MATHEMATICAL MODELING — APPLIED ASPECTS

EXPLORATION OF DESCRIBING THE VECTOR-PARAMETRIC BI-SPLINE, DEFINED BY THE FORTH DEGREE SPLINE WITH CONTROL POINTS INCIDENT WITH SURFACE OF APPROPRIATE SMOOTHNESS

page 4–7

The article proposes description technique for spline vector & parametrical surfaces of the fourth degree with control points incidental to the surface and gives testing examples of application of this technique. Main purpose of researches is to develop an algorithm for solving some application problems which often impose specific demands to tools available with developers' or designers' workplace. For instance, it sometime becomes troublesome to produce smooth configuration, since the obtained curve does not belong to pre-set dotted carcass.

The technique of producing a vector & parametrical bispline with control points incidental (belonging) to relevant surface is proposed to overcome such inconvenience. Hence, a polynomial function of the fourth degree determined with five points x_0, y_0, x_1, y_1, x_2, y_2, x_3, y_3, x_4, y_4 may be represented, as below:

$$y = \alpha_0(u)y_0 + \alpha_1(u)y_1 + \alpha_2(u)y_2 + \alpha_3(u)y_3 + \alpha_4(u)y_4,$$

with function $\alpha_i(u)$ being the Lagrange polynomial coefficients.

Polynomial equation in matrix format may be expressed, as follows:

$$r = \left[\alpha_0(u)\alpha_1(u)\alpha_2(u)\alpha_3(u)\alpha_4(u)\right]\begin{bmatrix} r_{00} & r_{01} & r_{02} & r_{03} & r_{04} \\ r_{10} & r_{11} & r_{12} & r_{13} & r_{14} \\ r_{20} & r_{21} & r_{22} & r_{23} & r_{24} \\ r_{30} & r_{31} & r_{32} & r_{33} & r_{34} \\ r_{40} & r_{41} & r_{42} & r_{43} & r_{44} \end{bmatrix}\begin{bmatrix} \alpha_0(v) \\ \alpha_1(v) \\ \alpha_2(v) \\ \alpha_3(v) \\ \alpha_4(v) \end{bmatrix}.$$

With provided derivatives equity up to the third degree (inclusive) the equity of compound derivatives along the gluing line criterion is also met (i. e. continuity of the second quadric form is achieved throughout the entire surface). Equity of the compound derivatives should be achieved to obtain fine smoothness of the third degree surface, i. e.:

$$\left.\begin{aligned} r'''^{(i-1)}_{uuv(u=1)}(u,v) = r'''^{(i)}_{uuv(u=0)}(u,v),\ r'''^{(j-1)}_{uuv(v=1)}(u,v) = r'''^{(j)}_{uuv(v=0)}(u,v), \\ r'''^{(i-1)}_{uvv(u=1)}(u,v) = r'''^{(i)}_{uvv(u=0)}(u,v),\ r'''^{(j-1)}_{uvv(v=1)}(u,v) = r'''^{(j)}_{uvv(v=0)}(u,v). \end{aligned}\right\}$$

Calculation formulae for spline with third degree of smoothness should be applied to achieve this effect. Thus linear equations system with quadrodiagonal leading matrix may be obtained by means of preset three boundary conditions (thus increasing the flexibility of the method) providing a stable and unambiguous solution. Algorithm for development of the fourth degree bispline with control points belonging to relevant surface is developed. Results of the research may be helpful for developers, designers, APS users providing them with additional opportunities in developing smooth curved contours for elements and parts of machinery operating in mobile environments.

Test examples are provided for the fourth degree bisplines with third degree smoothness with control points incidental to the surface.

The proposed algorithm is suggested for implementation to improve efficient work of constructors, designers, developers.

Keywords: vector & parametric spline, bispline, spline with control points incidental to curved surface, third degree smoothness.

