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## SUMMARY. KEYWORDS

## ENGINEERING SCIENCE

**V. V. Akimov, M. V. Akimov, M. V. Platinina**  
**Determination of coefficients to Lama, hydrostatic character, heat resistance of firm alloys of TiC-TiNi depending on structure of composition**

Using values of elastic characteristics and speed of distribution of ultrasonic waves in a firm alloy of TiC-TiNi coefficients to Lama ( $\Lambda$ -lamda,  $\mu$ -mu), and also coefficient of hydrostatic character of H. There is done the assessment of heat resistance of a firm alloy of TiC-TiNi in comparison with firm alloys of BK6, BK8.

Keywords: firm alloys, elastic modules, coefficients to Lama, hydrostatic character, heat resistance, composition.

**A. L. Akhtulov, L. N. Akhtulova,**  
**A. E. Lyubakov, L. A. Ivanova**  
**The analysis of the main fire models used to determine the initial stage of inflammation**

In the article the analysis of basic models of fire the initial stage of inflammation, there is given a comprehensive approach and features of the object.

The proposed model takes into account the characteristics of the object, which allows not only to implement reliable and efficient

engineering and fire protection systems, but also to prevent the fire.

Keywords: mathematical modeling of the dynamics of fire development, the initial stage of ignition, differential equations of fire development, engineering and fire protection systems, industrial facilities.

**A. L. Akhtulov, L. N. Akhtulova, N. V. Bulakhova,**  
**Yu. V. Bulakhova, V. A. Bulakhov**  
**Improvement of quality management system of organization**

The article describes the structure of the organization management system which integrates almost all the generally accepted concept of management based on quality improvement and the creation of information support depending on the features of the organization.

Keywords: organization, management system, information management, process modeling management organization.

**Yu. A. Buryan, S. N. Polyakov, M. V. Silkov, D. O. Babichev**  
**Hydropneumatic accumulator with inertial motion converter**

The article describes the principles and mathematical model of the low-frequency anti-vibration support consisting of inertial motion converter based on rubber-cord shell filled with a liquid and a

hydropneumatic accumulator. The article shows that matching characteristics of a hydropneumatic accumulator and a hydraulic inertial motion converter can be obtained high efficiency low frequency vibration isolators for hanging power units in various industries.

Keywords: vibration isolation, rubber-cord shell, damper, motion converter, a hydropneumatic accumulator.

**E. N. Eremin, S. A. Borodikhin, A. S. Losev**  
**Studies of properties of deposited metal obtained by flux-cored wire PP-25Kh15MGsFR doped of boron carbide**

There are presented results of the study of structure and properties of the metal at surfacing flux-cored wire PP-25Kh15MGsFR with the additional administration of the compounds of boron carbide. The injection of boron carbide in the wire produces deposited metal with a stable structure and properties regardless of the technological modes of surfacing, as well as its improves performance heat resistance. This wire is recommended to increase tool strength of hot metal deformation.

Keywords: flux-cored wire, borides, deposited metal, hardness, heat resistance.

**E. N. Eremin, A. Z. Isagulov, T. V. Kovalyova**  
**Developing technology of obtaining high-strength casting forms on the basis of cold-hardening mixtures**

The article describes a technology obtaining high-strength casting forms on the basis of cold-hardening mixtures. It contains recommended values of technological features of molding mixtures, the results of studying influence of physical-mechanical and technological features of CHM on quality of casting forms and iron casting.

Keywords: foundry, cold-hardening mixtures, cores, casting.

**E. N. Eremin, V. Yu. Kulikov, T. V. Kovalyova**  
**Analysis of sand-resin mixtures while static and thermal exposure**

The article studies sand-tar mixtures during simultaneous static and thermal action. The equations of stress-strain state of mixture are derived in this paper. The results of study on the feasibility of a slight increasing pressure on mixture during forming procedure; dependence of tensile and flexural strength from applied static pressure on mixture during forming shell; dependence of form's roughness from pressure changes during shell forming procedure.

Keywords: shell forming, molding sand mixture, casting.

**E. N. Eremin, T. A. Sheveleva, Yu. O. Filippov, A. S. Losev, S. A. Borodikhin, A. E. Matalasova**  
**The structure and hardness of the metal teeth crowns deposited in flux-cored wire PP-AN170**

The results of research of structure and hardness of weld strength of metal teeth crowns when using semi-automatic surfacing with flux-cored wire PP-AN170 in comparison with the electrodes T-620 is done. There are proposed parameters of the mode of heat treatment of deposited metal. It is shown that the structure of the deposited metal consists of carbide segregations uniformly distributed in the martensite matrix with hardness above 60 HRC, which provides increased wear resistance.

Keywords: surfacing, teeth, flux-cored wire, hardness, structure, wear resistance.

**V. S. Kushner, D. S. Gubin**  
**Determination of the field of rational modes of milling nickel based super-alloys face mills using temperature dimensional stability (part 2)**

In the article the technique of theoretical definition of rational modes of milling nickel alloys is defined. As the main limitation is the wear rate with temperature dimensional stability of the cutting blade. The calculation of the temperature is carried out taking into account the relationship of temperature and resistance characteristics of nickel alloys plastic deformation, as well as taking into account the influence of the heat flows vents from the cutting zone in the tool and the workpiece.

Keywords: rational modes of milling, nickel based super-alloys, yield point, heat flux, deformation temperature, plastic deformation.

**A. Yu. Popov, D. Yu. Belan, V. V. Dyundin**  
**Improving quality of repair collectors traction motors through improved geometry of cutting tool**

The article discusses improving repair technology collector traction motors. To improve the quality of processing and performance

of repair collectors is proposed to replace finishing operations: grinding and polishing final turning cutter with sharpening of the cutting edge by technology «superblade».

Keywords: the collector-brush unit, finishing operations, cutting tool, technology sharpening «superblade», roughness.

**A. Yu. Popov, K. K. Gosina, I. V. Petrov, A. E. Makarova, D. G. Balova, A. V. Pepelyaev**  
**Classification, composition, advantages and disadvantages of multi-component composite materials**

The article presents the classification and the relevance of the use of polymers and composite materials, methods for their preparation and the benefits of mechanical characteristics. A more detailed understanding of the composite CFRP materials the example, namely, their types, and a brief description of the application are presented in the article. There are also attached tables and figures with detailed description of the technical characteristics of carbon fiber and carbon fiber kinds of woven fabric.

