SOFTWARE DEVELOPMENT FOR RENDERING OF POLYMERIZATION PROCESSES

K.G. Reznikov, S.L. Podvalny

Abstract: the article presents the implementation of software for visualization of polymerization processes for subsequent analysis of images of molecular weight distributions of polymers in real time. The mathematical modeling of polymerization is described. The main stages of the polymerization process and methods for their classification are considered. The termination stages are presented and a typical module for the random break mechanism is considered in detail. The kinetics of random termination polymerization is described. An algorithm for calculating the molecular weight distribution of a polymer with the introduction of a conditional polymerization time has been implemented and described. A block diagram and methods for visualizing the calculated results of the algorithm are presented. Software has been developed for calculating the molecular weight distribution of the polymer and rendering the obtained data. An example of software execution with the calculation of the molecular weight distribution at certain moments of conditional time is shown. The obtained molecular weight distribution was analyzed. The results of comparison with the main distributions are described. A method for optimizing the visualization of the calculated results of the algorithm for a more detailed study of the molecular weight distribution of polymers depending on the conditional time is presented

Key words: mathematical modeling, rendering, polymerization, chemical processes, software

PROBLEMS OF TECHNOLOGICAL PROCESSES MANAGEMENT IN ROAD CONSTRUCTION

V.L. Burkovskiy, I.N. Volkov

Abstract: roads are an important part of the economic component of the country, so their construction and operation is essential. There are some disadvantages in the quality of asphalt concrete pavements. The article discusses the specifics and problems of technological processes for the production and laying of asphalt mix, and also provides the structure of control systems in road construction. A pavement scheme is considered, where each stage is described, as well as various factors and problems that can affect the technological process and working moments are studied. The main characteristic of the finished asphalt concrete pavement is the compaction coefficient, which, as a result of all technological processes, must coincide with the standard value. Each technological stage has input and output control. All processes proceed linearly, without the completed previous stage, it is impossible to start the next one, which is one of the main problems. The theoretical material presented in the work can be used to create an intelligent system for managing technological processes in road construction. Such a system is very important in order to significantly improve the quality of the asphalt concrete pavement, reduce the time and cost of work

Key words: management, road construction, incoming and outgoing control, technological processes, asphalt mix, fill factor, structure of control systems

STUDY OF EMERGENCY OPERATION OF A STEAM TURBINE CONTROL SYSTEM AND ITS SIMULATION BASED ON ANY LOGIC CAPABILITIES

R.S. Dudarev, M.I. Chizhov

Abstact: the article discusses the study of the unstable operation of the power unit of a nuclear power plant, which consists in the occurrence of a resonance phenomenon due to an incorrectly operating program for controlling the electromagnetic valves of the automatic control system of the turbine, which, during normal operation, must steadily regulate the given electrical and thermal load, and also provide the possibility of their correct regulation, and simulation of power generation, as well as the failure of one of the steam supply valves to the turbine. The study of the control system revealed a deviation in the characteristics of the servomotors in terms of the electrical part, as a result of which it is recommended to accurately determine the cause of increased pressure insensitivity on the spool to perform an audit of the servomotors, as well as to modernize the control program for this system. Failure to perform these actions may lead to a load shedding situation, in which the control system will not keep the turbine at a speed below the safety switch setting, which may lead to the destruction of the turbine set

Key words: nuclear power plant, power unit, reactor, turbine, control system, modeling, optimization, generator, control valve

USE OF CONVOLUTIONAL NEURAL NETWORKS FOR PREDICTION OF BRAIN TUMORS

M.A. Likhotin

Abstract: this paper provides an opportunity to classify three types of brain tumors: meningioma, glioma and pituitary tumor by magnetic resonance imaging (MRI). In the study, convolutional neural networks are the main tool for classification. The paper provides a statement of the problem, the number of source images, splitting the input sample into trainable, test and validation, normalization of the input data set, and so on. The paper also describes the architecture of a convolutional neural network, which is used to train a brain tumor image classification model. It uses a pre-trained neural network EfficientNetB3, which was trained at the expense of the ImageNet service, which is a hierarchically organized image database. This study also presents the architecture of the EfficientNetB3 convolutional neural network, where the relationship between the layers is demonstrated along the chain. A detailed example of training a reduced convolutional neural network is considered, which demonstrates how the model improves on test and validation sets depending on the number of epochs. The summary statistics during training is also presented, where the epoch with the best result of the model on the validation set was identified, which is the result of training

