

Elastic linkage in joints with motion translation device

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The paper considers the vibration isolation systems containing levers of the first and second kind. The change in dynamic properties of mechanical vibratory systems containing the above-mentioned lever-type links is estimated. Based on the comparison of two systems, having the levers of the first and second kind, it has been concluded that both systems will have similar natural oscillation frequency while the dynamic damping frequency and the dependence of the frequencies on the system parameters will be different. It has been shown that when we have the levers of the second and first kind both types of vibration isolation systems are «locked up» at high frequencies, however, the levels of «locking» will be different. Besides, the system with the lever of the first kind behaves as a conventional system with one degree of freedom possessing the dynamic properties characterizing such systems. It has also been demonstrated that the registered differences being introduced into the system of levers of the first and second kind show themselves in schemes with kinematic excitation.

Keywords: vibration isolation system, lever-type link, dynamic damping, transfer function.

Vibration protection for pendulous solid body. Taking into account lever-type links

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The method of constructing mathematical models for the vibration protection systems with angular oscillations of the protected object in the form of a solid body is proposed. The method is aimed at taking into account the relationships between movement coordinates, which are determined by the type and parameters of the lever-type links. It has been shown that presence of the lever-type links is related to specific angular motions of the protected object. Besides, the lever acts as a standard linkage forming the system's spatial geometry (or metric). Thus, the mathematical model of the vibration protection system, having the protected object in the form of a pendulous solid body, reflects the characteristic features of the system. The lever type has a significant impact on the redistribution of interactions in case of several external actions. This is reflected in creating the frequency equation of the transfer function numerator. The technique for constructing transfer functions under different kinds of external disturbances is proposed. A number of examples is given.

Keywords: vibration protection systems, protection object, transfer functions, dynamic damping.

Rotary vibratory mixer with twin three-frequency elliptic type vibrator

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The new design of a rotary vibratory mixer with a twin three-frequency elliptic type vibrator has been proposed. It allows implementing the possibility to generate vibration action of multidirectional fluctuations throughout the chamber, where the concrete mix components are mixed, and to completely exclude the presence of dead zones. The impact is exerted by three vibrational fields identical in amplitude and different in frequency, evenly distributed throughout the mixing chamber that results

in qualitative intensification of the process of components mixing. The mixer design consists of two vibrators equipped with the midsection disk structural elements and pushers capable of generating vibrations of vibrator housing from the least corrugation. This ensures homogeneous peaks of the each point displacement values for external generatrices of the corrugated metal sheathes, thus enabling to realize a homogeneous distribution of the vibrational field in the mixing chamber. Besides, under the multi-frequency vibration, a high-quality intensification of the process of components mixing is implemented. It consists of simultaneous influence of the oscillations of two or more frequencies on the concrete mix and allows increasing the velocity of the mix particles movement under the imposition of propagation curves, which, in turn, increases vibration efficiency. Taking into account the fact that each grain size has its natural frequency, the multi-frequency vibration can be considered as a tool to influence on the largest number of grains, i.e. the intensity of the multi-frequency vibration is higher than that of each of the component fluctuations, thereby allowing you to reduce the mixing cycle of concrete mixes.

Keywords: concrete mix, corrugated sheath, vibration, vibrational field, vibrator, amplitude, frequency.

Airless tires. Development practice and testing results

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A wheeled running gear is a simple and most effective mechanism for converting rotary motion into linear one for a ground wheeled vehicle. However, a pneumatic tire has a significant disadvantage consisting in stopping the vehicle due to the loss of excessive air pressure in a tire that may lead to a serious traffic accident. Another drawback is the complexity of the pneumatic tire manufacturing processes and large amounts of energy to utilize them. Advances in polymer chemistry allow you to develop a new design of tires, and their performance is ensured not by the compressed air pressure but the physical and mechanical properties of structural materials used, for example, elastic polyurethanes. At the Motor Transport Department of Bratsk State University, the airless tire designs and experimental models have been developed and manufactured. To manufacture the airless tires, the two-component injection molding hot curing polyurethanes were used. The tire tests were carried out both at the test desks of the department and on a car. The assessment of elastic and damping properties of the airless tires was performed by the normal stiffness characteristics constructed in the quasi-static loading mode. The impact of new airless tire designs on the vehicle performance characteristics was assessed using the expert criteria in terms of vibration level, noise, motion stability, steering response, road holding. The experimental results allowed selecting the most appropriate polyurethane compounding, developing the technology for manufacturing tires and wheels, making rational changes in tires design and improving their technical performance. Application of elastic polyurethanes allows solving the problem of the decommissioned tires reuse and, thereby, making the problem of their disposal less urgent. The proposed solution is based on replacing the compressed air with elastic polymeric elements in the form of non-closed rectangular in cross section rings, which are mounted inside the worn or substandard tires. In order to justify the size of the elastic elements cross section and their number for a particular vehicle wheels, the computational studies have been conducted. For experimental verification of the design decisions and calculations, a prototype was made based on the worn by 90% Dunlop 235/75 R15 tire with the installed polyurethane rings. Experimental studies were carried out at the wheel test desks of the Department, the results being reported in the form of the normal stiffness characteristics and dependencies between the inelastic resistance force amplitude and tire deflection to assess elastic and absorption properties. The paper shows that new designs of the airless tires are quite efficient and allow us to solve the problem of disposing of sub-standard tires and vehicles safety, their characteristics being substantiated by calculation and proved experimentally.

Keywords: wheeled running gear, airless tire, flexible polyurethane, experiment, calculation.