Keywords: polymers, composite materials, carbon fiber, carbon fiber, carbon fiber.

**B. N. Stikhanovskiy, E. S. Chernova**  
**The impact device with measuring ring magnet to detect defects**

The subject of the research is application of electromagnetic percussive construction by the materials defectoscopy. The purpose of the research is the increase of indices of transducer signal amplitude and sensitivity enhancement of the device. The authors use the inspection method, which applies to the group of the mechanic methods of nondestructive inspection. We monitor the materials of carbon steel, concrete and wood by the instrumentality of the offer construction. The inspection consists in comparison of the signal received when stroke on the model with defects in structure with the signal received from the similar model without defects in structure. The inspection results are dependences of change of tension values by models from different materials with defects and without them. These dependences make it possible to use the indicated construction for different materials when mechanical nondestructive inspection. The authors drew the conclusions and gave advices about the value of transducer signal and sensitivity enhancement of the device.

Keywords: control, defectoscopy, blow, firing pin, elastic rebound, percussive device.

**V. I. Trushlyakov, E. A. Yutkin**  
**Overview of means for de-orbiting of large-scale space debris objects as the service operation of spacecraft in orbit**

This article provides an overview and analyzes means and methods for de-orbiting of large-scale space debris objects. Systemized information about developing in the USA, European Union countries, Japan, China and Russian Federation methods of on-orbit servicing (docking and capturing) and main approaches for solving servicing problems are obtained.

Keywords: near-Earth space pollution, large-scale space debris, docking with non-cooperative objects on orbit, on-orbit servicing.

**K. V. Averkov, A. G. Kisel, Yu. V. Titov**  
**Improving operational performance V-belt transmission by improving the shape of pulley groove**

The article deals with the aspects of the contact between the V-belt and the V-pulley. It is known that when the V-belt bends its cross-section deforms. The authors propose to shape the V-pulley groove so that it matches the deformed V-belt cross-section. For this purpose, the authors have derived the V-belt lateral surface equation.

Keywords: V-belt transmission, contact tensions, deformation, Poisson effect, pulley.

**M. I. Biserikan, V. V. Ivanov**  
**The influence of quality machining on technical resource wheels rolling**

The analysis of the impact of the nonnormable waviness of the rolling surface of wheels of rolling stock, arising as a result of lack of effective technology of repair on a technical resource of wheels is described. A mathematical model describing the effect of the waviness of the rolling surface on the character of wear is presented.

Keywords: Abrasive wear, fatigue damage, overhaul life, car wheel, mechanical treatment.

**S. S. Busarov, V. L. Yusha, V. K. Vasiliev, A. V. Nedovenchanyy, A. Yu. Gromov, M. A. Chizhikov**  
**A theoretical estimate of possibility of replacing low consumption multi-stage reciprocating compressors**

The article discusses the possibility of using long-stroke low-speed single-stage reciprocating compressors running with non-lubricated part to compress the gas to a pressure of more than 2 MPa the example of ammonia in terms of allowable temperature modes.

Keywords: reciprocating compressor, heat transfer, mathematical model.

**G. G. Kustikov, M. A. Taran, O. I. Uskova**  
**High efficiency air curtain**

The operation of the side air curtains is investigated. The optimum parameters of its work are determined. Implementation of the modeling process of air curtains is realized in the program Ansys Fluent. The result is a visual form of the distribution of temperature and speed indoors, given the size of the gap and the angle of the direction blinds. Applying the results of the study will reduce the cost of maintaining the required parameters of the indoor air.

Keywords: air curtain, modeling, energy saving.

**Yu. P. Makushev, L. Yu. Volkova**  
**Calculation of electrohydraulic valve control flow injector needle and its diagnosis**

There is examined the device and operation of nozzles with electrohydraulic controlled needle stroke. The design procedure of the injector valve assembly with electrohydraulic control and technique of diagnosis is given.

Keywords: nozzle, electronic control valve, magnetomotive force, the spring, the inertia fuel leakage, diagnosis.

**A. G. Mikhailov, E. E. Novikova, S. V. Terebilov**  
**Calculated characteristics for reversible furnace of fire-tube boiler**

The classification of fire-tube boilers as a heat source for autonomous heating systems, and the characteristics of their design are considered. There are the results of numerical calculations using the  $k-\varepsilon$  model of turbulent combustion processes in reversible heat furnaces with a different profile for gaseous fuels. The highest average temperatures in the volume and density of heat flows correspond to the reverse furnace with profile of ellipse.

Keywords: fire-tube boiler, reversible furnace, combustion, temperature, heat flux density.

**A. G. Mikhailov, E. N. Slobodina, S. V. Terebilov**  
**Condensation for heat transfer in low-pressure volume vacuum boiler**

For a long time to heat equipment the condensation was neglected, it was assumed that the process does not require the application of advanced heating surfaces and other stimulation techniques. The article presents results of studies of the effect of condensation in the discharged volume on the effectiveness of the vacuum boiler. Studying the process of low pressure condensation will identify shortcomings and to choose rational methods of heat transfer.

Keywords : vacuum boiler, condensation, heat transfer, pressure, efficiency.

**D. S. Rechenko, A. A. Ezhov, D. G. Balova, I. A. Tsarenko, A. G. Kisel, R. U. Kamenov**  
**Types of carbide wear plates at the blade handling and methods of treatment**

In this article the actual problem of the wear of inserts in treatment of blade, as well as methods of diagnosis and how to solve their appearance. Understanding the destruction of all types of plates and methods for their analysis ensure longer lifetime of the tool and predictability of its working surface quality as well as improved performance and damage to expensive parts.

Keywords: cutting tool inserts, wear types, diagnostics.

