system, high-precision dosing, block diagram of the algorithm, control of parameters

ABOUT ONE APPROACH TO SOLVING THE PROBLEM OF FORECASTING THE AMOUNT OF ELECTRICITY CONSUMPTION USING MACHINE LEARNING METHODS

S.A. Oleynikova, K.A. Bidnenko, A.V. Malyugin

Abstract: the work is devoted to solving the problem of forecasting the volume of electricity consumption for energy grid companies using the example of LLC «DEK». Subscribers (individuals and legal entities) need a forecast of hourly consumption to understand the advisability of using a particular tariff or certain capacities. The company's management is even more interested in this forecast, since the availability of this information makes it possible to more accurately assess the required volumes and minimize risks when making management decisions. The specifics of the subject area, the characteristics of the factors influencing the result, as well as the analysis of possible approaches to forecasting made it possible to determine the best way to estimate power consumption. It is based on the use of artificial neural networks. The specifics of the problem determined the structure of the network: a recurrent neural network with two hidden layers was proposed, which is capable of learning long-term dependencies. As a result, the following tasks were solved: input data that will influence the volume of electricity consumption was determined; data preprocessing was carried out; the structure of an artificial neural network has been designed to obtain the predicted value; an application has been implemented that, using a trained neural network, allows you to predict the amount of electricity consumed

Keywords: recurrent neural network, machine learning, artificial intelligence, forecasting, amount of electricity consumed

SOFTWARE IMPLEMENTATION OF MOBILE ROBOT MOTION CONTROL USING QR CODE

A.V. Kalyashina, L.F. Fatkullina

Abstract: this study is devoted to the software implementation of motion control of a mobile robot using a QR code. The purpose of the study is to provide autonomous movement of a mobile robot along a path with obstacles, using movement algorithms based on information from sensory devices and QR codes. Previously, an analysis of the existing algorithms for the movement of mobile robots was carried out, their advantages and disadvantages were reflected. To achieve the goal, a block diagram of a mobile robot was developed, which demonstrates the connection of the controller with external devices for collecting information and controlling movement. Signals were received and their preliminary processing was carried out by sensor devices - infrared and ultrasonic sensors and an accelerometer. Tetrix was chosen as the hardware for modeling, the National Instrument myRIO microcontroller for software implementation, and LabVIEW for the development environment. An algorithm has been developed for constructing the trajectory of the robot along a given route using a QR code, which allows reading the encoded information with a scanner. The QR code is necessary, first of all, to determine the direction of traffic at intersections. During the experiments, two maps of the area with different trajectories of movement were used. Implemented various options for the movement of the robot - straight, turn left, turn right. Thanks to the implementation of the algorithm, the exact following of the mobile robot to a given end point in a warehouse environment is ensured. The issue of navigation is solved with the help of a map of black lines, which forms a network of possible routes. The experimental results were obtained under the conditions of an engineering test site

Keywords: mobile robot, warehouse logistics, sensory devices, microcontroller, motion algorithm, QR code

APPLICATION OF AN ACTIVE METASURFACE FOR CODING IN DATA TRANSMISSION

E.A. Ishchenko, Yu.G. Pasternak, V.A. Penduyrin, S.M. Fedorov

Abstract: the article discusses the design of an antenna with an active metamaterial surface, which is used to encode information. The design is based on highly directional planar Uda-Yaga antennas, which radiate linearly polarized waves, which makes it possible to control signal characteristics based on the polarization loss factor. Based on the influence of the polarization loss coefficient, as well as by switching the layers of the metamaterial, it is possible to ensure data transmission taking into account additional coding and encryption. Based on the proposed design, an antenna was formed with four radiators, each of which has a different angle of inclination, which provides a mismatch of polarizations at the wrong location, as well as with a metasurface that blocks the radiation of information for codes that are not used at the time of transmission. A feature of the proposed design is the possibility of generating polarization-modulated signals with codes 00, 01, 10, 11. This design provides additional encryption with the possibility of permuting different combinations in the amount of 24 positions. Thanks to the implementation of such a construction, it was shown that the use of such a construction allows the use of dynamically reconfigured metasurfaces for data encryption in data transmission systems. Such a system improves data security by using a combination of a metamaterial that acts as a meta-key, as well as antenna polarization directions based on the tilt angle of the wave polarization vectors

