MODELLING AND OPTIMIZATION IN MATERIAL CONSTRUCTION TECHNOLOGY

MATHEMATICAL MODEL OF DETERMINATION OF CONCENTRATION OF CARBON GAS IN EXHAUST GASES OF AUTOMOBILES

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Abstract

Cars are moved by means of a power unit - an internal combustion engine. During operation, the engine burns fuel. Depending on the type of fuel burned, the air flow rate factor and the type of engine, the combustion of the fuel can occur with the formation of products of complete and incomplete combustion. With complete combustion of the fuel, the combustion products consist of the following components: carbon dioxide CO_2, water vapor H_2O, excess oxygen O_2 and nitrogen N_2. If there are sulfur compounds in the fuel, the combustion products contain sulfur oxides SO_2 and SO_3, which are classified as harmful emissions. Nitrogen oxides in the exhaust gas usually contain NO_x and NO_2, which are also harmful to the environment. With incomplete combustion, combustible gases can appear in the combustion products of the fuel: carbon monoxide CO, hydrogen H_2, methane CH_4, and sometimes hydrocarbons C_mH_n.

In recent years, the problem of environmental protection has become increasingly important. In order to find ways to reduce air pollution, a large number of complex studies are being carried out. The success of such studies largely depends on the ability of gas analysis to determine the concentration of various harmful emissions in combustion products and industrial emissions.

The aim of the work is to develop a mathematical model for determining the concentration of carbon monoxide in the exhaust gases of cars.The study used the exhaust gases of the petrol engine of ZAZ Forza.

The content of harmful substances in the exhaust gases of cars depends on the operational modes of the car (the speed of the crankshaft, the speed of the car and the load on the car). To construct a mathematical model for determining the concentration of carbon monoxide in the exhaust gases of cars from the above factors in the form of a first-order polynomial, the methods of planning the experiment were used, namely, a complete factor experiment.

The obtained mathematical model allows to determine the concentration of carbon monoxide in the exhaust gases of cars, depending on the operating conditions of the car (the speed of the crankshaft, the speed of the car and the load on the car).

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ANALYSIS OF MATHEMATICAL MODELS OF FLOW STRESS FOR THE CONDITION OF HIGH-SPEED BLOCKS OF WIRE ROD MILLS

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Abstract

Mathematical models of rolling processes are widely used to predict technological parameters and product quality property, as well as in systems of automatic control and accounting. A required component of such models, in the form of software products, are models for determining the resistance of metal to deformation – flow stress for conditions of deformation.. The accuracy of determining the resistance to deformation by a significant amount depends on the accuracy of the determination of rolling power and other power-consuming parameters, which, in turn, determine the characteristics of the equipment, the quality of the products and the technical and economic indicators of the production processes. Therefore, the refinement of existing and the development of new models to determine the resistance to deformation, which more closely correspond with modern technological processes, remains a very topical task.

The purpose of this work is to analyze known mathematical models of resistance to deformation and possibilities of their application for conditions of high-speed blocks of wire rod mills.

Based on the analysis of known mathematical models of resistance to deformation, refined models of Zyuzin and Andreyuk are proposed. For both models it is recommended to determine the degree of deformation due to the relative change in the cross-sectional area, and the coefficient taking into account the influence of the strain rate is calculated to the values of this parameter in 300 s^{-1}. When exceeding this value, the coefficient is taken as a constant calculated for the specified value of the deformation rate. In addition, for the model of Zyuzin proposed, obtained from the approximation of experimental data, the dependence on the coefficient, which takes into account the influence of the rate of deformation. Refined models can be used to determine the resistance to deformation in high-speed blocks in the development of technology and in systems of automatic control.

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MATHEMATICAL MODELLING A ROUTE OF HYDROTRANSPORT BY MEANS OF PARABOLIC SPLINES

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Abstract

One of dustiness sources on work stations is open transportation of loose materials (sand, cement and other dust materials) by means of carriers and conveyors, and also different cargo handling facilities and launders. The most reliable, simple in manufacturing and not demanding the big expenses is without a pressure hydraulic type of transport for disalignment of materials to a dry condition. At sampling of optimum values a slope and a contour to launder, flow rates, parametres of a route and other factors was possiblly dustiness decrease on work stations in transit loose materials with its help.