Modeling and assessment of hydraulic shock absorber damping capacity

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A hydraulic shock absorber in the vehicle suspension acts as a major damping element. That is why the assessment of the ride quality and vehicle vibration loading and, therefore, the convergence of the calculation results and the field tests data will depend on the modeling accuracy of its damping capacity. In the paper, the construction of the inelastic resistance model in the hydraulic shock absorber is carried out using mathematical tools of the elliptic power-law model of the pneumatic tire absorption capacity, which was previously developed and thoroughly theoretically and experimentally proven. This is justified by the analysis of the operating charts of different shock absorbers, which reveals significant similarity of the closed curve chart and an ellipse line both on the compression stroke and the shock absorber rebound. Besides, semi-diameters of semi-ellipses match with the coordinate axes, and their values will depend on the maximum speed and the piston movement amplitude. The assessment of the inelastic resistance parameters of the absorber's sample model was conducted by statistical processing of

experimental measurements diagrams constructed for different piston peak-to-peak values and speed and in the amount sufficient to provide statistical reliability of the results using the regression analysis techniques. The experiment was conducted on the hydro-pulsating test desk of the Motor Transport Department of Bratsk State University. The analysis of the experimental diagrams shows that the peak value of the drag force both during the compression stroke and the shock absorber rebound does not depend on the amplitude values of the piston stroke, i.e. it can be assumed that the respective exponents are equal to zero. The dependence of the drag force peak value on the piston speed amplitude values is the power function in nature. This confirms the correctness of the provisions adopted in the mathematical model development.

Keywords: hydraulic shock absorber, damping capacity, testing, elliptic power-law model, hydro-pulsating test desk.

Design and calculation of automobile airless tires

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The simplicity and high efficiency of a wheeled running gear as a mechanism for translating rotary motion into reciprocating one have made for its wide automotive application, including cars. However, a pneumatic tire has a significant disadvantage consisting in stopping the vehicle due to the loss of excessive air pressure. Furthermore, the loss of excessive air pressure in a pneumatic tire of the traditional design when driving a motor vehicle with high speed can result in a serious traffic accident. Therefore, the creation of new designs of the airless tires made of flexible polymers able to increase traffic safety as well as the development and improvement of the methods of their calculation are currently the pressing tasks. With financial support of the Ministry of Education and Science of the Russian Federation in the framework of the research "The development of automotive airless tires", the mathematical model of the radial-type deformation process of the airless tires with flexible spokes made of elastic polyurethanes was developed to solve the performance targets. This allows assessing its elastic properties and constructing the normal stiffness characteristics at the stage of designing a wheeled running gear.

Keywords: tires of increased safety, bullet-proof wheels, tires made of elastic polyurethanes, normal stiffness coefficient, flexible spokes, longitudinal bending.

Principles of developing the new designs of variable stiffness joints

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The article states the principles of developing the new designs of variable stiffness joints. The expediency of using such joints in the vehicles, which are operated in difficult road conditions, as well as in technological machines when there is the need to change the stiffness parameters of the machine while in operation has been proved. The rational variation ranges of the stiffness parameters for such joints have been determined. Through the example of one of the joint design variations, its structure has been examined, and the dependencies by which the total stiffness and the parameters variation ranges are selected have been produced. The principles for developing new designs have been formulated, which include the following stages: defining the field of joint application in the machine, the choice of design options of the joint structural schemes, the total stiffness distribution between the joint's elastic elements, the performance criteria definition, the choice for the optimal joint connection that meets the specified requirements. The sequence for the performance criteria by the example of the elastic coupling element (sleeve) calculation has been given. The computational scheme has been developed under the assumptions made: the sleeve is evenly compressed; the sleeve is considered as a long thin-walled cylindrical shell. The strains and stresses in the sleeve, which is loaded by the external pressure arising at twisting the torsion spring in the variable stiffness joints, have been determined. The problem was solved by the overlay technique. The obtained expressions (9) – (20) make a scientific basis for further research and development of new joints designs with the specified range of stiffness variation and load capacity of the vehicles elastic elements.

Keywords: variable stiffness joints, bending theory of axisymmetric cylindrical shells, internal force factors.

Design calculation of shell-plate saddle of flange sealing joint

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The design calculation of a shell-plate saddle of a flange sealing joint has been considered – a statically loaded shell-plate saddle taking into account the fluid pressure action based on the design and checking calculations (the fluid pressure action taken into consideration) of the valve sealing joint. The analytical calculation conducted according to the proposed technique can be used as a test one to verify the results of the finite element modeling. The technique to determine the rational geometrical sizes of the shell-plate saddle of the flange sealing joint implemented in the PTC MathCAD and allowing minimizing the sealing force on the saddle that provides reducing the overall and mass drive parameters and joint in general has been proposed. The calculation of the saddle geometrical dimensions has been presented as an algorithm consisting of three logically interconnected parts: 1) stiffness calculation; 2) strength calculation; 3) calculation of the saddle rational dimensions. The implemented calculation is fully automatically controlled and requires only the initial data to be specified at the start. The results obtained by calculating the geometric dimensions are being tested that eliminates errors in the computational block Given PTC MathCAD. The schemes of loading the shell-plate saddle considering the fluid pressure action performed in the automated systems of calculation and design APM WinMachine and MSC. vN4W.

Keywords: shock loading, elastic elements, geometrical parameters optimization, flange sealing joint, shell-plate saddle, stiffness, strength calculation of thin-walled structures.

The account of hardening material characteristics in applying of Meyer's empirical law

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The technique for determining the contact characteristics depending on the elastic-plastic material properties with Hollomon's hardening power law $\varepsilon_y = \sigma_y / E^$ and the hardening exponent n has been proposed. Besides, Meyer's empirical law, which connects the force arising at indenting a sphere having indentation diameter d has been used. Initially, the Meyer law has not been associated with mechanical characteristics of the material being tested. The relationships between the hardening exponent n and the Mayer law's constant m developed by S.I. Bulychev have been used in the study. To take into account the «sink-in/pile-up» effects, the parameter $c^2 = h_c / h$ has been used, where h_c is the depth at which the sphere contact occurs, h is the indentation depth relative to the original surface level. The application limits of the proposed expressions have been defined. The lack of necessity to determine the Meyer law's constants has been shown. The comparison of the obtained and published results of the finite element analysis of sphere indentation into the elastic-plastic hardenable half-space has been produced.*

Keywords: sphere indentation, elastic-plastic contact, hardening of material, hardening exponent, Meyer's law.