Key words: convolutional neural network, brain tumor, classification, architecture, learning

DEVELOPMENT OF SPECIAL MATHEMATICAL SOFTWARE FOR THE SYSTEM OF CONTROL OF THE INCOMING APPLICATIONS FLOW

S.A. Oleinikova, A.V. Dyatchina

Abstract: the object of the study is a service or production system, one of the main tasks in which will be the efficient distribution of the incoming flow of applications by performers in terms of the selected criteria. The purpose of this work is to develop software that will be the basis of the system for managing the flow of incoming applications. to solve the problem of assigning a single task, taking into account several criteria and time constraints. As a result, an optimization problem is proposed that takes into account a set of criteria specified by the corresponding matrices that describe the degree of efficiency of each work performed by each performer, and time constraints that take into account the schedule of performers performing tasks that have arrived earlier. Analysis of the specifics of the problem under study made it possible to come to the conclusion about the expediency of preliminary convolution of the criteria. However, time constraints do not allow the use of well-known methods for solving similar problems. In this regard, an evolutionary genetic algorithm has been chosen as a possible variant of its solution. The paper presents the structure of the chromosome, and also describes algorithms for the formation of a new population, crossing and mutation, taking into account time constraints and using convolution of criteria as a fitness function

Key words: assignment problem, time constraints, mathematical model

MATHEMATICAL MODELING OF LONG LINE OPERATION BASED ON REPRESENTATION AS A CHAIN WITH DISTRIBUTED PARAMETERS

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

Abstract: in this paper some analogies are made, and the analysis of electromagnetic radiation sources is carried out. These sources are power transmission lines (power lines), the theory of which is based on the description of circuits with distributed parameters (long lines). Telegraphic equations and the method of their analytical solution are considered. The analytical dependences are obtained based on the representation of a long line by an equivalent circuit in the form of a passive circuit consisting of linear capacitances, inductances and conductivities. The recording of telegraphic equations is based on the classical method of analysis based on Ohm's law and Kirchhoff's rules using the method of complex amplitudes. The obtained analytical dependences make it possible to analyze the processes of propagation of currents and voltages in a long line in time and space. A computer simulation is carried out in the time domain of the passage of a signal in the form of a rectangular pulse through a long line at different values of load resistance, and the dependence of the shape of the output signal on the number of segments of the long line is analyzed. The perspective of the development of the issue under consideration is the transition from the description in the theory of currents and voltages to the description in the theory of electric and magnetic field strengths (creation of a model of electromagnetic interaction)

Key words: mathematical modeling, circuits with distributed parameters, time modeling, power transmission lines (power lines), theory of long lines

SIMULATION OF ELECTROMECHANICAL PROCESSES IN A SOLID-STATE WAVE GYROSCOPE WITH PIEZOELECTRIC TRANSDUCERS

I.L. Bataronov, G.E. Shunin, S.A. Kostryukov, V.V. Peshkov

Abstract: the eigenvalue problem and the mixed boundary value problem for the electroelasticity equations describing oscillations of the cylindrical resonator of a solid-state wave gyroscope with piezoelectric transducers was solved numerically. The developed integrated system of finite element analysis of gravity inertial sensors was used for the solution. The natural frequency spectrum, elastic strain energy, and dissipative characteristics of an oscillating resonator are calculated. The evolution of the oscillation form of a resonator excited by an alternating sinusoidal voltage of a given amplitude at the operating frequency of the resonator applied to two opposite piezoelectric elements at different times is shown. The spectrum of natural frequencies, the energy and dissipative characteristics of the oscillating resonator, the time dependence of the electric potential on the piezoelectric elements, the level of the background alternating voltage on the receiving piezoelements located at an angle of 45 degrees to the piezoelectric elements of the excitation system are determined. An estimate of the time it takes for a solid-state wave gyroscope to reach its operating mode was carried out. These factors should be taken into account when choosing the design of the resonator and the system for removing and processing the signal from the piezoelectric elements of the gyroscope

Key words: solid-state wave gyroscope, cylindrical resonator, electroelasticity equations, mixed boundary value problem, eigenvalue problem, finite element analysis