Key words: metamaterial, data encryption, polarization, polarization coding

SIGNAL-CODE CONSTRUCTIONS AND STRUCTURE OF SIGNALS RADIO LINES OF SATELLITE COMMUNICATION

D.G. Pantenkov, V.P. Litvinenko, A.N. Glushkov

Abstract: currently, satellite communication systems are widely used in the daily life of civil and special consumers of information and allow for its prompt delivery between subscribers located at considerable distances from each other to solve various target tasks. To transmit information via satellite communication channels in DVB-S and DVB-S2 standards in the L-, S-, C-, Ku-, K-, Ka-frequency bands in modern satellite communication systems, digital modulation and coding methods are used, taking into account the typical values of signal-to-noise ratios for real modems. As a modulation of satellite communication signals, phase modulation with different encoding rates (QPSK, 8-PSK, 16-PSK) or quadrature amplitude modulation with different encoding rates (QAM-8, QAM-16, QAM-32, QAM-64) are mainly used. Modern satellite communication systems use Reed-Solomon codes, Turbo codes, convolutional codes, cascade codes as noise-resistant codes. At the same time, the main efforts of the developers of satellite communication systems are aimed at increasing the bandwidth of the satellite communication network, provided that the guaranteed coverage area is increased and the probability of error per bit of transmitted information is fixed. In this article, as a typical model example, the issues of formation and structure of the channel information sequence in the modes of continuous transmission, packet transmission and transmission of the request-calling channel are considered, schemes for generating signals of the subscriber station and signals of the request-calling channel are presented, the required durations of information slots and channel information data rates are indicated

Key words: satellite communication radio lines, signal-code design, coding, subscriber channel, request-call channel, packet data transmission, on-board information processing, information transmission rate, typical model example

FEATURES OF THE CONSTRUCTION OF THE INTERMEDIATE FREQUENCY PATHSUPERHETERODYNE RADIO RECEIVER WITH DIGITAL SIGNA PROCESSING

A.I. Grevtsev, V.I. Zimarin, V.V. Kapitanov

Abstract: when designing the receiving path of the intermediate frequency of a superheterodyne radio receiver with digital signal processing in relation to narrowband signals, it becomes necessary to take into account the features of choosing the nominal value of the intermediate frequency and sampling not only the useful signal, but also all the interfering frequency components coming to the input of the analog-to-digital converter. The aim of the work is to develop proposals for constructing an intermediate frequency path of a superheterodyne radio receiver with digital signal processing, taking into account the attenuation of undesirable frequency components of the nearest spectrum display during analog-to-digital signal conversion. The novelty elements are the approach to choosing the nominal value of the intermediate frequency and determining the requirements for the minimum value of the interference bandwidth of the antialiasing filter. The paper shows how, at the design stage, a preliminary selection of the structure of the intermediate frequency path is carried out, the nominal value of the intermediate frequency is determined, an antialiasing bandpass filter is selected, which provides attenuation of undesirable components of the spectrum in neighboring reception channels and within the display of the multiplied spectrum during analog-to-digital signal conversion. The proposed approach makes it possible to form a block diagram of the second intermediate frequency path and to make requirements for its functional elements

Key words: radio receiver with digital signal processing, intermediate frequency path, spectrum multiplication, interference band, bandpass filter