Developing the mathematical model of contacting a short cylindrical shell and a cone

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The structural contact problem of indenting a hard cone into the short end of a cylindrical shell has been considered. This problem arises in the performance analysis of sealing joints, pick up fittings, centering or damping devices where a cone and a cylindrical shell can be used. In the process of loading, the contact between the plug and the shell can be transformed from the line contact to the surface one and vice versa, which determines (except for the friction force reverse) the deformation process nonlinearity. The description of the deflected mode must be performed in the framework of the Timoshenko – Reissner model, which allows avoiding the generation of the concentrated forces at the contacting boundaries as in the case of using the Kirchhoff-Love model. It is proposed to use the new normal fundamental functions for solving the shell deformation equation

under the Timoshenko-Reissner model similar to A.N. Krylov's functions used to solve the shell deformation equations in the framework of the Kirchhoff-Love model. The variations of the shell deformation equation under the Timoshenko-Reissner model relative both to the normal rotation angle to the middle surface and the radial movement of the shell middle surface points are given. The expression for the force with which the cone is indented into the end shell has been produced under which the line contact is changed into the surface one.

Keywords: contact problem, Timoshenko-Reissner shell, joint, A.N. Krylov's functions.

Forces in coupling engagement of end gear

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The knowledge on geometry, kinematics and force interaction determine the strength calculation of any coupling engagement type. An important factor in proper evaluation of the engagement performance is the correct interaction assessment: the forces acting in the engagement, their value and contribution to a particular negative effect. The paper seeks to review the forces generated in the coupling engagement of the end gear and the choice of the force components necessary to carry out further calculations and determine the characteristics. Using geometric constructions and trigonometric relationships, the expressions to identify each component have been produced. The decomposition of the normal force value into the radial and circumferential components has been applied by analogy with the known engagement types and as the most convenient one from the point of view of evaluating the individual components of the available data (torque, the wheels diameters). A distinctive feature of the calculation is the fact that the normal force value taken for further calculations depends on two parameters, the combination of which must eventually produce the maximum normal force. These parameters are the peripheral force and the angle between the normal and tangential components. The study has revealed that the maximum normal force is at the points close to the gear teeth inner circumference. The angle between the directions of the normal and tangential component at the given point has been uniquely defined for each ratio of the diameters of the gear pitch circles. With the increase of this ratio, the angle decreases. Thus, the dependences to determine the forces in the end gear coupling engagement have been obtained that will further allow determining the permissible contact and bending stresses.

Keywords: end gear, engagement forces, profiles interaction.

MODELING AND CONTROL IN MECHANICAL SYSTEMS

Analysis of draft loading balancing schemes for alternating current railroads

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The two-phase draft loading balancing schemes for alternating current railroads have been analyzed by means of computer modeling using the Fazonord-Kachestvo program. The Scott and Shtaynmets schemes as well as B. M Borodulin two-phase unbalanced-to-balanced transformers were considered. It has been shown that the most preferable is the Shtaynmets scheme demonstrating the following advantages: the possibility to balance both two-phase and single-phase loading; decrease in reactive electric power consumption; full utilization of a three-phase transformer rated power; low error sensitivity of the circuit parameters. It has been revealed that to implement the Shtaynmets scheme, it is necessary to connect three adjustable reactive elements to 27.5 kV phases.

The study has been performed within the framework of the scientific research "Intellectual Networks (Smart Grid) for an Effective Power System of the Future". Contract No. 11.G34.31.0044 of 27.10.2011.

Keywords: systems of railroads power supply, unbalanced-to-balanced transformers.

Interval simulation for power systems emergency modes

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When simulating normal and emergency modes of power systems (EPS), the parameters of power elements are determined according to the passport, design or reference data. Besides, the considerable number of assumptions is used, in particular, the parameters are considered to be invariable or low time-varying. At the same time, it is known that the parameters mentioned depend on many factors and can undergo noticeable changes while in operation. Therefore, to correctly analyse the EPS, the mathematical models taking into account the uncertainty of initial data are required. One of the most effective means to consider the uncertainty is the interval analysis method. The article considers the issues of applying the interval analysis to calculate the EPS emergency modes. Unlike the well-known researches in the sphere of the EPS interval analysis, where the one-linear statement is used, the article proposes more general approach based on the use of phase coordinates and applicable to determine the asymmetrical set modes as well as the problems of short-circuit currents calculation in case of asymmetrical damages. The interval determination technique of the short-circuit currents based on use of phase coordinates and the latticed equivalent circuits from the RLC-elements connected by the complete graphs schemes has been proposed. Based on the computer-aided simulation and according to the developed experimental application «IntCALC», it has been shown that the interval analysis is an effective way of taking into account the initial data uncertainty when calculating the EPS emergency modes. This problem becomes topical at the present stage of the power industry development characterized by the large-scale introduction of digital protective relays and system automatic equipment.