**D. S. Rechenko, E. V. Leontyeva, M. G. Matveeva**  
**Research of geometry of turning hard-alloy plates for processing of a heat resisting alloy of HN65KMVYuTL**

The geometry of the hard-alloy cutting tool defines its firmness, quality and reliability of blade processing. Today there is a large number of the firms delivering the metal-cutting tool to Russia. The nomenclature of the presented tool is various and turns on the cutting tool for various type of processing. Thus, geometrical

parameters of sharpening of an edge, that is rounding radius at top, a forward and back corner are very various that doesn't provide understanding of a potential resource of the cutting tool. Processing of heat resisting alloys is very problematic owing to their physicomaterial properties that demands studying of geometrical parameters of plates. This work is directed on research of geometry of turning hard-alloy plates for processing of a heat resisting alloy of HN65KMVYuTL.

Keywords: metal working, sharpening of the hard-alloy tool.

**G. S. Russkikh, A. V. Onufrienko, E. Yu. Glazkova**  
**Calculation of rubber-cord stretching damper**

A preliminary analysis of mechanical characteristics of rubber-cord stretching damper on mathematical models of rubber-cord shells with stretch cord threads in the general formulation of the membrane theory of shells of revolution mesh is carried out. The comparison of the simulation results in the assumption of non-stretchable cords and the experimental data is shown.

Keywords: Rubber-cord stretching damper, rubber-cord shell, stretch cord, mathematical model.

**D. V. Sitnikov, S. V. Klishin, M. V. Ugrenov, V. V. Bokhan, A. V. Zubarev**  
**Evaluation of mechanical resistances of system for dynamic testing of direct-flow pipes**

The early analysis of the value of the mechanical resistances of the system for the dynamic testing of direct-flow pipes used for vibroinsulation of hydraulic units is done. Measurement of the mechanical resistances of the test system determines the mechanical resistance of the pipes more accurately compared to the procedures in which construction of the test system taken as perfectly rigid body.

Keywords: mechanical resistance of pipe, the dynamic tests, vibroinsulation.

**G. I. Chernov, A. A. Panyutich, V. L. Yusha, V. K. Vasiliev, A. V. Zinovieva, S. N. Mikhailets**  
**Theoretical analysis of workflow efficiency of screw oil-filled compressor on control frequency modes of capacity**

The article deals with current issues of raising efficiency of the screw oil-filled compressor frequency regulation capacity. The comparative analysis of the compressor when submitting an independent oil pump and using the displacement of the oil supply from the oil is done. The analysis is done on the basis of the developed mathematical model.

Keywords: screw oil-filled compressor, cooling capacity, the efficiency of the compressor, capacity control.

**N. N. Chigrik**  
**Calculating limiting sizes of piston compression rings of internal combustion engine in view of inaccuracies in the ring sizes. A part 1**

In the article the justification of correctness of selection on the GOST 8.051-81 and RD 50-98-86 micrometer lever MP 25 of the GOST 4381-87 for conducting a control by measurement of the biggest and smallest height of piston compression rings applied in constructions of petrol engines ZMZ-402.10, ZMZ-4062.10 is established. The extension of a true field of a dissipation of a distribution curve of collection mean is obtained by means of join of compositions of homogeneous samples of results of a control by measurement of the greatest and least altitude of piston compression rings, concerning coordinate of middle of a spacing of tolerance of the size their height  $EC(Tb) = -0,006$  mm, testifies to partial implementation of a hypothesis of allocation of collection mean and her dot estimations of the GOCT 8.207-76 under the law of the Gauss with presence of fields of probability errors I and II of a kind in connection with offset of her instantaneous center of a dissipation, abatement of a dispersion  $D(x)$  and considerable extension of fields of a dissipation of distribution curves of homogeneous samples.

Keywords: piston compression ring, internal combustion engine, control by measurement, supply of unity of measurements, inaccuracy of measurings.

**P. A. Batrakov**  
**Numerical investigation of nitric oxide formation from combustion of natural gas in of different profiles furnaces of furnace-tube boilers**

The numerical analysis of heat transfer processes and the flow of reacting gases in the furnaces fire-tube boilers of different profiles are presented in the article. The analysis is performed with ANSYS CFX. The calculations are carried out using ANSYS CFX. A graphical representation of research in the form of

variables that characterize the ecological characteristics of the operation of the furnace and the boiler as a whole are presented. The recommendations are made on the selection of the maximum values of the field of rational environmental performance of work fire-tube boiler furnaces in various fields lists the temperature and the concentration of nitrogen oxides at the outlet.

Keywords: fire-tube boiler, furnace, nitric oxide.

**I. A. Bugay, E. V. Vasiliev, M. V. Vasilieva**  
**Increasing accuracy and efficiency of machining of hard materials by precision conciliar broaches with carbide cutting part**

Development of construction of broaches allows to process surfaces with greater precision and tool life. When machining of hard materials existing designs broaches and tool material does not provide stability sized and tool life. Using modular broaches with carbide cutting part with a radius of rounding of the blade is less than 1 micron allows for an increase in precision machining of surfaces up to 2 mm and extends the life of pulling in 3 times.

Keywords: broaching, hard alloy, durability, performance, mounting, processing.

**V. A. Ilyichev, V. S. Korneyev, S. A. Korneyev**  
**Discrete mathematical model of a flat rubber-cord sleeve**

This article is devoted to construction and verification of the mathematical model of highly flexible couplings with the operating member in the form of rubber-cord drive. The construction of which together with the method of assembling a disk designed to «NPP» Progress» are protected by patents of the Russian Federation.

Keywords: highly elastic coupling, rubber-disk member, a mathematical model, load characteristics.

**V. A. Ilyichov, I. A. Penkov, V. S. Korneyev, S. A. Korneyev**  
**Experimental stand for the study load characteristics of rubber-cord flat couplings**

In this article, we describe a specially designed experimental stand for testing and the method of determining load characteristics of rubber-cord disc (plate) for highly flexible couplings.

Keywords: rubber-coupling, test bench, load characteristics.

**E. V. Klimentyev, A. Yu. Kondyurin, I. A. Penkov, V. S. Korneyev, S. A. Korneyev**  
**Experiment stand for determining the mechanical properties and thermodynamic parameters of pneumatic elements with rubber-shell**

In this article, we describe the experimental stand for definitions and basic thermodynamic parameters of elastic and elastic-damping characteristics of pneumatic elements with rubber-shell.

Keywords: pneumatic elements, air damping, experimental stand, elastic-damping characteristics.