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DEVELOPMENT OF MODELS AND ALGORITHMS FOR OPTIMIZATION OF RESOURCE CONSUMPTION IN THE DATA STORAGE BASED ON CLOUD PLATFORM

page 7–11

The use of cloud computing technology to build information systems of research organization is discussed in this paper. The main purpose is to determine the key parameters that affect how each resource involved in the construction of systems and optimization of resource consumption taking into account solvable problem. The research results are based on queuing theory, methods of optimization and simulation. Mathematical models of service requests users to store data on a cloud platform. Also the algorithm of load balancing algorithm and intellectual migration data in cloud storage data is developed. The algorithms allow scale information system without lowering the volume of resources involved in the work. Performance evaluation showed decrease query processing time by increasing system capacity by using developed technology. The research results can be used to improve the efficiency of software and hardware resources, quality of services in information systems to the cloud platform, as well as to avoid overloading services.

Keywords: load distribution, cloud computing, DSS, data migration, simulation.

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TECHNOLOGY ORGANIC AND INORGANIC SUBSTANCES

VIBRATION INFLUENCE RESEARCH ON MELT JET HYDRODYNAMICS OF NITROGEN FERTILIZER PRODUCTION VIBRO-GRANULATORS

page 12–15

This article discusses the use of vibro-granulators in the chemical industry and some results of theoretical research in this field. The main purpose of the study is to optimize the device operation by examining the effect of disk-emitter for creating periodic oscillations of the device basket to change the pressure in the flowing fluid streams. The solution of the Navier-Stokes equations to describe the hydrodynamics of axisymmetric jet allows obtaining expressions for the pressure, axial and radial velocity as a function of time and distance. Consideration of the solution with the initial conditions, which are determined by the hydrodynamics of the internal device and the boundary conditions for the jet, allows obtaining an expression for the pressure. The presented method makes it possible to determine the impact of the characteristics of the disk-emitter of the vibro-granulators on the pressure in the jets, which determines the physics of the collapse them into individual droplets. The optimal choice of parameters according to the received results allows obtaining monodisperse droplets and beads, which significantly improves the quality of the finished product. We propose to use the study according to the calculation of hydrodynamic jets issuing from basket of vibro-granulator, which uses disk-emitter to create vibrations. The research results can be used by design engineers and technologists involved in the design and operation of new and modernization of existing production of mineral fertilizers.

Keywords: vibro-granulator, granule, disk-emitter, oscillations, hydrodynamics, liquid jet.

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ANALYSIS OF FOREIGN DIESEL FUELS AND PROSPECT OF IMPROVEMENT OF THEIR ECOLOGICAL PERFORMANCE

page 16–21

The progressive development of humanity determines the increase in energy consumption in general and diesel fuel as well.

Increasing the consumption of diesel fuel leads to negative consequences. In this regard all over the world there is a problem to improve their environmental performance. A comparative evaluation of the consumption of cleaner diesel fuel and fuel with high sulfur content among the various countries of the world is conducted. On the example of the Russian Federation it is presented information on the annual emissions of combustion

products. The effect of the sulfur content in diesel fuel emissions of solid particles in the exhaust gases is evaluated.

The hazard of diesel soot by increasing adsorption on its surface of polycyclic aromatic hydrocarbons is proved.

The effect on emissions of solid particles of fractional composition of the product and the content of aromatic hydrocarbons is considered.

The hazardous effects on the environment of sulfur compounds in the diesel fuel are shown.

The necessity of purposeful study the possibility of replacing the aromatic component in the fuel using a strategy of environmentally-friendly additives is proved.

Keywords: diesel fuel, environmental hazard, sulfur compounds, emissions, additives.

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DESTRUCTION ANALYSIS OF THE ANTIFOAM ADDITIVE

page 21–24

The article presents the results of a study changes in the structural-group composition of molecules of the antifoam additives, which occur during long-term use of hydraulic oil «Hydraunycoil FH-51», thereby reducing the guaranteed resource life of oil and, in turn, the reliability of the hydraulic system of the aircraft and the aircraft safety factor. The types of structural molecules of polyorganosiloxane liquid, their group composition and atomic mass are defined. It is found that during long-term use of hydraulic oil antifoam additive molecule susceptible to degradation breaking Si–O linkages and internal molecular rearrangement. As a result, these processes are formed low-molecular structure capable of sealing, thermal degradation, and participation in the processes of oxidation of hydrocarbons of all types.