Theoretical and experimental researches of disalignment materials with the help without pressure hydraulic transport were observed in many robots, but the theory disalignment of loose materials in a fluid stream to the present time is absent also sampling characteristics of a route, its contour, conditions of transportation, sites of slakers of speed and other parametres have no scientific substantiation.

The work purpose is working out algorithm of mathematical modelling a route of hydrotransport which has a smooth contour and the minimum expenses of energy for a collision.

Owing to technological habits the route of a launder hydrotransport of loose materials cannot be rectilinear on all length. The launder line consists of rectilinear sections which are bridged by slight curves. It is experimentally proved, that in places of the greatest curvature of a route owing to a collision of firm corpuscles in a following launder considerable energy is lost. For decrease in losses it is necessary to find a route profile, i.e. a contour which has the minimum curvature.

For the solution this problem the method of modelling smooth contours is used by parabolic splines. The given method shows satisfactory results in cases, when difference of altitudes the small. If the required route is abrupt infringements of isogeometrical characteristics of parabolic splines are possible, i.e. the condition of monotony a spline is not satisfied. In these cases it is necessary to use apparatuses of modelling which keep geometrical characteristics of a contour, for example, splines in the form of beams.

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MODEL OF THE MECHANISM CATALYTIC REACTIONS OF DEEP OXIDATION OF CARBON OXIDE

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Abstract

Heterogeneous catalytic reactions are among the complex multistage processes. The most important, typical stages of the processes under consideration are: adsorption of reagents, surface chemical reaction, desorption of products. The rate of these stages depends on the surface concentrations of the reagents, which are not available for direct determination in ordinary kinetic experiments. The problem is to express the reaction rate as a function of the concentrations measured (or partial pressures) of substances in the gas phase. To solve the problem, it is necessary to know the nature of these dependencies.

The purpose of the work is to establish the regularities of the mechanism of catalytic deep oxidation reactions on intermetallide Ni-Al catalysts and to determine their activation energy.

The mathematical description of the speed of the catalytic process in the form of kinetic equations can be purely empirical, resulting only from kinetic measurements or justified simultaneously by other physicochemical methods. On the basis of the results of such complex studies, stage process diagrams arise, from which certain kinetic relationships follow. To calculate the mathematical model, experimental studies were carried out at various temperatures. Based on the experimental data c, the effective reaction rate constant and coefficient were calculated.

The kinetic curve with which the activation energy of the oxidation reaction of propane on a leached intermetallic catalyst was determined was determined from the values of the effective reaction rate constant using the equation of the rate constant versus temperature.

The kinetic characteristics of oxidation of carbon monoxide and propane on an intermetallic catalyst of the composition Ni-Co-Mn-Cu-Al are determined. On the basis of the modified model of Mars-Van Crevelin, effective reaction rate constants and activation energies were obtained. For the oxidation of carbon monoxide on a Ni-Al-Co-Mn-Cu catalyst, the activation energy is 37.2 kJ/mol, which is 1.4 times lower than the activation energy of Ni-Al alloys. Thus, the developed multicomponent catalyst has a lower effective activation energy of the reactions, and therefore it more efficiently oxidizes the carbon monoxide.

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ANALYSIS OF THE NEURAL NETWORK MODELS IN THE PROBLEMS OF OPTIMIZING THE TECHNOLOGY OF ENERGY CONDENSED SYSTEMS

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Abstract

Optimizing the technology of energycondensed systems is the subject area in this article. In the technology of explosives without TNT, one of the problems is the determination of technological parameters. There are results of full-scale experiments, obtained at a private joint-stock company in Zaporozhe. The formulation of the problem is to determine the optimal technological parameters when using new technologies of nitrate condensed systems. The mathematical formulation of the problem consists in determining the output parameter - the strength of ammonium nitrate with the available input data

From a formal point of view, the formulated problem is an approximation problem. The author knows the classical approaches to solving problems of this class, but it is proposed to use the mathematical apparat of the theory of artificial neural networks.

Based on the theorem of Hecht-Nielsen and Kolmogorv-Arnold and the consequences of them, it is proposed to consider one and two-layer neural networks. The technology of creating a neural-network component is considered in stages.

The preliminary stage of preparation of training samples for a neural network is disassembled. In the event that the specified network error is sufficiently small, a separate software module is developed to obtain the required volume of training samples. The parameters of the choice of network architecture and its learning are analyzed. Two types of sigmoidal activation functions are considered.