**E. V. Klimentyev, V. S. Korneyev, S. A. Korneyev**  
**Mathematical modeling of thermodynamic processes in pneumatic elements air damping**

On the basis of the general provisions of continuum mechanics and a number of simplifying assumptions proposes engineering method of calculation of the thermodynamic parameters of the gas in the pneumatic element air damping for vibration damping in the suspensions of vehicles and systems, depreciation of fixed objects. There is introduced the concept of structural (internal) parameter characterizing the current state of the valve device. Heat exchange with the environment is described by the law of polytropic process. There are clarified the conditions of existence of steady state operation.

Keywords: pneumatic elements, air damping, mathematical modeling, the entropy jump.

**E. V. Klimentyev, V. S. Korneyev, S. A. Korneyev**  
**Numerical analysis of pneumatic shock absorber at standard mode, loading and various control algorithms**

For example, the numerical solution of the two test problems is illustrated by the authors developed an engineering method for calculating the thermodynamic parameters of the gas in the pneumatic element air damping at different algorithms control valve device. Particular attention is paid to the existence of steady state operation of the pneumatic shock absorber and level reaches the temperature and pressure of the gas.

Keywords: pneumatic elements, air damping, steady state, index of the polytrope.

**A. Yu. Kondyurin**  
**To the problem of selection of constructive scheme of piston of hybrid machine with volume action**

In the work design of piston hybrid machines of volumetric action are considered. On the basis of the carried-out analysis the machine design with the piston sealing executed in the form of the hydrodiode providing a liquid consumption from injection unit is offered. It is more, than from compressor.

Keywords: Pumps, compressors, hybrid equipment, labyrinth seal.

**A. Yu. Kondyurin, V. A. Zubarev, V. A. Shepetkov**  
**Pi fittings of the pneumatic branch-pipe with the rubber-cord cushion**

There are invariants for the geometric dimensions of the rubber-cord cushions shape with the Pi fittings moving the pneumatic shock-absorber in the axle direction. It is stated that cylindrical guide fittings are related to the Pi fittings too.

Keywords: pneumatic shock-absorber, rubber-cord cushion, fitting.

**D. A. Kuzeeva**  
**Design and experimental study of hybrid power piston machine with a gas volume of suction**

This article describes new design of hybrid power piston machine with gas volume of suction marking tasks, that are necessary to solve to create it. We present the design of the experimental stand with a sample unit, as well as some results of the experiment to test the operability.

Keywords: pump-compressor, cooling, water jacket, piston machine.

**I. E. Lobov**  
**Development and pilot study of piston compressor cooling system based on oscillatory phenomena of gas in pressure line**

In work the analysis of the existing cooling systems of compressors of volume action is carried out. The new cooling system based on the oscillatory phenomena of gas in a pressure line is offered. The experimental stand for this system is described, and results of the made experiments are given.

Keywords: piston compressor, cooling system, pilot study.

**L. D. Malaya**  
**Method of suitability of technological process for control of quantitative indicators**

This article is devoted to statistical analysis of technological processes. Reviewed hypotheses of the statistical distribution defining moments of the distribution and Pearson's criterion prove the normality of the distribution. The experiment with subsequent analysis of data is conducted to determine the suitability and reproducibility.

Keywords: statistical distribution, technological process, the Pearson criterion, suitability, reproducibility.

**M. Yu. Manzin, V. V. Vasiliev**  
**The area as information source for driver**

The article discusses the factors determining the density of information flow due to the characteristics of the area. To this end, a method of estimation the amount of information received by the driver when driving a vehicle. The proposed methodology in the future will allow you to choose the option to automate the process of traffic management in accordance with the purpose of the machine.

Keywords: information, the flux density, input control, output control, intensity of service.

**P. V. Nazarov, E. V. Vasiliev, V. A. Sergeev, M. V. Vasilieva**  
**Upgrading special machine designed for grinding of front surface and flute broach**

Expansion of technological possibilities of a special machine is designed for grinding the front surface of teeth pulling. The developed design of the machine will allow positioning of machine components up to 0,001 mm and grind at speeds up to 200 m/s. The radius of curvature of the blade as a result of pulling the tooth grinding equipment developed is at less than 1 micron.

Keywords: broaching, grinding, grinding machine, precision profile grinding.

**K. V. Pavlyuchenko**  
**Theoretical study of motion of a particle in the inclined air channel**

The article investigates the process of a particle motion in the air stream of an inclined channel. The obtained mathematical relations describe the process of a particle motion in an inclined channel and dependence of its flight trajectory from the technological and design parameters of the channel.

Keywords: air stream, aerodynamic force, flight trajectory, grain cleaning.

**S. V. Roslov, A. P. Progovorov, A. N. Scherbo**  
**The influence of dynamic properties of diesel engine on its operational and technological indicators**

The causes of deterioration of parameters of diesel engines with turbocharged T-90 tank on the transition modes are found. The system of short-term supply of additional air at the initial stage of the transition regime is developed and the results of experimental studies to evaluate its effectiveness are presented.

Keywords: diesel, transient, tank, pumping, dynamic properties.

**E. N. Slobodina**  
**The effect of boiling process in chamber with low pressure on the efficiency of vacuum boiler**

The process of boiling is of great importance in the work of the vacuum boiler. The article considers the influence of boiling heat transfer coefficient at low pressure on the efficiency of the vacuum boiler. According to the saturation temperature at boiling, heat transfer coefficients from the pressures are presented.

Keywords: vacuum boiler, boiling, heat transfer, pressure, heat loss, efficiency.

**A. M. Smirnov, P. A. Senkin, N. I. Prokopenko**  
**Evaluation of wear of plunger without disassembly of fuel pump of high pressure diesel**

The authors propose a new method of diagnosing plunger pairs directly on the engine. The paper presents results of theoretical and experimental studies which support the feasibility of plunger diagnostics at the early stages of wear.

Keywords: fuel injection equipment, fuel high-pressure pump, plunger pair, diagnostics, hydraulic density, wear.

**V. Yu. Usikov**  
**Laboratory research of functional dependence of coefficient of resistance to motion of wheel on external factors**

Results of laboratory research on determination of functional dependence of coefficient of resistance to the motion of a wheel on external factors are considered (air pressure in the tire, the loading falling on a wheel, numbers of consecutive pass of a wheel on the soil basis of a deformable basic surface) at the motion on loamy soil of various humidity and wet river sand.