Keywords: electric power systems, emergency modes, interval simulation

New technologies to improve the energy efficiency elements of production equipment

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When carrying out the drying process, the major task is to ensure the uniform moisture removal from wood at minimal energy consumption. As to their design, most of the convection drying chambers are equipped with the upper and lower circulating channels separated by a false ceiling. The energy carrier circulation in such drying chambers occurs in a closed circuit with a U-turn flow at 180 degrees. This flow is turbulent and characterized by the presence of swirlings and uneven distribution of the working agent on the cross section of the drying chamber. All of these factors have a negative impact on the quality of drying as a whole and make up a prospective area of scientific research contributing to solving the problem of energy efficiency and the timber drying time. In conducting experimental studying of the direction and speed of the working agent flow, it turned out that the rate of speed differs considerably as to the vertical interval of the lower circulating channel. Since the energy supply to the material being dried depends on the working agent velocity, it is evident that the final moisture content deviation from the specified one will be observed in the timber storage pile, which, in turn, is the cause of technological waste. To align the working agent flow, a series of experiments to select the configuration, the number and location of the guide device for aligning the input profile was carried out. In the end, the most rational distribution of the velocity profile when installing two guiding devices has been obtained. Knowing the power rating of the drying chamber and the timber drying time, with the working agent flow being aligned through the storage pile height, one can optimize the operating characteristics of the chamber, namely, to reduce the drying time by 10-15 hours per cycle and lower the defective products up to 6%, electricity and heat saving will reach 15-20 %.

Keywords: guiding devices, chamber aerodynamics, computing experiment, working agent velocity fields, timber moisture content, drying processes.

Model of the system of strains and cut-down layer deformation parameters in the cutting zone

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The interrelation of the cut-down layer strain with the stress distribution in the cutting area and the tool wedge loading have been considered. The investigation results of the cutting process contact characteristics when turning heat-resistant steels and alloys in the technologically appropriate range of the operating modes variation have been given. The current state of the problem of the cut-down layer strain when turning heat-resistant steels and alloys from the perspectives of the plastic collapse theory has been produced. It has been shown that the deformation of the material being machined is characterized by the value of relative shear ε and chips shrinkage ξ when cutting, as well as the geometric parameters that determine the location of the resultant cutting force in the conditional shear plane and on the front surface of the tool. As a result of the conducted studies, the cut-down layer strain parameters and the system of strains acting in the cutting area that allow forming the loading model of a tool have been determined. It is necessary to predict its performance in the edge cutting machining of high strength difficult-to-cut materials.

Keywords: strains, plastic deformation, cut-down layer, relative shear, chips shrinkage, cutting zone.

Technique to forecast general aviation development in the Russian Federation using artificial neural networks

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The Russian general aviation is in its infancy today, but its popularity is increasing day by day, so its development requires continuous monitoring and forecasting its future state. The Russian general aviation forecast development is a complex problem that requires a comprehensive approach to solve it. The prognostic parameters such as predictors are used to predict the change of complex variables. The article considers the predictors sample creation process using the expert estimates technique to forecast the Russian general aviation fleet changes. The resulting sample has been updated and checked up, using the correlation analysis method. Complex relationships between the predictor variables and the dependent variables are approximated by means of different methods. The appropriateness of applying the artificial neural networks method to predict the development of general aviation in Russia by comparing the forecast results for the past period with the ones obtained using the regression analysis has been proved. A preliminary analysis of the input data and their normalization has been performed. The training of the neural network of the selected structure has been implemented. The trained network has been tested. The accuracy and reliability of the test data have been checked up. The forecast data production using the trained network has been realized.

Keywords: predictors sample, expert estimates technique, correlation analysis, artificial neural networks, regression analysis.

Automated control system for electric steam-generating unit

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The design of the KEPR-250/0.4 steam-generating unit as the automation object has been considered. The requirements to the automated control system, which are to be implemented using the chosen equipment, have been formulated. The parameters to be controlled have been selected, their effect on the unit functioning and the probable causes for their marginal error have been studied. The switch-on sequence of the unit has been studied. The algorithm for preventing the increase in water salt content inside the steam-generating unit while in operation has been described. The features of the chosen OWEN PLC73 programmable logical controller (PLC) have been considered regarding to the problem of the steam unit automation: the availability of analog and discrete inputs and outputs, communication interfaces with dispatching systems, indication elements. The specifics of connecting discrete and analog sensors as well as actuation mechanisms to PLC have been noted. The elements of the human-machine interface have been described: indication by alarm lamps, sound alarm system, messages

on the PLC LCD display. The possible improvements of the operational characteristics have been formulated: adding the steam temperature sensor, replacement of the mechanical regulating devices by the electronic ones.

Keywords: steam generation unit, automation, diagnostics, technical state.

ID system of electromagnetic influence sources at power engineering facilities

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Nowadays, the automatic process control systems (APCS) of power engineering facilities based on the use of electromechanical components have been much depreciated. Instead of such APCS, the digital technologies (DT) having advanced functions and relatively low noise immunity to electromagnetic influence are becoming more and more common. To limit the electromagnetic influence on the DT up to the level providing their performance, it is essential to identify the electromagnetic influence and its sources. The overwhelming majority of electromagnetic influences is regular in nature, easy to predict and identify. There are, however, sporadic electromagnetic influences which are difficult to identify because of their stochastic nature. One of the ways to identify the sporadic disturbance is to develop the identification and monitoring system of electromagnetic influences. Such a system will identify the interference and its source via special sensors collecting data on the electromagnetic influence. The data will further be processed by the system. In its turn, the interference source identification will allow developing technical measures for reducing electromagnetic influence on DT. Consequently, the suggested identification system will allow a power facility to be prepared for the DT implementation, in-service trend and dynamic inspection of electromagnetic changes as well as real-time determination and registration of the effective values of electromagnetic environment to be carried out. In addition, it will warn the equipment and DT against failure because of harmful electromagnetic influences as well as spot the electromagnetic influences source location and eliminate interferences.

Keywords: interference identification, power facility, electromagnetic, source.