IMPROVING THE ENVIRONMENTAL ASSESSMENT OF A REAL ESTATE OBJECT BY SOFTWARE ENGINEERING METHODS

O.V. Kuripta, Yu.A. Vorob'eva, O.V. Minakova

Abstract: environmental safety of real estate as a science has been developed in assessing the quality of human habitat. The presented software application allows not only to carry out such an assessment, but also to help the user determine exactly what activities need to be carried out to increase the sustainability class of the habitat. The work implements a decision support module based on the conducted habitat assessment, which helps the user to evaluate possible options for improving environmental safety. The software application is implemented using the C# programming language in the Microsoft Visual Studio 2017 development environment, the format for storing program settings is JSON. The database management system is Microsoft SQL Server. The software application allows you to fill out the primary environmental assessment, calculate the sustainability class of the habitat, display a list of measures to improve the sustainability class, recalculate the primary environmental assessment, import and export the session file and save the report in text format. The software application also implements a decision-making assistance function, the purpose of which is to inform the user about the criteria that need to be changed and improved on the property

Key words: software application, environmental assessment, habitat sustainability

DECISION SUPPORT WHEN MANAGING THE PRODUCTION OF CARBON NANOTUBES WITH SPECIFIED SETTINGS

E.A. Burakova

Abstract: the article deals with the concept of managing the industrial production of carbon nanotubes (CNTs) with specified settings by the CVD method based on a new approach to managing the production system and taking into account the control factors provided by the introduction of additional stages of catalyst treatment by physical action. Based on this concept, a decision support methodology was developed and implemented in the industrial production of CNTs with specified settings, which made it possible to create an information system (IS) ensuring the technologist with all information about the composition and conditions of catalyst treatment by physical influence, contributing to the synthesis of nanostructures with parameters which values are the closest to the given ones. Using of IS in the production process contributes to a significant reduction in time and resources costs caused by the need to conduct additional experiments in order to establish conditions for obtaining a catalyst that ensures the implementation of CNTs synthesis with specified settings. It was established that the introduction of additional components into the technological system of CNTs production (decision support systems and technological stages of catalyst treatment by physical action) enables the system, without changing the conditions for the synthesis of nanostructures, quickly proceed to obtaining nanostructures with the required parameter values which are different from previously produced ones

Key words: decision support, methodology, management, information system, production of carbon nanotubes

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SIMULATION MODEL OF FLIGHT CONTROL OF A GROUP OF UNMANNED AERIAL VEHICLES BASED ON THE BEE COLONY ALGORITHM

K.V. Egorova

Abstract: today it is relevant to use a group of unmanned aerial vehicles in areas associated with a risk to human life, due to their scalability, flexibility and an expanded set of functions performed, which is promising when solving professional tasks related to practical activities in geographical areas with research features. The use of these devices is observed in many areas of human life when solving critical tasks. Most often, the main task to be solved when planning and organizing the work of a group of unmanned aerial vehicles is the task of organizing interaction between the group members. To date, several algorithms have been identified that make it possible to ensure the interaction of a group of unmanned aerial vehicles. This article is devoted to the task of controlling the field of a group of unmanned aerial vehicles based on the bee colony algorithm. The bee colony algorithm can be used as the basis of the method of automated control of a group of unmanned aerial vehicles to organize effective intra-group interaction. The author attempts to build a scientific base for the subsequent implementation and use of this algorithm in practice. To carry out the work, theoretical research methods were applied, as well as scientific materials of domestic and foreign authorship were used

Key words: unmanned aerial vehicle, simulation model, algorithm, control, bee colony, flight, group

DETERMINATION OF THE OPTIMAL SET OF VARIABLES USING MACHINE LEARNING METHODS IN THE STUDY OF RATING SYSTEMS

I.A. Sedykh, I.V. Strugov

Abstract: the application of machine learning methods, in particular classification and clustering tasks, is considered to determine the optimal number of variables included in the model, as well as the selection of key significant indicators within the first stages of the work devoted to the analysis of modern rating systems and their features, as well as the study of approaches to their modeling. The study uses a pre-processed and prepared sample of data consisting of film ratings and describing some qualitative and quantitative characteristics of film parameters, compiled on the basis of the open TMDB database (The Movie Database). The case of using clustering and classification problems to test various options for combining variables into sets for evaluating the values of the rating indicator is presented. The implementation of k-means and hierarchical clustering methods for the clustering problem, as well as decision tree and support vector machine (SVM) methods in the course of classification of the sample under study using R programming tools is presented. To determine the optimal number of clusters in the process of implementing the k-means method, the elbow method is used. The interpretation of both the intermediate results of the step-by-step progress of the work and the totality of the conclusions obtained is proposed, the direction of the vector of further progress of the study is determined, and a visual comparison of accuracy indicators during the final analysis of the results obtained for the methods involved is provided