Keywords: coefficient of resistance to motion, design of experiments, full factorial experiment, the air pressure in the tire, wheel load, the number of wheels on a track passage.

**V. Yu. Usikov**  
**Development of mathematical model for multi-purpose vehicle on deformable ground taking into account variations in the impact of external factors on wheels**

There is considered developed mathematical model to determine performance characteristics of multi-axis linear motion of the car on deformable support surface with the functional dependence of the resistance to motion of the wheels of a vehicle from the load on the wheel and their structural arrangement in the wheel formula car and set tire pressure.

Keywords: cars, multi-purpose, cross-country, deformable bearing surface, paddle wheels, the control of air pressure in the tires, coefficient of resistance to the movement.

**N. Yu. Filkin, V. L. Yusha, V. K. Vasiliev, E. A. Likhobabina**  
**Theoretical assessment of the influence of a ratio between axial sizes of elements of flowing part of short diffuser on its gas and dynamics efficiency**

In the article shortcomings of a short diffuser and ways of improvement of its work are analyzed, the problem in relation to the diffuser design with the directing is posed. Theoretical research of the short diffuser with various length directing is executed, the object of research is described, the calculation procedure is stated.

Results of research and its analysis are presented, the direction of further work on this task designated.

Keywords: the short diffuser, directing, a field of speeds, losses of pressure.

**O. V. Chemisenko, R. I. Kosarenko, V. A. Makienko**  
**Research of concentration and temperature dependences of mechanical properties of nanocomposites on the basis of PTFE**

The article describes the results of studies of the effect of concentration nanomodifiers and temperature mechanical properties of nanocomposites based on PTFE. It is shown that with increasing temperature up to 1500C mechanical properties decrease monotonically in 3–6,5 times.

Keywords: polymeric composite materials, silicon dioxide, cryptocrystalline graphite, PTFE.

**I. A. Sysuev, I. V. Prud, O. E. Serdyuk, V. V. Skitchenko, K. V. Vasilevich, K. A. Epifantseva, M. F. Fedorchuk**  
**Perception of graphic image in printed publication made on color substrate**

The article considers issues that relate to creation of attractive and readable external graphic image of a page of printed publications. For evaluation of the graphical image of page one of the important parameters is contrast. The change of contrast of graphic image of the page is shown when using colored paper as substrate. The results of expert evaluation of perception of graphic image in printed publications are provided that made on different color paper.

Keywords: a graphic image of the page, print publications, contrast, saturation of text, a method for estimating the saturation of a text of printed publications, color substrate.

**I. A. Sysuev, I. V. Prud, O. E. Serdyuk, V. V. Skitchenko, K. V. Vasilevich, K. A. Epifantseva, M. F. Fedorchuk**  
**Upgrading software tool method for estimating saturation of text in printed publications made on the color substrate**

The article considers issues that relate to the creation of attractive and readable external graphic image of a page in printed publications. For evaluation of the graphical image of page one of the important parameters is contrast. The improved software tool and method for estimating saturation of the text in printed publications is provided taking into account the color of the substrate (paper). The change of the contrast of graphic image on the page is shown when using colored paper.

Keywords: a graphic image of the page, print publications, contrast, saturation of text, a method for estimating the saturation of a text of printed publications, color substrate.

**N. P. Badalyan, A. A. Mitrofanov, E. A. Chaschin, L. I. Shemanaeva**  
**The method of development of mathematical models  $\alpha$ ,  $\beta$  for adjoint electrical systems by correction of steady-state operation mode**

A method of development of mathematical models of  $\alpha$ ,  $\beta$  entail EDCS in correction mode of power system steady-state combination Tellegen and decomposition theorem is considered.

Keywords: correction, theorem, system, node, branch, location, setting, current, voltage.

**V. V. Kharlamov, M. F. Baysadykov, A. S. Khloptsov**  
**Estimation of wear intensity of electrical DC machine brush by method of analysis of dust particles**

The article discusses the research of intensity of brush wear for DC electrical machines from the changes in the electrical and mechanical factors. The intensity of the brush wear is estimated using the method of particle size analysis. Experimental study and formulate the regression equation for the intensity of brush wear is done.

Keywords: DC machine, electric brushes, brush wear, collector and brush assembly, the method of particle size analysis.

**V. P. Beloglazov, L. V. Beloglazova, I. E. Chavrikov, N. N. Roschin**  
**The influence of axial symmetry «sombbrero» on the IVAC efficiency indicator**

The main idea of this work is to identify the impact of the shift in performance indicator of ash collector. This work is important for the realization of the IVC industrial model. The best efficiency is achieved when the correct size, proportions and the ratio of one element to the other, it is very difficult to design in life. There are calculated various options for testing to identify deviations

from the collection efficiency of the primary results in vibrations sombrero because of the high flow rates of exhaust gases. Developing apparatus IVAC performs on the instructions of the fund «Energy without frontiers.»

Keywords: ash collection, inertial vacuum ash collector, IVAC, design.

**A. L. Kashtanov, A. A. Komyakov, T. V. Komyakova**  
**Performance analysis of smoothers in traction substations of DC electrified railways using measurement systems**

The paper presents the results of performance evaluation of smoothers in traction substations of Podvoloshnaya — Shalya area according to the measuring systems installed on converter units and catenary feeders. An experimental frequency response of smoother is made. Recommendations for improving the schemes of smoothers are presented.

Keywords: traction power supply, smoother, energy accounting, direct current.

**Yu. V. Kondratyev, A. V. Tarasenko, A. A. Komyakov, V. L. Nezevak**  
**Calculation of parameters of series compensation of reactive power in traction AC**

The technique for parameters definition of the reactive power compensation series devices in traction power supply system of AC electric Railways is developed.

Keywords: traction power supply, alternating current, reactive power, series compensation device, options.

