Dynamics and Strength of Machines

The paper considers problems in reducing the vibration activity of modern rail transport networks in big cities, primarily, the metro system, which provides the biggest carriage of passengers. The growing intensity of traffic in the lines and the ever-increasing load and necessity of building new subway lines, as well as of other kinds of rapid-transit rail transport (monorail roads, express tramways, and others) dictates the necessity to account for the possible impact of transport facilities on the surrounding buildings. Hence, recently, more strict norms are being introduced to relevant regulatory documents. They regulate the definitive physical parameters of vibration and noise admissible in urban rail transport. Metro system shallow subway lines are known to be a source of increased vibration, which propagates in the ground and is transmitted to the foundations of buildings located in the metro system land allocation area. Therefore, it is critical to reduce the level of vibrations and structural noise in the development area adjacent to the metro system lines being projected and built. Different technical solutions based on conventional vibration isolation schemes are not always effective. A development is known with a sleeper track design using separate rubber cushions. A technical solution is known, which is based on the design of the German firm GERB with the usage of metal springs. Also known are methods based on using rubber mats. All these solutions fail to meet sanitary norms. The design of a track vibration isolation system using any elastic elements has a service constraint. The track deflection under the weight of a car shall not exceed 4 mm. Hence, the eigen frequency of the entire mechanical system train - track – vibration isolation – tunnel lining - ground cannot be lower than 8 to 10 Hz. Hence, the vibration isolation factors for common vibration isolation schemes are insufficient. It is necessary to ensure stiffness with track depression within 4 mm and increase the level of vibration isolation at the same time. Presently, the metro system has no track vibration isolation system whose design would meet sanitary norm requirements to vibration and structural noise. The paper addresses the problem of suppressing vibrations created by metro trains. Vibrations occurring due to interaction of the railway train and rails in the rail-wheel point of contact are reduced by placing hydraulic vibration isolators with inner inertial elements under the track structure. The study builds models of systems of the metro stock. It is investigated using dynamic stiffness methods for both the case of using vibration isolators and without them. The result is comapred against experimental data. The vibration oscillation effect is predicted to increase (by 6 to 30 dB) whilst retaining the required static stiffness value.

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The rotor of the intermediate-pressure cylinder of steam turbine T-250/300-240 is used for investigating the influence of a transverse crack on its vibration condition with account of faces contact. The rotor is considered in the rotating coordinate system and modelled as a 3D body resting on rigid supports. The finite-element method is used, whereas the crack is modelled using a technique allowing to create on an arbitrary surface a layer of double nodes belonging to different faces of the crack. The matrices in the motion equation are built for a completely open

crack, whereas the contact conditions on the crack faces are satisfied by introducing contact forces applied in the double nodes. The time solution of the problem is based on the Newmark scheme, and at each time step iterations determine the distribution of contact forces on the crack faces.

The basic variant for numerical investigations with different rotational speeds was a rotor with a 50 % deep crack located in the middle of the rotor body between the discs. In other variants, the crack location over the length of the rotor and the crack depth were changed. It was found that the first natural frequencies of an integral rotor and the segregated natural frequencies of a rotor with a crack when faces contact was not accounted for are lower than the working frequency. According to estimates, a rotor with a "breathing" crack acquires periodic vibrations with a complex spectrum of harmonic components where one can distinguish the first, second and third harmonics. At a rotational speed close to one-half of the lowest natural frequency of an integral rotor, the 2/1 resonance of the second harmonic component is observed. Above this rotational speed, the harmonics are redistributed, and the first harmonic becomes predominant. In the frequency range close to natural frequencies with the first mode of flexural vibrations, the fundamental resonance for the rotational component occurs. The amplitudes of harmonics decrease with an increase of the rotational speed to the running one.

If the location of a crack and its depth change, the differences in the values of vibration characteristics can be significant, though the qualitative pattern of results changes insignificantly.

Keywords: *rotor, oscillations, transverse crack, finite element model, crack faces, contact, resonance.*

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Nonlinear dynamics of one disk elastic rotor is treated. The shaft is attached in two arbitrary length journal bearings. Unbalance between disk center mass and point of disk attaching to the

shaft takes place. The forced vibrations occur due to this unbalance, which always present in a disk. The self-sustained vibrations caused by interaction between fluid film and journal. Nonlinear mathematical model of interaction of forced vibrations and self-sustained vibrations in one-disk elastic rotors is treated. Finite element procedure is used to analyze forces of oil film. The forces of the journal bearings are calculated if form of power series with respect to the generalized displacements and the velocities of the journal. The results of nonlinear analysis of rotor dynamics are presented on frequency responses. The region of almost periodic vibrations is calculated. Both periodic monoharmonic vibrations and the almost periodic motions are observed in the above-mentioned frequency range.