ANALYSIS OF PROCESSES OF ELECTROMAGNETIC INTERACTION OF OBJECTS WITHIN CELLULAR COMMUNICATION SYSTEMS

I.S. Kireev, I.V. Zubarev, A.V. Burkovsky

Abstract: an important task at the level of the design solution is to calculate the characteristics of the signal at any point where communication is maintained. Based on the results of the calculation, it can be assumed how many base stations are needed to ensure high-quality reception and transmission of the signal in the operating conditions of base stations. Since in an urban environment with a high density of buildings there are features in the form of multipath signals with complex interference, shadow zones in which signal propagation is difficult, it is necessary to have at least approximate models capable of describing the propagation of radio waves in these conditions. A particular problem is the occurrence of intersymbol interference, in which the delay duration will be longer than the duration of the information symbol. The paper presents the most common models for the analysis of electromagnetic interaction in radio communication systems, including cellular communication systems. The structure of the cellular network is presented, the influence of single obstacles on the propagation of radio waves is considered. The basis of the presented models is the principle of superposition, that is, the principle of representing the signal propagation route in the form of separate sections of paths along which the interaction between the subscriber and the base station is carried out

Key words: radio communication, cellular communication systems, cellular communication structure, two-beam propagation model, single obstacles

ANALYSIS OF THE OPERATION OF A FRACTAL H-TREE TYPE ANTENNA FOR DIGITAL COMMUNICATION SYSTEMS

A.S. Novak, M.S. Pashchenko, A.A. Antonov

Abstract: communication has become one of the foundations of infrastructure development. In particular, radio communication systems are being developed that simultaneously use different frequency ranges. When creating devices, manufacturers are switching to higher frequencies and broadband data transmission. This suggests that there is a need to improve modern antennas. The fractal H-tree antenna is a good basis for obtaining a reduced–size multiband antenna in the following frequency ranges: 4.4 – 4.9 GHz and 24.5 - 29.5 GHz (5 G - fifth generation network). The operation of the fifth generation (5G) network is explained by the use of high-frequency waves, which provide good signal directivity. That is, a high-frequency signal will be sent to the place where there is a large request in traffic. The resulting system will have fast operation and high performance. The communications industry should strive to support as many devices per square kilometer as possible. Therefore, the problem with communication in densely populated places and in places with a large number of people should take a back seat. This paper presents the results of modeling a fractal tree antenna. Studies of the type of polarization and matching of vibrators with each other were carried out using the MMANA-GAL software package. The dimensions are designed to cover a certain frequency range. The analysis of antenna characteristics in the 5G frequency range is carried out; the choice of the number of antenna iterations is made by evaluating key parameters

Key words: fractal antenna, iteration, tree antenna, radiation pattern, polarization, gain

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MEASUREMENT OF NAKAGAMI DISTRIBUTION PARAMETERS

A.N. Glushkov, Yu.V. Litvinenko, A.V. Mandrykin, E.V. Chernoyarova

Abstract: the task of experimental determination of parameters of models of radio communication channels is relevant in connection with the development of information transmission systems. In addition to the traditional models for radio engineering with Gaussian interference and Rayleigh or Rice fading, other options appear that take into account the features of new means of communication. Models based on the Nakagami probability distribution density arise in multipath radio channels and describe the change in the level of the received signal (its fading) in various reception conditions and frequency ranges, and in its various variants generalize classical models. The two-dimensional Nakagami distribution makes it possible to take into account the correlation properties of neighboring samples of a random process, expanding the possibilities of modeling fades with acceptable complexity. To adequately display the probabilistic properties of fluctuations in the amplitude of the received signal, measurements of the parameters of a two-dimensional model are necessary. A signal fading simulator with a given two-dimensional Nakagami distribution is considered, which allows the measurement procedure to be investigated and can be used independently as a source of random process samples when modeling a communication channel. The obtained results can be used in theoretical studies of the communication system and in its experimental modeling (testing) using a communication channel simulator. The advantages of the Nakagami model are mathematical simplicity, a small number of parameters and experimentally confirmed compliance with real communication channels

Key words: communication channel, signal fading, modeling, probability distribution density, measurement