The process of learning the neuro-network component and its features is described. As an algorithm, an algorithm for back propagation of an error without an inertial component is used. The trained neural networks were tested on the reserved samples. An analysis of numerical results is made, on the basis of which it is possible to choose from the set of applicants the best neural network component. Of the many applicants with almost identical parameters, it was decided to choose a neural network with the simplest architecture. The trained network was further built into the overall process of optimizing the technology of energy condensed systems.

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MATHEMATICAL MODELING OF DISPERSION PROCESS OF EMISSIONS FROM CONSTANTLY OPERATING STATIONARY SOURCE OF POLLUTION

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Abstract

The processes of extraction and processing of ironstone are accompanied by pollution of atmospheric air when carrying out the specific technological processes. The main task is to minimize harmful emissions and reduce their negative impact on the environment. The problem of atmospheric air pollution in cities became so serious that there is a need for timely information of changes in measures and level of pollution for more detailed monitoring system implementation.

The authors pay attention to the development of a mathematical model and its numerical implementation for the creation of software for calculations of the concentration of impurities (carbon monoxide) entering the atmosphere from a permanently operating stationary source of pollution, namely from «Northern mining and processing plant».

The mathematical model is based on the solution of the three-dimensional transfer equations of the impurity, which comes directly from the permanently operating stationary source (mining and processing plant). To construct a numerical model, the implicit alternating-triangular difference scheme is used, which approximates the equation and is constructed on a rectangular difference grid.

The concentration is determined in the center of the difference cells, the components of the velocity vector of the air are given at the boundaries of the difference cells. The approximation of the derivatives of the first and second order and the splitting of the difference equation into four steps in integration over time are carried out.

As a result, the created software allows conducting computational experiments to calculate atmospheric air pollution zones with carbon monoxide, taking into account meteorological parameters.

Areas and levels of pollution located in the direction of the wind relatively to the source of pollution are determined. The possibility of estimating the measure and level of pollution may be useful for developing a scheme for location of observation posts for atmospheric air quality in the city for the system of monitoring and taking steps for environmental safety of the population.

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APPLICATION OF METHODS OF MATHEMATICAL DESIGN AT DEVELOPMENT OF COMPOSITIONS OF REACTIONARY MIXTURES FOR CAUSING OF MULTICOMPONENT SHS-COATINGS

Sereda B.P., Palekhova I.V., Kruglyak I.V.

Abstract

In order to improve the reliability of equipment, reduce the cost of its maintenance, increase the service life, titanium-based coatings are widely used. Since in difficult operating conditions one-component titanium coatings are not able to provide the necessary working properties of products, it is advisable to saturate the metal surface with several elements. Joint saturation of Ti and Si steels allows not only to increase the hardness of the surface layer, heat resistance and corrosion resistance of products, but also to increase the thickness of applied coatings and accelerate the process of their formation. Since most traditional methods of chemical heat treatment are characterized by high energy costs and process durations, the authors considered a resource-efficient technology of chemical-thermal treatment of steels in conditions of self-propagating high-temperature synthesis (SHS).

The purpose of this work was the development of powdered SHS-mixtures for the deposition of multicomponent coatings on the basis of titanium in the regime of thermal autoignition, the study of the physicochemical processes of coating formation, the determination of the optimum technological parameters of the SHS process with complex saturation, the study of their influence on the kinetics of layer growth and the evaluation their quality.

The gas-transported SHS-technology of obtaining multicomponent titanium coatings in the regime of thermal self-ignition on iron-carbon alloys is considered. The regularities and mechanisms of their formation are investigated. The dependence of coating thickness on technological process parameters (temperature and duration of isothermal aging) was established experimentally.

In order to analyze the formation of complex coatings based on titanium under SHS conditions, the equilibrium state of the reaction products in multicomponent powder systems was calculated. The proposed kinetic scheme of chemical transformations is proposed. Kinetic and thermophysical regularities of coating growth are established.

Using the methods of mathematical modeling, the authors developed compositions of SHS-charges for obtaining multicomponent titanium coatings on carbon steels. Data are obtained on the effect of the thermophysical characteristics of SHS-charges on the structure, strength and porosity of the coatings. Titanosilated materials with SHS-coatings have improved performance characteristics in comparison with diffusion analogues.

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TO OPTIMIZATION OF CONTROL BY HEAT WORK FOR FLAMING THERMAL FURNACES CHAMBER TYPE AT HEATING OF MASSIVE BARS

Zinchenko V.Yu., Ivanov V.I., Cheprasov A.I., Kayukov Yu.M.