Keywords: antifoam additive, oil aging, destruction of molecules, oxygen-containing compounds, oxidation of hydrocarbons.

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REGULARITIES OF THE COATINGS FORMATION FROM BRONZE AND BABBIT POWDERS BY HOT PRESSING METHOD

page 24–27

The paper is devoted to the development of new coating made of bronze and babbit powders by hot pressing method. The purpose of the work is to explore the possibility and establish the regularities of coating formation on the surface with use of powders which have been obtained by grinding waste products. The new device for hot-pressing processes which allows you to control shrinkage has been developed for experimental studies. The studies of the coating were carried out by the methods of optical metallography, X-ray analysis, mechanical testing. It is shown that the formation of the structure combines the processes of the liquid phase sintering of the powder mixture and the diffusion interaction with tinned of steel surface 20. The structure of coating consists of the bronze solid phase and babbit soft phase that

provides wear resistance. The established regularities allow you to control the processes of coating formation, creating permanent connections with the steel surface and using waste products. The developed technology can be used for manufacturing new and for their repair worn details of ship locking reinforcement of cargo systems (flanges, cranes, valves).

Keywords: hot pressing, bronze powders, babbit shavings, coating.

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INFLUENCE OF MULTIPASS WELDING ON THE ENERGY OF GRAIN BOUNDARIES IN NICKEL ALLOYS

page 27–30

The problem of crack resistance in nickel-based alloys requires an individual approach in the study for each case. Especially difficult to describe the mechanism of crack formation is the presence of welding heat. Nickel-based alloy In52 during deposition multilayer fusing tend to form ductility dip cracks (DDC) in the heat-affected zone. Taking into account all the factors affecting the process of cracking was developed a method of numerical evaluation the strength of the grain boundaries.

It was calculated the cohesive energy of the multilayer fusing made by wire In52, in the heat-affected zone, based the thermodynamics theory of grain boundaries. Scanning electron microscope, optical microinterferometer were used to evaluate the crystallographic orientation of grain boundaries and it profile after vacuum etching.

It was found that with increasing misorientation angle θ the cohesive energy is decreased. Less resistant to formation DDC are high-angle grain boundaries with range misorientation inside of 45–60° and average E_{coh} 3,1 J/m^2. The reasons of decrease the cohesive energy in alloys In52 during multipass fusion welding is adsorption of S and O from the grains body to grain boundary. Given similar energy absorption S and O on the GB, it can be assumed that GB concentration of oxygen is 4,5–5 times higher than the sulfur. The average concentration of O and S on the surface of DDC for high angle boundaries is inside of 2,3–4,5 and 0,5–1 at. %, respectively.

Determination of the cohesive energy as a criterion of the probability formation DDC, permit to evaluate crack resistance of fusing, as well as to develop technological recommendations for prevent the formation of defects in the brittleness temperature range.

Keywords: grain boundary, ductility-dip crack, segregation energy, cohesive energy, adsorption.

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SYNTHESIS AND INVESTIGATION OF MAGNETITE DISSOLUTION KINETICS IN THE MODEL ENVIRONMENTS

page 31–32

The article describes the magnetite dissolution kinetics in the modeling environment depending on the time of dissolution and pH. The results of solubility by spectrophotometry, atomic absorption and gravimetric methods are given. It is revealed that the magnetite is better soluble in an acidic medium with a decrease in acidity and in alkaline environment magnetite is more soluble at higher pH. It is revealed that the magnetite solubility increases with increasing time of incubation. The order of reaction (I-st order) and rate constant of magnetite dissolution are determined. The optimum concentration of the starting materials and conditions of the magnetite synthesis are matched. It is found that the magnetite is able to dissolve in the model environments and can be used for delivery of the iron (II) into the body.