Keywords: *asymmetrical one disk rotor, arbitrary length journal bearings, forced vibrations, self-sustained vibrations, finite-element procedure, almost periodic motions.*

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The gas-pump units blades profile geometry changing influence estimation on the character of one's vibration method has been designed. The reasons of axe compressor blades geometry changing have been described, the method of blade profile mathematical formalization has been selected. To interpolate the blades profile the Hermitte polynomial and the ellipse equation have been used, which allow to calculate the profile section square and one's inertia momentum using the numerical integral calculation method.

The blades profile was considered as the combination of four different sections with the conditions of smooth connections taking to account the results of profile points displacements measuring. It was considered the different kinds of gas-pump units vibrations both with the accurate solutions of corresponding equations of vibrations taking to account the initial and boundary conditions, the mathematical models of such process was realized to compare the blades vibrations parameter with different geometrical configurations and the influence of the profile section

square and one's inertia momentum changing, which are presented in vibrations equations as coefficients, on the vibrations parameters. It allows to make the analysis of the axe compressor blades real technical state to take a decision concerning one's future exploitation.

The corresponding software was designed, the test calculations was made, the results was presented as the graphics both with value of the section square and one's inertia momentum for the real profile.

Keywords: *compressor, blade profile, shape changes, vibrations, vibration equation, square, inertia momentum*

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Applied Mathematics

In this paper we propose a regionally-structured method for identifying nonuniform temperatures of a construct surrounding an environment under high speed thermal processes with oscillating heat exchange. It is built regional- analytical structure of the solution of tasks accurately satisfy high-speed oscillating heat transfer to the border areas of the complex doubly connected domain at any given time depending on the ambient temperature and relative heat transfer coefficients. Regionally-analytical structures of problem solving were built, these structures accurately satisfy high-speed oscillating heat transfer on boundary areas of the complex doubly connected areas at any given time-depended environment temperature and any relative heat-transfer coefficients. The structures of these solutions allow for displays of simulated results and regionally-analytical prediction of high-speed oscillating thermal processes on agreed displays in real-time. The use of S-functions in the structures of solutions for the inclusion of information about the area geometry for the first time makes it possible to construct continuously differentiable basis functions in the approximate regional-analytical problems of high heat transfer.

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Литвин О. О., Штепа Н. І., Кулик С. І., Чорна О. С. Математичне моделювання розподілу корисних копалин між системою нерегулярно розміщених похилих свердловин методами глобальної інтерлінації функцій.....39

Building methods of three-demensional minerals distribution model on the base of minerals distribution at the every value of given system of inclined boreholes information and three variable functions interlineations methods are proposed in the article. Building methods of three variable functions interlineations formulae with using of Donald Shepard and Oleg N. Litvin global interpolation formulae generalization are presented. Properties of built math models and perspectives of their using for mineral exploration are investigated. This building method of math models of three-dimensional distribution of minerals between inclined boreholes allows, after appropriate generalization, build math models of earth crust structure with using of all core components of inclined boreholes, which will lead to effective mineral exploration and prospecting methods creation. Using information for such math modeling type is more accessible and easy in comparison with information getting by seismic tomography methods. At the same time it allows present mineral distribution at deposit place in the form of three variable single functions. It open ups possibilities for exploration of new prospecting methods.

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Ecological Aspects in Mechanical Engineering

Kanilo P.M., Sarapina M.V., and Kostenko K.V. Global Energy and Ecological Issues, and Photosynthesis .....

Life on planet Earth emerged and is sustained due to photosynthesis. Photosynthesising systems formed on the planet an oxygen-containing atmosphere with an ozone shield, a biosphere with fertile soil, an adequate climate and a rational level of temperatures of the near-earth atmosphere to provide a living environment for the human race. Photosynthesising systems are extremely sensitive to environmental contamination with toxic, cancerous-mutagenic and other hazardous substances, which even in small concentrations reduce effectiveness of photosynthesis.