Abstract

The flaming thermal furnaces of chamber type got wide distribution in connection with universality of heat treatment by different in a form and mass of bars, but quite often are economic ineffective aggregates. In this connection a basic task is certain of development of control by the fields of temperature in furnaces, by motion of warming gases and also optimization of heat work in the whole.

The analytical decision of nonlinear tasks of radiation-convective heat exchange at the non-stationary temperature of warming environment in the furnaces of this type has substantial complications. So, differential equation of heat conductivity from nonlinear dependence of thermophysical metal parameters on a temperature, become nonlinear and does not have an only decision.

A task of this work is a making of simple mathematical model of heating of massive bars, allowing without the decision of differential equation to work out the algorithm of change of temperature of warming environment in time, which provides the given distribution of temperature on the section of the heated metal.

Coming from that an optimal on a quick-action control is the piece-wise linear function of time and the temperature of warming environment changes from a maximum-possible size to the value, corresponding to the given temperature of metal surface, development of control algorithm is taken to determination of moments of switching of the thermal loading of furnace.

As basic data at a modeling there are give the thermophysical parameters of metal charge, limitations on speed of its heating, temperature of furnace, initial and eventual distribution of temperature on the section of metal.

On results calculations there is determine the temperature-time mode at which in a metal the given distribution of temperature during the minimum interval of time is provided.

At the definition of the required distribution of temperature in a bar it is apple the method of lines, in accordance with which the heated thickness of metal is divided into separate areas, and a decision is executed by the method of progressive approximations.

Adequacy of mathematical model there is define by comparison of optimal on a quick-action algorithms of control with the results of calculation on the models of other authors. Enough convergence of the got results is detected.

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METHOD OF PHYSICAL MODELING OF FLOATING OF THE NONMETALLIC INCLUSIONS GROUP IN A TEEMING LADLE

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Abstract

The authors considered an important problem for steel quality, consisting in removal of nonmetallic inclusions. The peculiarity of this work is the consideration of the floating process of nonmetallic inclusions in a ladle without the use of any external influences (blowing of inert gas, electromagnetic stirring, etc.), but only by Archimedean force. Such formulation of the problem is relevant for teeming ladles of small capacity, not equipped with blowing devices and electromagnetic stirrers.

In order to study the processes of floating up a group of nonmetallic inclusions in steel, the authors have proposed to use the method of physical modeling on the water model. The task, solved in this paper, is the development of a physical modeling technique consisting in determining the similarity numbers for the description of the process, calculating the scales of modeling and selecting substances for imitation of the main phases.

On the basis of the carried out work, it is determined that the process of floating up a group of nonmetallic inclusions can be described by Archimedes number, number of homochronality and a dimensionless linear simplex. In view of the fact that the linear scale of the model satisfying these criteria is 1.7: 1 for water, a hypothesis of self-similarity of the dimensionless linear simplex has been put forward. The hypothesis makes possible an adequate simulation of floating up a group of nonmetallic inclusions up to 300 μm on models at a scale of 1:10. An experiment plan is proposed to confirm this hypothesis. The consequences of confirmation and refutation of the hypothesis based on modeling results are considered.

The technique proposed by the authors after an insignificant development will allow to carry out adequate physical modeling of the process of floating of nonmetallic inclusions in the ladle under various external influences, in particular, during inert gas blowing, electromagnetic stirring, etc.

The results of the experiment with the developed technique will allow to determine the holding time of the teeming ladle sufficient for the floatind up the nonmetallic inclusions of various sizes in industrial conditions.

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MATHEMATICAL MODEL OF FORMING GAS-METALLIC FLOW IN STEEL-TAPPING CHANNEL OF THE CONVERTER

Pohvalityi A.A., Sigarev E.M., Chubin K.I., Poletaev V.P., Pohvalita O.V.

Abstract

For obtaining steels responsible destination in most cases requires a particularly low residual content of dissolved gases and harmful impurities, including oxygen (less than 15 ppm) and sulfur (30-100 ppm). The content of these impurities in the finished product depends to a large extent not only on the overall level of the technology of smelting, after-treatment and casting, but also on the degree of perfection of the melt protection technology from contact with the atmosphere at the stages of tapping and transfusion. Improving the technology of melt tapping, taking into account the possibility of using the refining potential steel-tapping channel of the oxygen converter, is an urgent task.