**O. A. Lysenko, V. V. Sushkov, V. V. Timoshkin**  
**The appraisal coefficient of efficient oil pumping units of well pad pump station by genetic algorithms**

A method for identifying pumping unit of well pad pump station (WPPS) efficiency of the station is based on genetic algorithms and data received from sensors of temperature, pressure, flow. The approbation of the proposed method is on the basis of experimental data obtained from operating units. A distinctive feature of the proposed method is the identification of other efficiency pumping unit with limited information about the physical quantities of the fluid.

Keywords: oil pumping station, genetic algorithms, identification.

**A. I. Antonov, M. G. Vishnyagov, Yu. M. Denchik, D. A. Zubanov, V. I. Kleutin, A. A. Ruppel, A. A. Sidorenko**  
**The analysis of definition of conductive low-frequency interference with non-sinusoidal voltage curve factor**

There are described tests on JSC «Plant of fasteners». The article describes a method of processing the results of experimental studies of quality of electric energy by means of software in the development environment LabVIEW. The analysis of compliance with total harmonic voltage components is done in each phase area of the enterprise requirements of GOST 32144-2013.

Keywords: power quality, non-sinusoidal voltage coefficient, electromagnetic interference, waveform voltage, statistical data processing.

**A. V. Ded, S. V. Biryukov, A. V. Parshukova**  
**Simulation in Matlab long asymmetrical modes of power supply systems**

The article describes the implementation in the environment of Simulink (Matlab) long asymmetric mode portion of the distribution network voltage of 0,4 kV. The model and algorithms for calculating the energy parameters of the power supply system are reproduced by applying the math packet in Matlab and Simulink library blocks SimPowerSystem.

Keywords: power quality, simulation model, unbalanced load, the power loss.

**T. A. Novozhilov, A. N. Novozhilov, A. P. Popov, N. V. Malinin**  
**Overcurrent protection on the balanced magnetic switch**

In the article is suggested a simple conception of overcurrent protection on the balanced magnetic switch of electrical lines and devices. Removable elements of this conception are cheap and it allows us to successfully use it to short-circuit failure protection in a wide range of dynamic current, where there are no current transformers or they cannot be installed. For this implementation is developed a mathematical model of the magnetic field broad band, which allows to calculate parameters of overcurrent protection on the balanced magnetic switch with a fine precision.

This is allow to assess impact of protection on the balanced magnetic switch in busbars adjacent phases. The parameters of removable element is given, as well an example of calculating and setting the threshold of overcurrent protection on the balanced magnetic switch also is given.

Keywords: protection equipment, overcurrent protection on the balanced magnetic switch, mathematical model of the magnetic field busbar.

**P. V. Petrov, E. M. Rezanov, V. R. Vedruchenko, A. P. Starikov**  
**Determination of optimum thickness of thermal isolation of the protecting designs of buildings at capital repairs**

The technique and algorithm of determination of optimum thickness of warming layer of protecting building designs at capital repairs is offered. Scientific development considers normative documents on thermal protection of buildings and justification of the applied economic decisions.

Expediency of application of the offered algorithm allowing to lower the given expenses of the heat preserving actions at capital repairs of buildings is proved.

Keywords: efficiency, expenses, thermal energy, heat transfer, thickness of protections, temperature.

**I. A. Batyrev**  
**The influence of carrier frequency offset on quality of received OFDM signal**

This paper provides the analysis of influence of carrier frequency offset on OFDM signal. There is considered influence of shear on the quality of the received signal. Recommendations on synchronization accuracy to ensure good reception are given.

Keywords: carrier frequency offset, OFDM, inter-channel interference.

**D. A. Boreyko**  
**The advanced approach to modeling integral components of the LC filters**

The paper suggests ways to improve the approaches to the design of integrated LC filters to reduce overall development time devices. An attempt to answer questions regarding the implementation of integrated components is done. There are proposed improvements tested in the simulation of two bandpass filters, presented data on their electrical parameters.

Keywords: integral LC filter, multilayer integrated components, design approach, electromagnetics simulation.

**A. V. Nikonov, A. V. Milykh**  
**The model of automated process control (lighting) at enterprise**

The approach uses automated control system as the core of an individual process of the industrial enterprise. The structure of the process is presented in generalized form both analog and discrete model. To build the model they used the method of analogies.

Keywords: model, automatic control system, adaptive system, decision box, algorithm.

**I. M. Zuga**  
**Computer-aided process facilities layouts design under multicriteria optimization**

Computer-aided plant facilities layouts design scheme is proposed. Schemes synthesis is performed based on a range of quality criteria in two phases. System algorithm stipulates three ways for initial solution generation: interactive and automated modes. Corresponding Delphi 7 software is developed.

Keywords: mutual arrangement of facilities, scheme design automation, optimization.

**I. M. Zuga, V. G. Khomchenko**  
**Automated calculation of distances between the facilities at sight check with due regard to their multivariant mutual arrangement**

The forms of subareas prohibiting to locate in them the center of other facility from the couple of facilities under consideration have been determined in respect to the accepted geometrical images of the facilities in the plan. Algorithms to perform automated calculation of actual distances between the facilities at sight check with due regard to the combinations of geometrical images of facilities from the couple under consideration and their mutual arrangement have been obtained.

Keywords: topology of admissible area, multivariance of mutual arrangement of facilities, algorithm to calculate distances.

**A. M. Purtov**

**Methods and means of analysis of auto-transport networks in GisAuto**

The ways of application of taxonomy, reduction of graphs, simulation and geoinformation systems are developed for the analysis of routes in auto-transport networks. The technology is shown on examples of the analysis of popular routes of Omsk. The example of construction GIS — maps the graph of delays on a route is resulted. The method of a reduction of graphs receives estimations of the influence of delays on the time of travel on a route. Examples of the use of developed methods and means are shown.

Keywords: geoinformation system, simulation, reduction of graphs, taxonomy, analysis of data, auto-transport networks.

**A. E. Ultan**

**About «The intellectual triple-purpose computer components» and the main factors influencing its design**

The article is devoted to design of intellectual computer components of threefold appointment. There is explained the meaning of «The intellectual triple-purpose computer components». The work contains definition of algorithms separable from knowledge and inseparable from knowledge.

Keywords: component, education, Internet.