METHOD FOR SIMULATING MAGNETIC FIELD RADIATIONS OF RADIO ELECTRONIC EQUIPMENT IN NEAR FIELDS

V.V. Glotov, I.V. Semeikin, A.E. Rud

Abstract: the article presents an algorithm for modeling sources of electromagnetic interference using measurements made in the near field of the magnetic field emitted by power electronic equipment. This type of measurement occurs at the intra-hardware level of electromagnetic compatibility. To predict the emitted magnetic field, a model based on elementary magnetic dipoles has been developed. This model is derived from near-field measurements. To determine the model parameters, an optimization procedure is used in combination with matrix inversion. Unlike standard approaches, the new technique makes it possible to find equivalent radiation sources with a small number of dipoles in the shortest computation time. The article also demonstrates an experimental study of the developed technique and compares the results obtained with the classical method, namely using a hardware-software complex for scanning a near electromagnetic field. To experimentally test this method, magnetic measurements are carried out in the near field to find an equivalent model in the case of a single-turn coil, a toroidal coil and a DC/DC converter. The results obtained using the developed technique have an error relative to the near-field scanner of about 10%, which is a good indicator for its implementation in industry

Key words: equivalent sources, magnetic dipoles, magnetic field, near fields, optimization method

METHOD FOR EFFICIENT ASSESSMENT OF CONDUCTIVE INTERFERENCE LEVEL FOR AC-DC CONVERTER

M.A. Romashchenko, A.V. Gudkov

Abstract: the article considers an approach to reduce the time and the cost of preliminary assessment of compliance with the standards of electromagnetic compatibility of switching power supplies of the AC-DC type. The solution of the problem of increasing the efficiency of the development of pulsed AC-DC converters at the stage of preliminary testing of the level of conductive interference is considered. The proposed approach is to replace the expensive procedure of using a radio interference meter, which is advisable during acceptance tests, with an engineering evaluation measurement using an oscilloscope with a Fast Fourier Transform function. A method implementing this approach is described, a block diagram of the connection of the test device, measuring equipment and auxiliary equipment when measuring the voltage of radio interference using the equivalent of a network is given. The novelty of the method is justified, which consists in adding a decoupling amplifier between the line impedance stabilization network and an oscilloscope powered by a battery, which eliminates the possibility of additional interference. The results of an experimental study of the proposed method are presented in the form of resultant spectrograms of conductive interference generated by a consumer pulsed AC-DC converter with a power of 120 watts. The spectrograms obtained using an oscilloscope and a spectrum analyzer in the range of 9 kHz-30 MHz are compared. The effectiveness of the method is confirmed and recommendations are given on the practical application of the method in the activities of a development engineer

Key words: switching power supply, conductive interference, AC-DC converter, electromagnetic compatibility

MICROSTRIP IMPLANTATION ANTENNA RANGE MICS/ISM FOR MEDICAL AND PLATINUM COMMUNICATIONS SYSTEMS

E.D. Egorova, D.V. Zhuravlev

Abstract: the article considers the study of a microstrip implantation antenna of MICS/ISM range, designed for use in communication systems of medical implants. Its advantages lie in the ability to transmit data over long distances with minimal signal loss, providing high-quality communication between devices inside the body. The antenna was designed to operate inside the human body, where there is a lot of interference caused by tissues and fluids. The MICS/ISM band provides a high degree of immunity to external interference and ensures reliable communications between the implants and external devices. Within the study, general evaluations are made of the operating bands allocated for medical applications, the radiation geometry of the implant antennas, and the limits on the specific absorption rate. The results of experimental studies performed on phantoms simulating the human body are also presented. Due to its compact size and low mass, the antenna can be used in a wide range of medical implants, including pacemakers, sensors and other devices. Thus, the developed MICS/ISM band microstrip implantation antenna represents a promising solution for reliable medical implant communication systems capable of high data transmission efficiency

Key words: medical implant, microstrip implantable antenna, directional pattern, MICS-band, ISM-band