MODERN TECHNOLOGIES

Application of metal-bonded diamond wheels for metal-cutting tools integrated setting

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The paper reflects the advantages of application of the cutting tools integrated structures, which become widespread due to their high performance and efficiency when handling a wide range of different materials. The problems of cutting tools integrated setting by means of the existing methods and the need for their improvement to ensure the set-up geometrical and qualitative parameters depending on the production conditions have been marked out. The traditional methods of the cutting tools integrated setting have been considered. The application advantages of the metal-bonded diamond wheels for handling the cutters of a split-design tooling in comparison with traditional abrasive materials have been revealed. The main reasons for the loss of cutting ability of the metal-bonded diamond wheels have been established. The attention is paid to the up-to-date combined methods of handling that allow increasing the efficiency of diamond wheels application for the cutting tool setting. The method of the combined electro-diamond computer-controlled handling a continuous electrochemical trimming process has been proposed enabling to block the loading process and increase the efficiency of the metal-bonded diamond wheels application under the conditions of the metal-cutting tools integrated setting.

Keywords: cutting tools, grinding, diamond wheel, tool materials.

Effect of slurry waste of aluminum production on structure formation of clay and silica ceramic material

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Obtaining the clear-burn wall ceramic materials of lowered average density is possible on the basis of gas purification dust of the ferroalloy production. For the directed control of the silica crock strength and frost resistance, the compound flux material – the additive of carbonized clay loam and gas treatment residue (GTR) of the restored sludge collector of aluminum production has been used. The use of combination of the compound flux material ensures more complete burning-out of organic impurities and promotes sintering processes during firing. This is due to the thermal clay loam degradation, which provides formation of water vapor and carbon dioxide, and the presence of active fusible matters in gas treatment residue. By means of the method of mathematical planning of the experiment, it has been revealed that the rational firing temperature (up to 950°C) and the compound flux material consumption (loam content being 30%, gas treatment residue being 5-15%) provide obtaining the ceramic body of the specified frost resistance (F35-F50) and compressive strength not less than 10 MPa. It has been established that the ceramic body fired at 800°C contains quartz, celsians, cristobalite and calcium aluminates. Besides, a significant amount of pores as small as 10 microns are formed within the structure of the ceramic body (including safe - up to 0.1 micron and intermediate - 0.5-10 microns), which have positive effect on frost resistance.

Keywords: clay and silica ceramic material, gas purification dust of ferroalloy production, carbonized clay loam, gas treatment residue of the restored sludge collector of aluminum production, compound flux material.

Microporous wall ceramic materials produced from industrial waste

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Production of the articles possessing increased frost resistance and improved heat-insulating properties is a priority in the sphere of fired wall materials manufacturing. The structure of porous ceramic materials affects on the product performance characteristics. The presence of fuel residues in the heat and power engineering and metallurgy heavy-tonnage disperse waste predetermines the production of micro-porous ceramic materials possessing improved heat-insulating properties. Besides, the production of ceramic materials having enhanced porosity requires developing the manufacturing methods to strengthen cell walls. The article reveals the results of the integrated studies of the dry compaction ceramic wall materials produced of high-calcium fly ash from the Irsha Borodino field coal combustion and gas purification dust of Bratsk Ferroalloy Plant. Besides, the use of gas purification dust of the ferroalloys production, the particles of which have a cluster-based structure, presupposes the enrichment of the porous body structure by the initial interglobular porosity. To increase frost resistance of ash-siliceous ceramic materials while preserving high porosity, it is proposed to activate endogenous steam and gas emission at the stages of primary and final ceramic body crystallization by means of introducing carbonized clay loam mined from Anzebi deposits.

Keywords: high-calcium fly ash, gas purification dust of ferroalloy production, exterior wall ceramics, structure formation, pore structure, frost resistance, micro-porous wall materials.

Mathematical modeling for operating procedures of rotary loggers with variable load outreach

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The design analysis of domestic and foreign handling machinery (loaders, lorry-mounted and other types of self-propelled cranes) demonstrates that currently the variable load outreach machinery is employed everywhere. In the designs of such machinery, various telescopic devices (booms, handles) are widely used. Besides, the loggers equipped with telescopic booms are used for loading long-sized timber. The analysis of parameters and technical capabilities of such machinery proves their

advantages over some other types of loggers, the most important of them being a variable load outreach that extends their operating capabilities. Constructively, the variable load outreach can be equipped with the telescopic device, so the development of a logger with a telescopic boom is a promising tendency. The loggers' operating conditions and subject of labor are specific, and, therefore, the investigation results obtained for other types of hoisting and forestry machines can't be applied to the study being conducted. This gives reasons for developing the theoretical bases for designing and improvement of the loggers of this type. In the article, the mathematical modeling of operational procedures of the rotary loggers' performance is carried out applying the mathematical models developed on the basis of Lagrange's second kind equation. The mathematical modeling includes the assessment of the production equipment dynamic loading by means of the analysis of kinetic energy of the system, the analysis of the various kinematic parameters effect on the loadings arising in hydraulic cylinders of hoisting mechanisms and the mechanisms of changing the telescopic boom outreach as well as optimization of kinematics parameters.

Keywords: mathematical modeling, kinematic parameters, structural members loading, rotary logger with variable load outreach.

Research into physical and chemical properties of two-component paintwork materials

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One of the ways to obtain light-diffusing volume optical effect throughout a paintwork coating to improve furniture products and board appearance is to use incompatible polymers in a paintwork material, i.e. creation of multicomponent paint and varnish systems. So, to form a two-component binary system of a paintwork coating preserving its refraction index for each phase, it is proposed to introduce nitrate base of polyvinyl acetate aqueous dispersion that will result in creation of heterophase colloidal system. It is also known that nitrocellulose and polyvinyl acetate are compatible mutually-soluble polymers. In their presence, the dispersing of polyvinyl acetate aqueous dispersion in the nitrate base medium occurs. As a result of dispersing, the phase polymer globes (polyvinyl acetate dispersion) will be surrounded by hydrated films (nitrocellulose varnish). The process of paintwork coating hardening will take place due to evaporation of water molecules surrounding the phase polymer particles. Therefore, the so-called "crystallizing out" of polyvinyl acetate particles throughout the basic film-forming without their interaction with medium molecules is realized. It is supposed that this fact has to have an effect on the optical properties of the obtained coating as to creating the volume effect of light absorption preserving its initial physical and mechanical characteristics.