In a number of papers, the operation of carbon deoxidation of the nondeoxidized steel is proposed to be performed during the process of melt tapping from the converter by organizing the blowing of a metal flow with an inert gas (argon) in the working space of the steel-tapping channel. Such a technique allows to reduce the pressure and consumption of neutral gas, to use the carbon potential of iron-carbon melt and to reduce resource and energy costs for the production of finished metal products. In known studies, there is practically no information on the mathematical description of the process of melt production with the organization of simultaneous deoxidation, which takes into account the peculiarities of the formation of the gas-metal flow in the steel-tapping channel of the oxygen converter.

The aim of the work is to develop mathematical models and numerical modeling of the melt tapping process with the determination of the influence of the consumption characteristics of the neutral gas and the geometrical parameters of the steel-tapping channel of the oxygen converter on the formation of the gas-liquid flow and the possibility of protecting the latter from atmospheric influences. According to the results of numerical simulation, it is proved that the use of an innovative two-chamber design of the steel-tapping channel of an oxygen converter can provide an increase in the degree of organization of the gas-metal stream and its protection against atmospheric influences.

The mathematical models for studying the influence of the structural and technological characteristics of the carbon deoxidation of the metal melt on the tapping into the steel-pouring ladle by the injection of neutral gas into the working space of the steel-tapping channel of the oxygen converter are presented.

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OPTIMIZATION OF COMPOSITIONS OF MULTICOMPONENT PROTECTIVE COATINGS ON BROTHERS AND BRASSES OBTAINED IN THE CONDITIONS OF SELF-SPREADING HIGH-TEMPERATURE SYNTHESIS

Kruglyak I.V., Kruglyak D.O., Sereda D.B.

Abstract

The results of the investigation of Ti-Al-Si, Ti-Al-Cr brass and bronze in the conditions of SHS are given in the work. The saturation process was studied at temperatures of 750 ± 850 ºC with exposure at these temperatures in the range of 0.5-1.5 h. As studies have shown, the process of titanium-alumino-siliconization at a temperature of 800 ºC and a process duration of 1.5 hours is most intensive. With an increase in exposure for more than 1.5 hours, the depth of the diffusion layer varies insignificantly. At a temperature of 850 °C and a duration of 1.5 hours, the samples are reflowed.

As a result of the regression analysis, a number of equations were obtained showing the dependence of the physical and mechanical properties of the protective coatings on the content of silicon, chromium, aluminum, and titanium. In a study on heat resistance, it was found that with increasing silicon content, the weight loss decreases. All other alloying elements (titanium, aluminum) are recommended to be taken at the upper level (10-15% by weight) in order to compensate for metal losses.

The optimal mode of auto-ignition process is: holding temperature - 900 ºC, holding time - 60 min, maximum heating temperature 800 ºC.

As a result of the thermodynamic analysis of the reactions of SHS mixtures, in the regime of thermal self-ignition, physico-chemical transformation schemes were developed, including 5 stages: inert heating; thermal self-ignition (the main exothermic reaction occurs); achievement of maximum process temperature; exothermic aging and cooling.

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DETERMINATION OF THE POWER ACTION OF THE ALTERNATING CURRENT ON METAL IN THE POOL LADLE-FURNACE UNIT

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Abstract

The work is devoted to theoretical research in the field of secondary steel processing. The expediency of using mathematical modeling for studying the processes taking place in the ladle-furnace units is noted.

A mathematical model of the electromagnetic field in the pool of metallurgical aggregates is proposed, in which the heating of metal by electric arcs of alternating current is used. This model makes it possible to calculate the density of electromagnetic forces acting on a liquid metal in metallurgical aggregates.

The results of calculating the magnitude of the electromagnetic forces of a metal melt arising during heating in a ladle with a capacity of 60 t on an alternating current ladle–furnace unit are presented. It was found that with the use of alternating current, the influence of electromagnetic forces on the secondary treatment process became less than with the use of direct current. The above illustrations show that in the ladle-furnace units of alternating current, considerable electromagnetic forces are observed only near the surface of the metal pool. It is shown that in the case of theoretical studies of metal mixing in aggregates of an alternating current ladle–furnace, electromagnetic forces can be attributed to insignificant factors.

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THE MAIN APPROACHES TO OPTIMIZING THE MASSES OF MECHANICAL TRANSMISSIONS' GEARS

Romaniuk O.D.