Key words: machine learning methods, classification problem, clustering problem, k-means method, hierarchical clustering, decision tree, support vector machine method, optimal number of variables, rating systems

COMPARISON OF THE SPEED OF NUMERICAL METHODS OF GAUSSIAN AND LUP DECOMPOSITION IN THE PROBLEM OF FINDING THE EQUILIBRIUM CHEMICAL COMPOSITION

P.A. Sechenov

Abstract: software complexes that allow determining the final composition of a complex heterogeneous system are considered. Such complexes are based on databases of individual substances. When calculating the equilibrium composition, the principle of maximum entropy was applied. The problem of finding the equilibrium chemical composition is presented as the solution of a nonlinear equation with constraints. To solve a nonlinear equation, the methods are used: 1) indeterminate Lagrange multipliers, which allows us to move from a problem with constraints to an unconditional optimization problem; 2) Newton-Raphson, which allows us to move from a nonlinear system of equations to a linear one; 3) Gaussian LUP decomposition is used to solve a system of linear equations, as well as for a similar problem. Theoretical information about the computational complexity of algorithms for solving a system of linear algebraic equations (SLAE) is given. The algorithmic complexity of the Gauss method is $O(N^3)$, the LUP decomposition method is solved faster, the decomposition of a matrix into two matrices is the same complexity, and the solution of two triangular matrices is performed in $O(N^2)$ time. The distinctive features of the LUP decomposition algorithm in comparison with the Gauss method are given. A computational experiment has been carried out showing the calculation speed for Gauss and LUP decomposition methods depending on the number of unknowns in the system of algebraic linear equations. Testing on three computer configurations showed that LUP decomposition is performed 1.1 to 4.5 times faster than the Gauss method

Key words: Gauss method, LUP decomposition, equilibrium composition, thermodynamics, algorithm performance

ALGORITHM FOR ADAPTIVE ESTIMATION OF PARAMETERS FOR NONLINEAR NONSTATIONARY SYSTEMS

N.K. Tung

Abstract: the paper considers the problem of estimating unknown parameters for a class of non-linear non-stationary systems. In this case, it is assumed that the system state matrix contains unknown non-stationary parameters. Let us assume that non-stationary parameters of the system can be represented as outputs of linear generators with unknown state matrix and initial conditions vector. It is proposed that the state vector, control signal and output variable are measurable. At the first step, the problem of parameterizing the initial dynamic model to a linear static regression model is solved. The second step is to estimate the unknown constant parameters of the linear regression model using the Dynamic Regressor Extension and Mixing method, which allows obtaining monotonic estimates and ensures the acceleration of the convergence of the estimates to the true values. The results of computer simulation showed the efficiency of the developed algorithm. In the paper an adaptive algorithm for estimating variable parameters was synthesized and the results of computer simulation were presented. Unlike analogues, in this paper we consider more complex assumptions for unknown non-stationary parameters, that the non-stationary parameters of the system can be represented as linear generators with unknown state matrix and initial conditions vector

Key words: non-stationary nonlinear systems, identification of parameters, regression model

IMAGE CONTRAST ENHANCEMENT BY MEANS OF MODIFIED S-SHAPED INTENSITY TRANSROFM

D.V. Nacharov

Abstract: a method for digital images contrast enhancement by means of a modified S-shaped transform is considered. The method supposes an approach to measure quantitative values and inflection points of the intensity transform function. In the introduction the classes of images to which the proposed method is applicable are listed. Also in introduction a brief discussion of image contrasting methods such as linear contrasting, stepwise image transformation, histogram matching, and histogram equalization is given. In the main part of the article examples of low-contrast images, examples of their processing by known methods are presented. Analysis of advantages and disadvantages of known methods is given. The main idea of the proposed method, which consists in the analytical determination of the S-shaped brightness transformation function exponents based on the determination of the boundaries of the brightness subranges to be compressed with a given coefficient using the intensity cumulative distribution function is formulated. examples of processing real images of various contents are given for the purpose of visual analysis of the effectiveness of the proposed contrast enhancement method comparing with known methods. The results of the advantages and disadvantages analysis of the proposed method are presented, an approach to the automated intensity transform quantitative parameters estimation is proposed. In conclusion the main results of the study are briefly characterized