Keywords: paintwork material, nitrocellulose varnish, polyvinyl acetate dispersion, physical and chemical indicators.

Use of hydrolized lignin in wood-polymer composites production

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Currently, more than two million tons of hydrolized lignin as hydrolysis production waste have been piled up on the territory of Zima hydrolysis plant. The conducted experimental research in the field of commercial products development has been successful, but it hasn't got any further development in the form of industrial production so far. To prevent self-ignition that can result in the emissions of sulfurous or muriatic, nitrogenous and other harmful substances in the atmosphere, the decision on conservation of lignin reservoir till the time when there is a possibility of lignin's being employed in industrial production has been made. In 2005, the work on the lignin disposal site backfilling was carried out on the territory of Zima hydrolysis plant using bottom ash waste of JSC Irkutskenergo under the technology developed by the scientists of Limnological Institute of the Siberian Branch of the Russian Academy of Sciences. Thus, the suppression of a burning dump as well as conservation of the most valuable raw material from its being destructed by fire were carried out simultaneously. Unfortunately, in many aspects the use of lignin isn't always available - organizationally, economically and technically. For example, lignin decomposition on a simpler chemical compounds (phenol, benzene etc.) at the comparable quality of the obtained products costs more than their synthesis from oil or gas. This paper reveals the results of the researches of physical and chemical properties of a glue compositions base on the application of phenolic-formaldehyde resins modified by hydrolized lignin. The hydrolized lignin composition and the structure have been considered. The possibility to employ hydrolized lignin as a modifying agent of phenolic-formaldehyde resin for the plywood production has been established. The mathematical models of the plywood compaction process have been developed, and the optimum parameters to produce plywood based on the application of SFZh-3013 resin brand modified by hydrolized lignin have been determined.

Keywords: hydrolytic lignin, modification, phenolic-formaldehyde resin, quality, durability, physical and mechanical indicators.

Effect of lubricant cooling liquid on durability of metal-cutting tool when turning

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In metal working processes, the lubricant cooling liquids (LCL) are used practically in every operation. The LCL supply to the cutting area allows increasing tool durability and the quality and processing accuracy due to the LCL lubricant and cooling action. The LCL application does not always contribute to better the processing operation. The choice of the most effective LCL for these specific conditions will provide the tool durability and finish. The aim of this paper is to experimentally determine the effect on the tool wear and durability when turning steel 45 with supply of 1,5% soda ash aqueous solution to the cutting area and the guidelines development on the given LCL application. Despite the fact that a large number of researches into the LCL functional action have been carried out recently, there is no universal technique that allows selecting the most effective brand for the specific processing conditions. Currently, the metalworking enterprises aren't able to select proper LCL for processing, the choice being based on the price and long-term operating experience of several brands. The researches were conducted when processing steel 45 on the FT-11 lathe with carbide tooling under the following modes: $V=35$ m/min; $S=0,10$ and $0,26$ mm /rev; $t=0,5$ mm; the cutting tool geometrical parameters: $\varphi = 93^\circ$; $\alpha = 10^\circ$; $\gamma = 7^\circ$; $r=0,8$ mm. During the tests, the wear of a cutter plate back surface was determined when processing with and without the LCL supply to the cutting area. According to the investigation results, the operational time-wear dependence diagrams of the tool were constructed. High cooling action of LCL of 1,5% soda ash aqueous solution results in the temperature difference across the cutting area that causes thermocracks in a cutter plate, microchipping and stripes. It is reasonable to apply such LCL under high speed processing when the LCL supply to the cutting area is hampered, and high temperatures arise in the cutting area. At low speed, the supply of 1,5% soda ash aqueous solution to the cutting area reduces tool durability.

Keywords: lubricant cooling liquid, tool durability, cutter plate, technological wear, optimum wear, tool aging, uniform wear, stripe.

The need for further research of energy consumption for timber cross-cutting

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The paper focuses on the influence of the main specific work when sawing wood with chain saws on the overall energy consumption when timber cross-cutting. There has been conducted a comparison of the published data on the basic values of the specific cutting work taken from the works by V.G. Kochegarov, B.G. Zalegaller. A significant (up to 20%) deviation of the calculated values of the specific cutting work from each other at cutting wood with chains when using different methods for calculating the specified value has been demonstrated. The paper substantiates the importance of further research of energy consumption of the process of timber cross-cutting with chain saws. A methodological framework for the pilot studies to determine the principal specific work of timber cross-cutting using chain saws has been proposed, the prospects for further research in this regard have been highlighted. In particular, the approach adapted to study the process of timber cross-cutting and based on the provisions of the general applied theory of materials grinding has been proposed. The possibility of applying the basic provisions of the fracture mechanics of materials to determine the numerical values of the basic values of the specific cutting work in the process of timber cross-cutting using chain saws has been analyzed. Also, the dependence between the elastic constants of wood, namely, the elasticity modulus of wood under cross-grain compression, and the specific cutting when sawing.

Keywords: wood sawing, cross-cutting, energy intensity, chain saws, specific cutting work.

Increase in drying efficiency of crushed wood for pellet production by Ekotoplivo company

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Expert monitoring of the production line having the capacity of 2000 kg/h to manufacture fuel wood granules (pellets) has been conducted. The average actual productivity of the line during 5 months has been 200 kg/h since placed in service. The design defects of the line primary equipment – the heat-generator, drying drum and press granulator – have been revealed. The theoretical power of the heat-generator has been 475 kW. The heat-generator has been recognized inoperative, hazardous to the personnel's health and subject to replacement by the modern one equipped with automatic fuel supply. The fractional composition of wood particles after drying has been defined. The measurements of the drying agent velocity in the drying drum have been conducted. The average productivity of the drying drum installed in the line has been 366 kg/h. The plant operation was unstable due to systematic fire outbreaks. It has been proposed to make changes in the drying plant design – to install a conveyor for removing large-sized wood particles at the drying drum exit. After technical upgrading, it has been experimentally established that the productivity of the drying section of the pellet line will increase up to 1000 kg/h. The drying section operation will be more effective, stable and fire- safe.