Abstract

The problem of stabilizing the kinematic and dynamic characteristics of a machine unit in the steady-state motion regime is usually realized by increasing the reduced moment of inertia. To do this, will be used the additional masses, the flywheels, which, unfortunately, increase the acceleration time and the mass of the machine. Elimination of the corresponding disadvantages of additional masses can be realized by changing the approach to the design of mechanical transmissions' gears.

In this work was made a deep analysis of the dependence of the main geometric parameters of the mechanical transmission. It was made with the aim of influencing the optimization process at the stage of preliminary design of the mass of the gear wheel, which corresponds to the flywheel moment of the flywheel.

The corresponding analysis was conducted according to the equations for determining the mass of the gears, taking into account their basic geometric parameters. As a result, were obtained the graphical dependences of the gear wheel mass on the mass ratio. These dependencies make it possible to optimize the main geometric parameters of the gears at the preliminary design stage. Accordingly, it is possible to reach the necessary value of their mass, the moment of inertia of which would correspond to the flywheel moment of the flywheel in the machine's executive body.

The use of the proposed approach in the design will allow to select the corresponding masses of gears, the moments of inertia of which correspond to the flywheel moment of the flywheel, which is necessary for stabilization of the dynamic characteristics of the machine's executive body.

Considering the fact that the rotational mass of the mechanical transmission in the drive circuit consists not only from the gear wheel, but from the mass of the shaft and bearings, further research can be aimed at expanding the mathematical model. The purposefulness of further research is due to the fact that the mass of the shaft and bearings in the gears that transmit significant torque is almost equal to the mass of the gear wheel.

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MATHEMATICAL MODELING OF THE METALLOGRAPHIC IMAGE BY SOLUTVING THE LAPLACE EQUATION BOUNDARY PROBLEMS

Klochko O. Yu.

Abstract

In the present paper we describe the new approaches for construction of computer models of metallographic heterogeneous structure using mathematical modeling and solving Laplace equation boundary problems, which allow one to obtain the high-accuracy images of structures. In our research we take the diffusion processes that occur during structure formation into account.

Our research has been carried out by modeling the structure formation of the complex heterophase alloys (e.g., high-chromium cast iron rolls) affected by a large number of complex processes similar to the hydrodynamic ones. The modeling has been performed with applicain of a range of boundary conditions in order to obtain and compare the solutions of Laplace equation.

In the process of modeling we have studied the interior regions specified by the microstructure image with the finite-difference iteration method used. As a result, the values of the conventional colors and their distribution have been found, while making a comparison of the original structure metallographic image with the distribution of the conventional colors. The described method helps one to achieve the minimum deviation in the results

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PHYSICO-CHEMICAL MODELING OF OBTAINING IN THE CONDITIONS OF SELF-PROPOGATING HIGH-TEMPERATURE SYNTHESIS FO CORROSION RESISTANT COATINGS

Beigyl O.A., Sereda D.B.

Abstract

There are many methods of strengthening the surface of brass and copper alloys, some of them are used in several versions. The most advanced techniques in this area include surface hardening using laser technology, electron beams, ion implantation, etc., as well as classical methods of chemical-thermal surface treatment (nitriding, boriding).

Surface saturation of copper materials with aluminum, chromium, boron, silicon, titanium and other elements is called diffusion saturation with metals. The product, the surface of which is enriched with these elements, acquires valuable properties, including high heat resistance, corrosion resistance, increased wear resistance and hardness.

Actual application of technologies that allow obtaining coatings with limited or minimal time of their formation. One such technology is the self-propagating high-temperature synthesis.

Among the SHS processes involving chemical compounds as reagents, the most significant class (having the largest technological applications) are the so-called SHS reactions with a reducing stage.

The paper presents the results of physical and chemical modeling. A model was developed for the formation of doped chromium-plated coatings under conditions of thermal autoignition, which consists of 5 stages. Anticorrosive protective coatings have been obtained to improve the performance characteristics of machine parts and mechanisms. It has been proved that, after the test, the best values are provided by protective coatings doped with silicon and titanium, due to the formation of passive oxide protective membranes Al_2O_3, Cr_2O_3, TiO_2, SiO_2. A comparative analysis of the corrosion resistance of protective coatings obtained under isothermal conditions and SHS showed that they have a mass loss of 1.7-2.1 times higher.