**A. V. Abramova, A. G. Topazh, L. A. Khvorova**

**Symbiotic nitrogen fixation features research and simulation model developed by AnyLogic software**

There is considered the model of symbiotic nitrogen fixation by legumes, which describes the biomass of shoots, roots, nodules and soil nitrogen dynamics. The model presents the system of differential equations. The total stock of available nitrogen and carbon for growth is distributed between roots and shoots in a certain proportion. The numerical analysis of characteristics of symbiotic nitrogen fixation is made in software environment AnyLogic.

Keywords: nitrogen fixation, soil mineral nitrogen, legumes, environmental conditions, algorithm, model.

**A. V. Boyarskaya, L. A. Khvorova**

**Recovery characteristics of thermal regime of soil in one and two-dimensional problems with interface**

The objective is to consider the following problems: temperature distribution in the soil with heterogeneous structure of its layers; determination of thermophysical characteristics of the soil — heat capacity, thermal conductivity and thermal diffusivity of leached black earth soil in Altai area of the River Ob; the algorithm and the numerical method for solving a two-dimensional problem of the soil thermal regime with the interface between the two regions with different thermophysical parameters. Temperature and heat-flux continuity conditions are established at the interface between soil compartments. The numerical method with the use of the longitudinal and transverse finite-difference scheme, that is the alternating direction method, is applied to the numerical solution of the problem. Problems of determining thermophysical coefficients at different values of moisture and diurnal and seasonal ranges of thermophysical parameters, which depend on soil moisture and density, are discussed.

Keywords: soil thermal regime, heat capacity, thermal conductivity, thermal diffusivity, model, finite-difference scheme.

**A. V. Leonov, V. A. Chaplyshkin**  
**Flying Ad Hoc Networks (FANETs)**

In this paper, Flying Ad Hoc Network (FANET) is a novel mobile ad hoc network type where the communicating nodes are Unmanned Aerial Vehicles (UAVs). The article talks about the FANET communication protocols and open research issues are presented. We survey the existing FANET protocols proposed for the physical layer, medium access control (MAC) layer, network layer, transport layer.

Keywords: mobile ad hoc networks, unmanned aerial vehicles, UAV, peer-to-peer networks, FANET, Flying Ad Hoc Network.

**I. P. Ubalekht**

**Properties of relationships for problem of design schemes of relational databases**

This paper investigates properties of relationships. There are introduced the following concepts: "Domain of definition of relationship", "Range of relationship", "Composition of relationship" and design matrix of composition of relationship. There is developed method of design of schemes of relational databases base on relationships and properties of relationships.

Used composition of relationships allows logical conclusion new relationships and give more convenient way for design schemes of databases.

Keywords: design of schemes of relational databases, schemes of relational databases, data models, ER-model.

**PHYSICAL AND MATHEMATICAL SCIENCES**

**V. N. Zadorozhnyi**

**Fractal queues simulation Peculiarities using GPSS World. Method ARAND**

Relevant to the modern theory of computer networks design questions of developing adequate service mathematical models of fractal traffic are considered. To solve the problem of realization of HTD, the method ARAND (Accurate RAND) proposed. Micro-defects revealed the mechanism of promotion time in GPSS World. Recommendations on modeling GPSS fractal systems with queues develop.

Keywords: Fractal traffic, queueing theory, simulation, random number generators.

**A. V. Zakurdaeva, E. V. Rezanova**

**Numerical investigation of the influence of external pressure on the dynamics of fluid spherical layer**

In this paper the results of investigations of a non-stationary problem of dynamics of a layer of the viscous incompressible fluid with free boundaries are presented in the spherically symmetric formulation. Dynamics of the spherical layer is determined by the thermal and inertial factors. A numerical solution algorithm for this problem is constructed. The results of numerical experiments for liquid glass containing a bubble of carbon dioxide are presented. The effect of the external pressure on the formation of the microspheres and temperature distribution is studied.

Keywords: spherical layer, viscous fluid, free boundary, numerical algorithm, mathematical modeling, heat transfer.

**A. V. Gerasimov, S. V. Pashkov,**

**Yu. F. Khristenko,**

**R. O. Cherepanov**

**Numerical simulation of grid and gridless method of collision of group of particles with the glass**

Study of deformation and fracture of glass when interacting with streams of technological and natural debris is necessary both in terms of preserving the integrity of the spacecraft on impact of large fragments, and to reduce the erosion of structural elements under the flow of ultrafine particles. The paper presents the mesh technique, based on the combined use of the method of Wilkins and the method of Johnson and meshless method based on SPH method. It is reviewed collision group of seven steel balls with a two-layer glass plate. A comparison of features of the two methods in modeling fracture process of glass elements.

Keywords: numerical modeling, mesh and meshless methods, blow, glass.

**A. V. Mischenko, Yu. V. Nemirovskiy**

**Decision making for dynamic tasks of composite rods by Bubnov–Galerkin method**

The decision of the initial-boundary dynamic problem of the composite visco-elastic rods by Bubnov–Galerkin method is suggested. The basic dynamic equations system is obtained taking into account the average shear deformation and external medium interaction. By Furie's method the problem is transformed to decision of the matrix equations for the vector time-functions represented the displacement. The basic coordinate functions are used in this method.

Keywords: composite rod, transverse-layered structure, dynamic influence, rigid characteristics.

**L. A. Merzhievskiy**

**Modeling of relaxation effects in shock wave processes in condensed environment**

Based on the model of the Maxwell viscoelastic body, combining the advantages of a continuum description and microstructural mechanisms of irreversible deformation, relaxation processes which realized in shock compression of condensed matter are analyzed. There is considered the split-off and attenuation of elastic precursor, the relaxation of shear stresses in the shock front, relaxation processes in a thin layer and in interaction of shock waves with rarefaction waves, in shock compression of porous and composite media, in impact of intense energy beams.

Keywords: shock compression, viscoelastic medium, relaxation, shear stresses.



**V. A. Bepalov, T. B. Gotselyuk, N. A. Kovalenko, I. P. Olegin**  
**Progressive damage model application for strength estimation of laminate carbon-filled plastics with different stress concentrator**

The progressive damage model approach for strength estimation of laminate carbon-filled plastic specimens with different stress concentrator by finite element method is submitted. The analysis of influence of finite element size and loading step on estimation of the result by this approach is implemented. Computational strength results for specimens with a hole, a countersink hole, a hole filled by bolt and series of holes subject to selected finite element mesh and load step for tension case is represented.