Keywords: synthesis, kinetics, magnetite, solubility, concentration, environment.

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DEVELOPMENT OF NEW WELDING CONSUMABLES FOR WET UNDERWATER WELDING OF HIGH-ALLOY CORROSION-RESISTANT STEEL

page 33–35

The paper describes the technology for mechanized wet underwater welding of high-alloy corrosion-resistant steel. The main purpose of the research is development of the pioneering self-shielding flux-cored wire for wet underwater welding. Quantity and quality characteristics were determined by using the mathematical experimental design method. Quantity and quality welding-technological characteristics, such as gas saturation of the weld metal, stability of the arc burning process in water environment, and optimal composition of slag-forming components of the flux-cored wire charge, were specified. Application of the experimental self-shielding wire for mechanized wet underwater welding of high-alloy corrosion-resistant steel will make it possible to increase productivity and improve quality of underwater welding-repair operations, and receive an economic effect due to reduction of downtime in production cycle of an object being repaired. Application of this technology will allow a partial or even complete absence of participation of humans in the welding process performed under extreme conditions in radioactive environment (in case of nuclear power plants) and in welding in deep waters. The research results can be used for welding-repair operations at nuclear power plants, ship-repair and ship-raising operations, and at hydraulic facilities. The proposed innovation technology makes it possible to fully replace the wet underwater covered-electrode welding technology.

Keywords: flux-cored wire, steel Ch18Ni10Ti, covered electrode, nuclear power plants, gas saturation, wet welding.

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PROCESSES AND EQUIPMENT OF FOOD AND CHEMICAL INDUSTRIES

IMPACT OF ELECTRICALLY ACTIVATED WATER FRACTIONS ON SOLUBILITY OF MEAT PROTEINS

page 36–38

The article examines and discusses the influence of electrically activated water on the proteins of muscle tissue. The aim of the study is to improve the solubility of proteins in muscle tissue to achieve greater yields and improve their quality through the use of electrically activated water fractions. The results of the studies of solubility change of sarcoplasmic and myofibrillar proteins are given. It is established the solubility level of sarcoplasmic and myofibrillar proteins in the presence of a catholyte, anolyte and drinking tap water (control). The efficiency of using electrically activated water fractions to improve the solubility of proteins in muscle tissue is shown. It is determined the dependence of the water-holding and fat-holding capacity, emulsifying capacity and emulsion stability on the protein solubility under the influence of the electrically activated water fractions. The results can be used in the production technology of emulsified sausage.

Keywords: electrically activated water, catholyte, anolyte, meat, proteins, solubility.

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RECEIVING HIGH-QUALITY RAW MATERIALS WITH IMPROVEMENT OF DRYING PROCESS

page 38–40

This article discusses the use of more effective and energy saving apparatus with counter-current swirling flows after the perfection in food, pharmaceutical, chemical, metallurgical and construction industries and gives the examples of some results of our research in this area.

The main purpose of the research is to determine the optimal designs of dust collectors to increase the productivity of drying process.

The use of the apparatus with counter-current swirling flows after the improvements in technological process of drying allows to increase the productivity of technological process, to improve the collection efficiency of the smallest fractions of the solid particles of milk, to reduce the hydraulic resistance of the apparatus and its geometrical dimensions.

While analysing the obtained results with the use of different designs of dust collecting equipment the most optimum design for carrying out this technological process was determined.

The research results can be applied by the process engineers involved in the field of food industry as well as construction, chemical, pharmaceutical and metallurgical ones.

We propose to introduce more efficient energy-saving apparatus with counter-current swirling flows for the technological process of food drying.

Keywords: drying, milk, collection, counter-current swirling flows, dust collection equipment.