DEVELOPMENT OF THE WILKINSON BROADBAND POWER DIVIDER

I.A. Chernoivanenko, E.A. Ishchenko, A.V. Ostankov, S.M. Fedorov

Abstract: the article discusses an improved design of the Wilkinson power divider to reduce its size. This device is designed to operate on two operating frequency ranges with central frequencies of 2.4 GHz and 5.8 GHz, respectively. The simulation was performed based on the use of the CST Studio Suite 2023 software product. The power divider is designed and modeled on a Rogers RT5880 substrate, which has a dielectric constant of $\varepsilon_r = 2.2$, a tangent of the loss angle of $\mathrm{tg}\,\delta = 0.0009$ and a thickness of $h = 1.57$. The developed device has one input and two outputs. The obtained simulation results show that the power divider provides equal power separation at both outputs of the structure. Based on the simulation simulation, it was obtained that the device has a voltage standing wave ratio (VSWR) at two central frequencies of 1.56 and 1.27, respectively. Return loss graphs showed that the developed Wilkinson power divider has two operating frequency ranges of 1.1-3.2 GHz and 4.8-6.5 GHz at a level of -10 dB. These frequency ranges indicate the broadband of the device. The simulated power loss graphs indicate a attenuation of 0.2 dB at 2.4 GHz and 0.6 dB at 5.8 GHz. The calculation of currents at a given power showed that the designed microstrip lines will withstand a load of 1 kW

Key words: power divider, transmission line, S-parameters, microstrip lines

PRE-CODING METHODOLOGY FOR THE UNMANNED AERIAL VEHICLE SYSTEM

A.V. Bashkirov, M.V. Khoroshailova, A.S. Demikhova

Abstract: in this article, the topological structures of the network coding and monitoring systems of unmanned aerial vehicles were analyzed in order to ensure effective data exchange for groups of unmanned aerial vehicles. The topological structures of the network coding and monitoring systems of unmanned aerial vehicles are similar to each other if we consider a multitude of unmanned aerial vehicles, a multitude of microsatellites and a command and control center as a source, repeater and destination, respectively. However, the performance of complex network coding with the probability of a symbolic error is low due to multi-user interference and multipath attenuation in the channels. In order to improve the quality and reliability indicators, an improved data transmission scheme of complex network coding based on pre-coding is presented here to increase the reliability of the operation of a variety of unmanned aerial vehicles. In addition to the theoretical analysis of the system, several parameters were tested using simulation experiments, including various topological structures, the number of source nodes and relay nodes, coding and pre-coding schemes. Modeling shows that the proposed transmission scheme provides reliability superior to the reliability of a conventional integrated network coding scheme for various topological structures, including structures with regular and irregular topology, and various channel coding schemes

Key words: information transmission, unmanned aerial vehicles codes, low-density parity check (LDPC), pre-coding, complex network coding

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DIGITAL SIGNAL DEMODULATOR WITH AMPLITUDE-PHASE MANIPULATION

A.N. Glushkov, Yu.V. Litvinenko, B.N. Tishykov, E.V. Chernoyarova

Abstract: the optimal digital algorithm for coherent demodulation of signals with amplitude-phase modulation (APSK) is investigated. Phase demodulation is performed on the basis of a phase detector of signals with multi-position phase manipulation, and the amplitudes of symbols are determined by the responses of quadrature signal processing channels. The analysis of the algorithm of signal processing with APSK is carried out, the time realizations of the responses of the demodulator are considered. The noise immunity of demodulation for signals with a two-level APSK for the two most common variants of constellations is determined, the probabilities of erroneous demodulation of the phase and amplitude of the signal are estimated, a comparative analysis of the noise immunity of signals with different constellations is given. The noise immunity of demodulation of signals with amplitude relative-phase manipulation (ARFM) is considered, a comparative analysis of signal-to-noise losses in comparison with APSK for various constellation variations is given. Statistical simulation of the demodulation algorithm under the influence of noise interference is carried out. The influence of errors in the estimation of threshold levels of the received signals on the noise immunity is investigated. The implementation of the demodulator is focused on programmable logic integrated circuits (FPGAs)

Key words: phase and amplitude manipulation, noise immunity, error probability, statistical simulation

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CALCULATION METHOD FOR EVALUATING THE LIMITING STRESS AMPLITUDES OF CYCLES IN CASE OF INHOMOGENEITY OF THE STRUCTURAL AND MECHANICAL CHARACTERISTICS OF WELDED JOINTS