Keywords: laminate, progressive damage model, failure criteria, finite element method.

**E. I. Kraus, I. I. Shabalin**  
**The influence of ground structure on processes of deformation and fracture under impact**

Modern spacecraft with the thermionic converter shoots off a nuclear powerplant (NPP) in emergency. However, there is a possibility that part of the reactor containing the nuclear fuel, despite the considerable thermal and mechanical stresses going through dense atmospheric layers can reach the surface of the Earth. The reactor can come up against both the water surface and rock formation or soft ground, since the surface of the Earth is various. In this article, we attempt to construct a model of a ground structure massif, which by its strength characteristics would meet soft rocks. We calculated the crash of the model NPP to the surface of homogeneous structure (sandstone) and a non-uniform discrete structure (blocks of granite-related cement weight) and a comparison of calculation results.

It is shown that the structure of the earth's surface, significantly affects the process of destruction of the reactor and the medium itself, as there are differences in the speed of propagation of compression waves. Therefore, there is a need to study the wave and strength properties of discrete block ground, as this will further more realistically predict the results of the destruction of the reactor.

Keywords: shock waves, deformation and fracture, interaction of solids.

**E. V. Amelina, S. K. Golushko, V. S. Erasov, S. V. Idimeshev, Yu. V. Nemirovskiy, B. V. Semisalov, A. V. Yurchenko, N. O. Yakovlev**

**Deformation of polymers and carbon fiber reinforced plastics: the analysis and processing of experimental data**

The article is concerned with the development of mathematical framework for processing and analysis of experimental data obtained from tests of polymer matrices and polymer composite materials. The analysis of the experimental data is carried out and methods for elimination of experiment's and measurement artifacts are proposed. Several approaches to the experimental data approximation are considered. One of them is based on the polynomial and piecewise polynomial approximation, other one uses methods without saturation. A comparison of the effectiveness of mentioned methods of approximation of the diagrams of deformation of polymers and carbon fiber reinforced plastics are carried out.

Keywords: polymers, carbon fiber reinforced plastics, deformation diagram, experiment data processing.

**P. A. Radchenko, S. P. Batuev, A. V. Radchenko, V. S. Plevkov**  
**Numerical simulation of deformation and fracture of space protective shell structures from concrete and fiber concrete under pulse loading**

This paper presents results of numerical simulation of interaction between aircraft Boeing 747–400 and protective shell of nuclear power plant. The shell is presented as complex multilayered cellular structure comprising layers of concrete and fiber concrete bonded with steel trusses. Numerical simulation is done three-dimensionally using the author's algorithm and software taking into account algorithms for building grids of complex geometric objects and parallel computations. The dynamics of stress–strain state and fracture of structure were studied.

Keywords: numerical modeling, finite element method, reinforced concrete, protective shell.

**M. A. Legan, V. A. Blinov**  
**Combined use of boundary element method and nonlocal fracture criteria**

Numerical algorithm for the strength of plane construction elements is constructed using the gradient fracture criterion and the boundary element method (the fictitious stress method). Calculation results obtained using the criterion of maximum stress, gradient fracture criterion, integral fracture criterion by Neuber-Novozhilov and three-parameter integral fracture criterion are compared both among themselves and with the experimental data.

Keywords: brittle fracture, stress concentration, non-local fracture criteria, experimental data.

**V. A. Taran, G. S. Russkikh, Z. N. Sokolovsky, A. Ju. Kondyurin**  
**Modelling of mechanical characteristics of thin wire after drawing (for example, stainless steel 321 (X10CrNiTi18-9))**

The object of study is a thin wire for the production of plate-carrying nets of mesh panels.

Experimentally on the example of steel 321 (X10CrNiTi18-9) and on the basis of rheological model there is shown that due to significant residual stress from the wire drawing mechanical characteristics significantly different from those of steel. There are presented methods of evaluation of the average values of residual stresses tangential module loading and unloading of the tensile stress, yield strength and tensile wire proportional characteristics of steel and the initial modulus of loading and unloading.

Keywords: wire, elastic modulus, residual stress, yield strength, proportional limit, drawing.

## CHEMICAL SCIENCES

**T. A. Didenko, A. O. Bogdanova**  
**Acid and alkaline activation of carbon-mineral material and its application for extraction of copper (II) ions from water solutions**

Activation of the carbon-mineral material received by sapropel carbonization is carried out by solutions of sulfuric acid and sodium hydroxide. The activation conditions leading to development of porous structure of carbon-mineral material are chosen. Mechanisms of acid and alkaline activation of carbon-mineral material are offered. Sorption ability of the activated samples in relation to sorbates of the organic and inorganic nature is defined. Comparison of the sorption properties of activated and initial materials are carried out.

Keywords: activation, carbon-mineral material, porous structure, sorption, copper ion (II).

**S. O. Podgorniy, O. T. Podgornaya, E. D. Skutin**  
**Studying adsorption of carbon monoxide on the components of the ZnSe–CdTe system by IRS MDCIR**

Adsorption of carbon monoxide on powders of solid solutions and binary compounds of the ZnSe–CdTe system is studied by IR-spectroscopy of multiple disturbed complete internal reflections. The adsorption of CO takes place by a donor–acceptor mechanism with surface atoms as acceptors. The stabilization of formed  $\sigma$ -bonds is caused by the dative interaction for CdTe and  $(\text{ZnSe})_x(\text{CdTe})_{1-x}$  solid solutions.

Keywords: semiconductors, solid solution, adsorption, IR-spectroscopy

**G. I. Razdyakonova, E. A. Strizhak, N. S. Mityaeva, M. N. Nagornaya**  
**The influence of oxidation of carbon black N326 on properties of rubber**

The results of comparative tests of the properties of rubber compounds and their vulcanized rubber, filled with oxidized of carbon black N326 and K354 are given. The correspondence to their degree of dispersion, speed of dispersion and vulcanization, dynamic indices of the properties of rubber is shown. Is established the prospect of the direction of the oxidizing modification of carbon black of N326 for import substitution of K354.

Keywords: carbon black, oxidation, rubber compounds, vulcanized rubber, deformation, hysteresis losses.