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TRANSPORT TECHNOLOGY

INTREGRATION OF THE CIRCULAR PIPES IN THE SUPPORTING SYSTEM OF BOXCAR TO ENSURE THE RATIONAL STRENGTH INDEXES

page 41–44

This article presents the features and results of the study on the integration of circular pipes in the supporting system of boxcar on the basis of the method proposed by the author. Application of this method ensures minimal consumption of materials under the conditions of strength and operational reliability by ensuring rational indicators of strength. Results of complex theoretical and computational checks of durability and operational reliability of improved boxcar design by the computer modeling pointed to the efficiency and effectiveness of the implemented technical solutions. So as a result of its test of strength in all cases calculated according to calculation mode found that the resulting equivalent load does not exceed the allowable normalized values, fatigue strength (in a test in 10^7 cycles) is provided, project service life is more than 32 years. Moreover, the results of additional analysis to ensure strength in welded joints have also confirmed their performance.

Keywords: boxcar, improving the supporting structure, integration of circular pipes, rational strength indicators.

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RECOMMENDATIONS FOR IMPLEMENTATION OF SHIP UNLOADING PROCESSES FOR TRANSPORTATION OF COMPRESSED NATURAL GAS

page 44–47

The article deals with the application of transportation technology of compressed natural gas in the development of offshore deposits of the Black Sea. The main purpose of the research is to develop recommendations for improvement of unloading terminals and modes of operation. Laying of two branches of connecting gas pipeline and use of them as a buffer capacity enables maintenance of the critical mode of gas leakage and the introduction of the compression equipment in circumstances where the gas pressure at the outlet of the compressor exceeds the pressure in the cargo tanks system. Observance of the recommendations concerning modes of unloading terminals facilitates implementation of unloading process with minimum energy and material costs. The research results can be used to successfully implement the project of gas transportation in the compressed state of different options for their implementation. For detailed justification of the modes of unloading terminals it is necessary an information about volumes of the transported gas using CNG technology and conditions of laying and connecting of the branches of connecting gas pipeline to the existing gas transportation infrastructure.

Keywords: compressed natural gas, unloading of vehicles, gas compression equipment, connecting gas pipeline.

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MECHANICAL ENGINEERING TEXNOLOGY

SYSTEMATIZATION OF APPLICATIONS OF THE OPERATOR OF PARALLEL TRANSPORT IN MODELING OF FLAT COMPARTMENTS OF TOOL SURFACES

page 48–51

The application of the flat compartments as modules of the models of tool surfaces for machine-building and other purpose in industries with the shape-generating technologies has been considered. The main purpose of the study is allocation and systematization the basic typical elementary flat compartments of tool surfaces, the use of which by means of the operator of parallel transport allows to reproduce virtually any of them. The application of the theory of multi-parameter affine mappings of the space and some of the results of our research in the direction of its applied unification have been discussed in this paper. A systematic morphological selection of elementary flat compartments of tool surfaces formed by the action of the operator of parallel transport, the results of which are visualized and mathematically described, was made in this paper. The methodical example of the practical application of development is being shown. The presented complex of geometric modules and their mathematical descriptions is being offered for a diversified use in computer-aided design to development with tool component, service-oriented to shape-generating machine-building and other technologies. The proposed system of flat compartments formed by the action of the operator of parallel transport allows to perform modeling of tool production objects of any complexity, from a flat in planning application to a complex profile shape-generating edge in manufacture of turbine blade.

Keywords: tool surface, modeling, multi-parameter mappings, operator of parallel transport, flat compartment, systematization.

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INCREASED RIGIDITY AND TECHNOLOGICAL POSSIBILITIES OF THE SPINDLE WITH PNEUMATIC SUPPORTS

page 51–54

This article presents the use of spindles on the conical air bearings in high-speed machines and the results of our research in this area. The main goal of the research is to develop methods and schemes for the collection, analysis, dissemination and use of knowledge about the possibilities of pneumatic supports from various sources to improve the technological capabilities of the spindles.

High-speed processing is widely used in many fields. Using this kind of processing allows to largely reduce the manufacturing costs and, along with this, to improve the cleanliness and accuracy by increasing the rigidity of the spindle.