Presently, hundreds of millions of tons of extremely hazardous and cancerous-mutagenic pollutants are emitted to the planet's environment. The level of deforestation is 10 to 12 mln. hectares annually, and over 6 mln. hectares of fertile land annually become deserts. Practically, one-third of the ocean's surface is covered with technogenic films, thus reducing the level of delivery of carbon dioxide gas from the atmosphere to the ocean.

A global ecosystem has emerged on planet Earth. It is developing not according to natural or social laws, but rather to its intrinsic socio-ecological laws. The ecosystem is losing its capacity for natural self-regulation. This results in the following: destruction of the biosphere's regenerative mechanisms; destruction and degradation of photosynthesising systems; reduced consumption of carbon dioxide from the atmosphere; the greenhouse effect-induced growing temperatures of the near-earth atmosphere layer, the increasing World ocean level, and redistribution of water precipitation and flooding of many planet's regions.

Keywords: *photosynthesising systems, environment, ecology, greenhouse gases, climate warming, eco-cancerogenic hazard, automotive transport.*

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Abramchuk F., Kabanov A., Petrov N. Method of calculation of exhaust gases emissions of biogas engine .....

In article has been presented method allows to calculate content of harmful chemical species in exhaust gases of biogas engine. To determine the equilibrium composition of internal combustion engine with spark ignition is proposed to use a system of 10 equations with 10 unknowns based on six chemical reactions, 3 equations of material balance and Dalton's law equation. The technique of algebraic solutions of system of nonlinear equations has been proposed. Compari-

son of results of calculations using this method with the results of experiments revealed that the difference between these values is no more than 10%.

***Keywords**: biogas, toxicity, gas engine, combustion process, equilibrium composition.*

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High Technology in Mechanical Engineering

For ships with a DC propulsion engine powered from AC voltage , and includes such elements of the system as a synchronous generator (SG), controlled rectifier, and the load in the form of electric propulsion DC induction motor, as for any autonomous system of this configuration , actual problem is the negative influence of powerful disturbing to the supply network . Taking into account the autonomy of the system described , it is necessary to take into account that the distortion of forms of currents and voltages ship directly affect the network and on the control system themselves that generate them . Due to the lack of security requirements in the scheme of the ship's power plant of neutral wire makes the system pulse shaping control power switches more critical to the observed distortions in the network in the form of network voltage unbalance on its inability to control the input and the output phase voltages SG.

To ensure stable operation of automation systems operating in the composition of these systems and to reduce the negative effects of controlled rectifier on the mains supply to ensure stable operation of the shock wave across the entire range in the presence of harmonic current and voltage values are significantly higher than the legal, given the unstable voltage level and frequency of feeding network , as well as non-uniform load on phases that due to the lack of the neutral conductor , gives unbalance current and voltage network as much as possible to improve the mains supply , in particular by improving the stability of the shock wave.

***Keywords:** elements of the structural models of devices approximation problems for identification and control of parameters of facilities management*

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Sustainable functioning of the energy sector of Ukraine is one of the most important component of national security and energy independence. Energy and fuel sector of the economy is the most inertia , capital-intensive and knowledge-based structure, particular importance stayed problems of qualified and objective analysis of its real technical condition and systems prognostication of changing conditions of the energy needs in order to create long-term strategy of development of basic components , including energy machine building. In this regard, scientific, technical, and organizational issues of the modernization program of power engineering complex to provide energy in Ukraine by reliable and economical domestic equipments have been considered.

On the basis of summarizing the results of basic research in the field of thermo-and-gas dynamics, thermal physics, problems of strength and reliability of the equipment and modern applied development in the field of design of more advanced equipment models has been formed the conceptual approaches to the problem of renewal of energy equipment and transfer of efficient technologies in production energy machine building sphere.

The concept, which was developed of innovative modernization of generating equipment based on the latest achievements of modern science and technology, includes the entire set of studies of the life cycle of main power equipment with history of its creation and operation features, which allows an assessment of the actual technical state of each individual unit at the time of decision on the withdrawal of its commissioning or carrying out renovations on a modern technological basis.

Pooling of the power machine-building enterprises in the energy holding can provide a solution to the problems associated with the development of innovative scientific and technological power machine-building complex of Ukraine and the preservation of its competitive capacity on the world market have been shown.

Keywords: *power machine-building, power modernization, energy security*

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