Key words: intensity, contrast, image, histogram, subrange, nonlinear transform

DESIGN METHODOLOGY AND IMPLEMENTATION OF A DIGITAL FILTER WITH MULTIPLE PASS BANDS FOR 5G APPLICATIONS

A.V. Bashkirov, R.N. Khoroshailov, I.A. Turetskiy

Abstract: the article presents a technique and implementation of a reconfigurable filter with a finite impulse response (FIR) using control logic, which is suitable for resolving multiple frequency bands using a single filter with a finite characteristic and a multiple set of coefficients. In the Matlab/Simulink environment, a model has been developed to study the performance of the desired higher-order FIR filter. An equivalent representation of the FIR filter is developed by the Xilinx compiler using exported filter coefficients. The FPGA implementation process was completed using Xilinx ISE 14.5 and an analysis was carried out of how a higher-order FIR filter affects the use of FPGA resources and its maximum operating frequency. Automatic selection of coefficients was used to obtain several frequency bands. High data transfer rates, area utilization efficiency and multiple bandwidth filters are key factors for 5G communications. An efficient reconfigurable FIR filter has been implemented with a FIR architecture based on multiplication-addition blocks (MAC). The result of modeling the proposed architecture shows that it can save from 79.8% to 83.3% of 4 input reference tables (LUT) and requires only 33% of the slice registers

Key words: FIR filter, FPGA, modeling, digital signal processing

INVESTIGATION OF ELECTRIC INDUCTION SENSOR OF ELECTROMAGNETIC FIELD STRENGTH CYLINDRICAL DIRECTIONAL RECEPTION

S.V. Biryukov

Abstract: the paper considers the interaction of an electro-inductive cylindrical sensor of the intensity of the electric component of the electromagnetic field of directional reception with a homogeneous field of free space and an inhomogeneous field of linear charge. The relationship between the measured electric field strength, the charges induced on the sensor's sensitive elements and the structural parameters of the sensor are established. The results obtained formed the basis for the development of a directional EF voltage sensor with the required metrological characteristics. The sensor consists of a conductive cylinder of radius R and height h and two cylindrical sensing elements, the design parameters of which are set by angular θ_0 and linear R and h dimensions. Expressions of sensitivity of the sensor and its error due to the non-uniformity of the field are given, and their evaluation is carried out. The evaluation shows the possibility of using the sensor, both in free space and near the field source. In free space, limited by the spatial range of measurement $0<a\leq0.5$ ($d=2R$) at $\theta_0=58°$, the error from the inhomogeneity of the sensor field will be no more than ± 0.2%. Near the source of the field, limited by the spatial range $a<1$ ($d<2R$) at $\theta_0=53°$ the sensor error will be no more than ±2.5%. The sensor sensitivity is (25÷100) mV/m

Key words: strength, field, electromagnetic, electric, electric field sensor, cylindrical sensor, directional reception sensor, sensitivity, error

MEASUREMENT OF HIGH-FREQUENCY LOSSES IN THE MAGNETIC WINDINGS OF A BUCK CONVERTER

A.V. Bashkirov, Ya.V. Skitsky, N.Yu. Veretennikov

Abstract: the stages of the experiment to determine the losses in the windings of the magnetic components of switching power supplies are presented. These losses are due to the flow of high-frequency currents: the proximity effect and the skin effect. For this purpose, the losses caused by magnetization reversal in the power inductor of the converter are calculated, as well as the power dissipated as a result of static and dynamic losses on the main transistor and the active rectification transistor of the buck converter is measured. In order to improve the accuracy of the experiment, as well as the convergence of the final results, several options for calculating losses in the magnetic circuit of the power inductor are used. For this, several types of the Steinmetz equation are used, namely, generalized and modified. The second option is necessary to take into account the difference between the law of change of the magnetic induction vector and the sinusoidal one. During the experiment, the actual values of the power dissipated into heat were obtained for all the main nodes of the power circuit of the step-down converter. The experimental technique described in the article can be used to verify and compare various methods of numerical and analytical modeling of heat losses in the windings of winding products, as well as on power transistors and circuit diodes