Keywords: pellets, fuel granules, raw materials crushing, wood particles drying, granulation.

Research into filtering properties of fibrous polymeric materials under pressure

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The fibrous polymer materials are used to develop the drainage systems that serve to protect the artificial soil structures from moisture precipitation and groundwater. The materials being part of the drainage structures are characterized by permeability varying under the external load influence. In this article, the study of changes in the bed drainage filtration capacity based on fibrous polymeric material and depending on the applied external vertical load in the plane perpendicular to the material plane has been presented. To conduct the experiments, a special plant that enables studying the drainage properties directly in the soil mass has been constructed. The drainage structures consisting of the materials of different thickness and surface density were put to the test. The obtained findings reflect the effect of the vertical pressure on the filtration capacity deterioration primarily due to decreasing of the fibrous polymeric material porosity caused by the increase in density owing to compression deformation. This subsequently results in reducing the efficiency of the entire drainage system. When providing the drainages made of fibrous polymeric materials being part of massive artificial soil structures, you need to consider the reduction in the filtering properties under the pressure increase.

Keywords: drainage, filtration, fibrous polymeric material, geotextile

Features of Scotch pine (*Pinus sylvestris* L.) formation under the Priangar'ye conditions

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The possibility of forest resources sustainable use and preservation of their biological diversity is the most important task of this country's forestry. Taking into account its economic importance, Scotch pine is the most suitable species for reforestation under the Priangar'ye conditions. The aim of the research is to reveal the characteristics of the forest plantations growth and natural regeneration on the planting areas of different age. The process of wood formation at different age periods is not the same, so it occurs differently. Therefore, the wood quality in the plantations of different age changes under the influence of many factors. The age-related changes in the qualitative characteristics of pine wood are associated with site conditions and have a cyclical nature. This paper presents the most common forest types and growing conditions in which the pine plantations of different age and of different process layouts for seeding and planting are formed and grow. The forest growth conditions, in which the forest plantations of different age groups grow, provide good accretion not only for Scots pine, but also for softwooded broadleaved species. Under ill-timed thinning, this may lead to unwanted changes in species composition.

Keywords: forest plantations, forest types, forest growth conditions, change in species composition, forest regeneration.

Effects of seedbed preparation on their germination

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In order to encourage mass seed germination and increase field germination, different ways of seedbed preparation are employed to overcome deep and induced seed dormancy. The action effectiveness depends on the species and biological characteristics of seeds, the dormancy type and the thoroughness in adherence to the preparation conditions. Some investigation results of seedbed treatment of Scots pine, American arborvitae and Biota orientalis have been revealed. The treatment was carried out in the climatic chamber BINDEP MKF- 240 made in Germany. The first-year maturity certified seeds were selected for the tests. After the treatment in the climatic chamber, the seed lots were weighed and compared to the control lot weight (raw seeds). Two series of experiments under different temperature and humidity conditions were conducted. The results demonstrated that thermal treatment not only accelerates, but also delays germination. A series of experiments are going to be continued.

Keywords: conifers seeds, seedbed treatment, germination, sprouting, weighing, climate chamber, temperature, humidity, stratification, growth stimulants.

Distribution of some chemical elements in snow cover of Bratsk

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In 2013, the snow samples were collected in Bratsk at the distance from 3 to 29 km to the north-east of JSC "RUSAL" (Bratsk Aluminum Plant) and in the background regional district – the Tunkinskaya valley located in the Republic of Buryatia. The choice of the chemical elements for the analysis is conditioned by the fact that the elements being part of the raw materials to produce primary aluminum (Li, Na, K, Al, Mg, Ca) refer to the second and third hazard class (Cd, Co, Pb). Silicon is included in the investigation since there is a large plant producing ferroalloys at the distance of less than 1 km from the BrAP. The peculiar feature of the snow cover in the investigated area of Bratsk has a high pH value (6.6 -7.8). The comparison of the elements content in the snow water filtrate in Bratsk with regional and local background values, the standard data of the elements content

in drinking water as well as the comparison of the elements content in the snow solid sediment with their percentage abundance in the earth crust has been conducted. The calculated ratio of the elements quantity in the snow water filtrate and the snow cover solid sediment partly reflects the ratio of the elements that make up the gaseous and solid compounds of the atmosphere. The conducted comparisons allow us to judge on the degree of transformation of such geochemical environment as snow cover and on the losses of raw materials when applying one or another technology.

Keywords: snow cover, distribution, atmosphere, fluorine, ratio, chemical elements.

Automated data management system for environmental monitoring of anthropogenic landscapes

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An information analytical system for monitoring the impact of coal mining on the environment has been developed. The system includes a database, geographic information systems and software to calculate the integral characteristics of the environment current state. The database with a web interface is designed for entering and storing data on the anthropogenic landscapes and the monitoring results of the environment state. The database structure contains twenty-one interrelated tables that allows taking into account the main activities carried out on the anthropogenic landscapes, including mining, land reclamation and monitoring the condition of flora, fauna and soil. The geographic information system with a web interface includes ecologically-related visual and thematic databases. The software module is designed to calculate the current integral characteristics of the natural environment of anthropogenic landscapes in the investigated areas and predict the term to neutralize pollution and restore the biological productivity of anthropogenic landscapes. The visualization of the natural environment of anthropogenic landscapes to detect anomalies and the qualitative assessment of the environment dynamics has been implemented. The relationship between the database and GIS provides the visual analysis options and study of spatial relationships between coal strip mines, the restoration technologies and the characteristics of their ecological status.