The presented method allows you to quickly and accurately obtain important information (the result of) using the specified input and output characteristics of the projected processing.

The research results can be applied to process engineers involved in the field of high-speed processing, as well as to obtain accurate parameters without extra costs.

We offer the use of this methodology for the calculation of the technological capabilities of the spindle, as well as determine its stiffness, which allows to increase the rigidity depending on the input parameter of the air support.

Keywords: spindle, air support, the groove of variable depth, geometrical parameters, stiffness, technological opportunity.

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IMPROVING OF WEAR RESISTANCE OF SCREW PARTS BY PLASMA SURFACING BY POWDERED MATERIALS

page 54–57

The use of reverse polarity plasma surfacing of the screw parts for the equipment of the processing enterprises of agricultural production and the results of our research in this area are discussed in this article. The main purpose of the research is the substantiation of the method of plasma surfacing of cylindrical equipment parts of the processing enterprises of agricultural production. The modern instruments and methods are used during research. The results of staged experiments provided the basis for the selection of the factors for matrix planning of laboratory tests in determining the geometric parameters of the deposited layer on the surfacing modes. The method of plasma surfacing by the powdered mixture, which provides the required mechanical properties of the deposited layer and offers for reclamation of the details of the processing equipment of agricultural enterprises, is proved. The tests at the company confirmed the results of laboratory tests to ensure the durability and quality of the deposited layers of detail.

Keywords: plasma surfacing, powder mixture, stainless steel, DC reverse polarity.

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SIMULATION OF FORMATION WAVINESS ON WORKING SURFACES RINGS OF ROLLER BEARINGS DURING CENTERLESS GRINDING OPERATIONS

page 57–61

In the article was investigated the formation of waviness on working surfaces rings of roller bearings, which causes the appearance of noise and vibration in the bearing units of machines and mechanisms. To establish patterns of appearance of waviness were used some principles of systems theory and mathematic simulation; in particular the establishments of transfer functions, finding the equation of dynamics, usage of Laplace transformations to solve differential equations, building locus diagrams and others.

For the purpose of analysis, centerless grinding system, with some simplifications was considered as a linear, continuous, closed dynamic system. On the basis of this was compiled flow-chart of plunge centerless grinding model on rigid shoes, and was found the transfer function. The solution of the system's characteristic equation revealed influence of waviness on the ground surface and the regeneration process of this waviness on the locus diagram of displacement vector of the workpiece's center.

As the investigation, result established a regularity of change of waviness harmonics depending on the geometry of rigid shoes setting. Management of waviness surface bodies of revolution on centerless grinding operations is an important prerequisite for getting optimum quality parameters of working surfaces of the roller bearing rings and as a result effect on exploitation properties of the bearing, such as noise, durability, and reliability. Using the results of this research will allow choosing such geometry of setting grinding on rigid shoes, which predictably increases or decreases the parameters of a particular harmonic of waviness.

Keywords: roller bearing, waviness, rigid shoes, locus diagram.

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POWER AND ENERGY SAVING

DEVELOPMENT OF OPERATION SUPPORT METHODS OF THE DRYING PLANT WITHIN A COGENERATION SYSTEM

page 62–66

In the article on the basis of the proposed cogeneration system it is developed a method to support the functioning of the dryer at the level of decision-making for the production of pellet fuel. Prediction of changes in moisture content of air in measuring air temperature at the inlet to the heat exchanger for heating air maintains temperature and aerodynamic drying modes based on the change speed of the fan motor of the air with a heating medium consisting of a cogeneration unit. In the production of, for example, 5,8 ths of wood pellets per year is possible to provide 860 flats of 120 m^2 area by pellet fuel, which allows taking into account the frequency control of the fan motor of the air to reduce the production cost of electricity and heat in the range of

20–30 % to obtain saving money by using pellet fuel for heating and hot water supply up to 40 %.

Keywords: pellet fuel, cogeneration system, drying plant.

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