Key words: high frequency loss, proximity effect, skin effect, ferrite loss, Steinmetz's equation, transistor loss, power dissipation, loss measurement in magnetic components

STUDY OF THE TECHNOLOGY OF MANUFACTURING NOISE REDUCTION HONEYCOMB PANELS FOR THE HOT PART OF A TURBOJET ENGINE

V.I. Fedoseev, M.V. Molod, V.I. Maksimenkov

Abstract: the article discusses the issues of manufacturing honeycomb panels used to reduce engine noise. The designs of single-layer and double-layer panels made of steel and titanium alloys are given. The shaping of these panels is carried out in dies in vacuum furnaces. The developed stamp designs do not exclude the appearance of defective signs. The developed design of the stamp allows the formation of a layered panel with stretching, which eliminates distortion of the cell faces. The scheme of the technological process of forming panels is given, including the materials used with an assessment of the ultimate deformations at different temperatures, the geometric parameters of the panels obtained, the kinematics of the stamp and the forming process. Tests with heating were carried out on a universal breaking machine with a record of the diagrams "σ-ε". The calculation of the shaping parameters with the estimation of the shaping effort is performed. At the same time, the tensile force of the panel during shaping is determined with an assessment of the limiting capabilities of the material determined during the tensile testing of samples. On the received panels, an increase in their quality was noted, which is necessary for the subsequent manufacture of the turbofan muffler casing

Key words: layered structures, shaping, heating, stamp, deformation

INVESTIGATION OF AXIAL FORCE AND TEMPERATURE IN THE CUTTING ZONE AT STRETCHING BASED ON COMPUTER SIMULATION

V.V. Kuts, V.S. Kochergin, O.N. Kirillov, M.V. Yakin

Abstract: the work is devoted to the study of axial force and temperature in the cutting zone during stretching with increased lifting values per tooth (0,2≤Sz≤0,5 mm/tooth) based on computer modeling of the cutting process in the Deform 3D program. Modeling was performed for structural steels: 45; 40X and 12KHN3A in accordance with a three-level three-factor plan of the experiment, where the factors were varied in the ranges: for the front angle from 5 to 15 degrees; for cutting speeds from 2 to 12 m/min and lifting per tooth from 0.2 to 0.5 mm /tooth. Using the Statistica program, dependencies were established for the axial cutting force, the axial cutting force of the cutting edge length per 1 mm, the specific axial cutting force and the temperature in the cutting zone, taking into account the material being processed, the cutting speed, the front angle and the amount of tooth lift. The data confirming the adequacy of the obtained regression equations are shown. The results obtained were compared with experimental data obtained by other researchers, their coincidence was established, which allows them to be used in the design of broaches with increased feed rates up to 0.5 mm

Keywords: stretching, feeding on the tooth, broaching, cutting force, temperature in the cutting zone

LAYERED PANEL FOR THE AIR INTAKE CHANNEL OF THE AIRCRAFT

V.I. Maksimenkov, M.V. Molod, P.S. Ogurtsov

Abstract: the article deals with the issues of analysis of honeycomb panels used in aircraft structures. The three-layer honeycomb panels used in the design of passenger aircraft, which provide the 4th chapter of the International ICAO Standard, are given. The task was set to increase the acoustic efficiency of layered panels by creating new structures. A three-layer design is presented, confirmed by a patent, which consists of an upper carrier layer made of perforated skin and C 685 meshes, and layers of honeycomb core, the density of which varies from the upper layer to the lower one in the ratio 1:2:3. This design expands the frequency spectrum, providing broadband noise absorption. Calculations of the density of each layer of the honeycomb panel are made. Strength calculations of samples of honeycomb filler with different densities were carried out. The obtained values of the ultimate compressive strength determine the choice of a layered structure, taking into account the allowable requirements. A technological process for the manufacture of a three-layer panel has been developed, which makes it possible to obtain layered panels of the required quality. A weight calculation was carried out, which makes it possible to determine that the developed design practically reduces the weight by more than 1.5 times compared to the base case. The tests carried out revealed the acoustic efficiency of this design by more than 2 times compared to the base case

Key words: honeycomb panel, density, technological process, grid, air intake channel