Keywords: monitoring of anthropogenically destroyed landscapes, information system, database, environment.

Quality assessment of open spaces (through the example of public plantings of Krasnoyarsk)

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The increase in the urban environment comfort is largely dependent upon the effectiveness of functioning of the city planting system. The city landscape gardening system is the main link in the ecological framework of the city, so the study of the growth processes of both individual trees and their populations in the urban environment is an urgent task. Its solution will allow predicting the plants growth, optimizing the structure and species composition of woody plants to adequately meet the conditions of the environment and have effect on improving its quality. To carry out the focused effort on the quality management of landscape gardening objects, it is necessary to occasionally assess their compliance with the urban development and social requirements. Thus, the landscape gardening objects are the objects of applied qualimetry, its main task being measuring the conformity degree of the object's quality with consumers' requirements by means of scoring methods. On this basis, the classification system of the multilevel quality assessment indicators has been developed, the applied qualimetry techniques to calculate the parameters and evaluate the quality level of landscape gardening objects have been adapted. The range of indicators to assess the quality level consists of four main units: functional planning, environmental, urban technogenic, operational. The testing of the developed technique has been performed through the example of assessing the level of public gardens quality in Krasnoyarsk. The assessment has been conducted according to 33 indicators, and the indicators of the maximum lagging in the public garden actual status from the required parameters. For each block of indicators, the guidelines on the site renovation are being worked out. The conducted assessment allows performing the renovation of landscape gardening objects by means of the methods adequate to the existing conditions.

Keywords: urbanization, woody plants, quality assessment, landscape gardening objects.

Bio-indicator assessment of air pollution in Krasnoyarsk

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*The development of industrial and power facilities and increase in the fleet of cars in cities promotes environment degradation and deterioration of people's health. Industrial enterprises emit a huge number of dangerous pollutants, including carcinogens that results in increase in the number of oncological diseases among citizens. The results of standard methods to determine the air pollution index don't often reflect the real qualitative and quantitative content of the polluting substances. To obtain the adequate and more complete information on the ecological state of the social facility territories, it has been proposed to use the bio-indicator methods. The article reveals the materials to assess the effect level of the aerogenic pollution by the response of coniferous plantings of *Pinus silvestris* L. and *Picea obovata*, which are widely used in urban landscape gardening. As part of the study, the morphometric measurements of needles length, volumetric determination of their volume have been carried out, the changes in humidity and pigmental system of the assimilatory apparatus have been analyzed. Besides, essential oil has been driven off the needles by means of the hydrodistillation method. According to its fraction ratio, the plantings sample plots were referred to four types of degradation depending on the level of human-induced impact. The conclusions drawn during the investigation by means of different bio-indicator methods are identical and this is indicative of the efficiency to apply any of the used methods when carrying out the environment state monitoring.*

Keywords: air pollution, bio-indicator methods, visual observations, pigmental system, essential oil.

Prospects for using biomats for recultivation of disturbed soils in the Far North

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The problem of the disturbed lands recultivation in the far North has been considered. The need to perform works on the defected areas restoration has been revealed. The survey of the existing conventional methods of the disturbed areas restoration consisting of two stages – technical and biological – has been conducted. The basic work package on the technological recultivation has been described, and the stages of biological recultivation have been listed as well. The estimation of the inefficiency of using the conventional method in the Far North has been given. Modern bioengineering technologies for land reclamation have been proposed. The expediency of application of biomats for the defected areas recovery has been given in detail. The technology for biomats application has been described. A comparative analysis of the costs to restore the disturbed site of the expendable well P-2012, JSC «Arktikgazstroy», the Yamalo-Nenetsk Autonomous District, by means of the conventional technique and using biomats has been given.

Keywords: recultivation, disturbed lands, biomats

Health problems among contemporary students under adverse environmental conditions

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As a result of environmental degradation, the establishment of the degree of the environmental pollution impact on the health status of the population under the effect of various ecological factors is of current importance. In this connection, students give rise to great concerns because, on the one hand, the health of this generation is to a considerable degree conditional on the life environment state throughout two previous decades. On the other hand, the effectiveness of their further working career depends on the health status of boys and girls involved in a long learning process. Disease incidence is one of the criteria to assess the health status of the age groups under consideration. A higher disease incidence level characterizes the territories with adverse environmental conditions, to which belongs the town of Bratsk. The article shows the results of studying the morbidity rate

among the students of Bratsk State University under the influence of adverse environmental conditions. The risk assessment of students' major pathologic syndromes in the urbanized environment has been given.

Keywords: environment, health, students, major pathologic syndromes risk.

On the effect of ionizing radiation on alkali- halide aerosol particles

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The method of transformation of alkali-halide microcrystals to nitrates of the corresponding alkaline metals has been developed and experimentally proved. The method is based on the analysis of the alkaline and haloid microcrystals properties following the impact of ionizing radiation on the «microcrystal – air» system. It has been shown that studying the dependence of the microcrystals properties on the radiation dose of the «crystal – air» system allows estimating the dominating type of interaction in the system – the heterogeneous one. The laboratory model of the ionizing radiation action on the atmospheric aerosol particles has been proposed. The heterogeneous mechanism of the ionizing radiation action on alkaline and haloid crystals as part of the «crystal – air» system has been proposed. X-ray and gamma radiation, when passing through the system, result in initiating heterogeneous reactions. When the dose rate is high, the transformation of alkaline and haloid microcrystals to nitrates of the corresponding alkaline metals is observed. Laboratory measurements and modeling are the central elements in atmospheric chemistry and are important for understanding the reactions occurring on the aerosol particles surface. The conducted researches show how alkaline and haloid microcrystals can be destroyed by ionizing radiation in the atmosphere and what the resulting products are.

Keywords: radiation, alkali-halide microcrystals, aerosol particles, heterogeneous reactions, atmospheric chemistry, laboratory modeling.