K.A. Molokov, V.V. Novikov, A.I. Mamontov

Abstract: as a result of overloads under the action of an external cyclic load on structures in the area of stress concentrators, the degree of cycle asymmetry, the level of maximum stresses and deformations in areas of significant inhomogeneity, which occurs especially when welding heat-strengthened steels, increase. Taking this into account, it is important to evaluate the limiting stress amplitudes of cycles, taking into account the structural and mechanical inhomogeneity for welded joints. The assessment of such limiting stress amplitudes for acting cyclic stresses in sections of the welded joint can be performed using diagrams of limiting stress amplitudes constructed for these sections of the heat-affected zone. The proposed method for constructing diagrams of limiting stress amplitudes for zones of a welded joint has been tested numerically on ferrite-pearlitic steels (steel 10, 50, St.3sp, 22K, 15G, etc.), it is based on the use of mathematical models of classical linear and structural-mechanical fracture mechanics materials. An engineering technique for calculating the limiting stress amplitudes and constructing Hay diagrams has been developed. An analytical calculation confirmed the validity of the proposed approach, which consists in determining the endurance limits and limiting stress amplitudes under high-cycle loading in a wide range of cycle asymmetry coefficient $-1 \leq r < 1$ for steels of the ferrite-pearlitic class with a yield strength of up to 400 MPa. A block diagram of the algorithm reflecting the search for the maximum length of a microcrack consistent with the boundary condition of equality of the average stresses of the cycle to the ultimate strength of the material is presented. A characteristic feature of the technique is the possibility of calculating the limiting stress amplitudes for high values of cycle asymmetry and cycle stresses, as well as the fact that it can take into account: characteristics of the external load; structural and mechanical characteristics in the area of the heat-affected zone, depending on the selected welding mode. The proposed method allows, with an error acceptable for engineering calculations, to build Smith and Hay fatigue diagrams for the tensile region, taking into account, among other things, the average grain size of the ferrite-pearlite material in the heat-affected zone (HAZ) of the welded joint. The numerically obtained diagrams of the limiting stress amplitudes were compared with the available experimental data for the class of ferrite-pearlitic steels. The results of the agreement between the numerical and experimental data convincingly indicate the applicability of the mathematical and physical models used in this calculation method

Key words: endurance limit, ferritic-pearlitic steel, heat-affected zone, plastic deformation, crack length, limiting cycle amplitude, stress intensity factor

INFLUENCE OF METHODS FOR MANUFACTURING HOLES IN NOZZLES ON THEIR HYDRAULIC PARAMETERS

O.N. Kirillov, E.A. Ryazantseva, V.V. Kuts, A.Yu. Ryazantsev

Abstract: the purpose of fuel injectors providing fuel and oxidizer supply to the combustion chamber of a liquid rocket engine in the required proportions is considered. Methods for obtaining tangential holes in injectors of liquid rocket engines are presented. Studies, including experimental ones, have been carried out to study the influence of the method of manufacturing tangential holes on the working parameters of injectors. The test equipment used to confirm the hydraulic characteristics of the injectors is shown. As a result of the conducted research and experiments, it was found that the mechanical method of obtaining tangential holes, without performing the finishing operation, does not make it possible to obtain the hydraulic characteristics of the injectors in accordance with the requirements of regulatory documentation. The electroerosive method of processing with non-profiled electrodes-tools, in the form of a rod, allows to obtain the necessary accuracy of the nozzle holes and has high productivity. The performed works allow us to conclude that in order to achieve the specified performance characteristics of liquid rocket engine injectors, the method of electroerosive hole manufacturing is currently preferable in relation to the mechanical method of their processing. The obtained results can be used for the manufacture of parts and assembly units of aerospace products using electrical processing methods, which, in particular, expands the scope of the use of the electroerosive processing method

Key words: nozzles, electrical discharge machining, hydraulic tests, nozzle spillage, rocket engine