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MODELING OF COMPOSITION OF THE POWDERED WIRE FOR OVERLAYING WELDING ACTIVE FACES OF THE FEEDER WITH OPTIMUM HARDNESS

Hasylo Yu.A., Ivchenko P.S., Kamel H.I., Dudnikov O.V.

Abstract

While in service there is an obtunding of active faces and deterioration the joint a rotor and the cage a rotor feeder of Swedish firm “Camear”, it is bundled to contact chafing of connecting surfaces in the conditions of a high pressure (squeezing) microvolumes working edges under the influence of

cutting of a woody cod and other firm subjects (electrodes, a wire, bolts, a bosk and other ectogenic subjects).

Active faces a rotor and the feeder cage cease to carry out the function and thus positive allowances which leads to emersion critical an expense of a meadow from a feeder and their preschedule removal from maintenance increase. Using different materials at overlaying welding of active faces a rotor and the cage we can reach increases in service life of feeders.

In the conditions of a world economic crisis, use a valuable material for overlaying welding of active faces a rotor and the cage of Swedish firm "Camear" has under itself no volume substantiation, in the further work we will observe recoveries by means of materials and sampling of a material which more all meets the requirements is made — has sufficient hardness, strength and impact strength.

Paper is devoted working out a tailored composition of a powdered wire with maintenance of the maximum hardness.

For the purpose abbreviation volume of explorations at sampling system of an alloy building welded metal is spent multifactorial correlation analysis.

To raise impact strength welded metal it is possible as a result of alloying by its cerium. It is known, that a microalloying became cerium leads to raise of plastic properties metal. For the purpose of check agency cerium on impact strength there were welded samples with different its contents. With increase in a mass corpuscle of cerium from 0,05 % to 0,1 % value of impact strength and hardness grow. At the further increase in the contents of cerium (from 0,1 % to 0,2 %) impact strength continues to raise, but hardness considerably drops. For the purpose of reception the optimum mechanical properties necessary for a material of active faces a rotor and the cage, cerium contents in welded metal have restricted within 0,06—0,12 %.

By results of exploration it is possible to draw a leading-out which material 50XHM which by means of mathematical planning (multifactorial correlation analysis) were in addition alloyed (increased contents of carbon, manganese and chromium) the most effective and inexpensive materials which can be used for restoration to overlaying weldings of active faces of details a feeder is.

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MATHEMATICAL MODELING OF STEPS OF THE SURFACE LOAD OF DETAILS IN DEPENDENCE FROM LOAD MODES

Chernet O.G., Sukhomlin V.I., Voloshchuk R.G.

Abstract

Methods of obtaining wear-resistant coatings are considered in this work, and mathematical modeling of the degree of wear of a surface layer is carried out, depending on the modes of combined loads. The graphic dependences of the intensity of wear on the surface layer of the component are obtained depending on the hardness, speed, combined loading modes and the period of tribological exams. An analysis of the transformation of the structure of wear-resistant layers from steel 45 is

carried out depending on the technological methods and physical and mechanical properties of the working surfaces, which are given in photographs with microstructures of the corresponding layers of the working surface. Also graphic dependences of microhardness of the corresponding areas of working surfaces are given.

Sufficiency of the estimation of the average general accumulation can be described with the help of quantiles normalizing normal distribution . The experiment investigates - the mass loss of material in the process of wear (X). The wear process is affected by the microhardness of the coating material (X1), the contact pressure P (X2), the velocity of the sample V (X3) and the wear time (X4).

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THE MATHEMATICAL MODEL OF THE CLEANING OF GRINDING SLUDGE PROCESS

Vernyhora V.D.

Abstract

Continuing pollution of the natural environment with solid, liquid and gaseous wastes of production and consumption, causing environmental degradation, has recently been the most acute environmental problem, has a priority social and economic significance.

At the machine-building enterprises, especially in bearing plants, thousands tons of metal-containing slurries are formed every month.

A special problem is grinding sludge, which is a conglomerate of metal particles with abrasive inclusions, impregnated with LCL (lubricant-cooling liquid), oils. Because of the high content of grinding sludge, there are no metal inclusions, oils and LCL; they cannot be utilized without pre-processing.

The authors [1] developed a technological process and a complex system of equipment for extracting metal particles from sludges of abrasive metal processing. The study of the process of sludge washing of abrasive treatment of metals was carried out [2].

The task of the work is to determine the amount of mineral oil I-20, which passes into the cleansing solution "Labomid" in the cleaning of grinding sludge process. The problem was solved by

finding the conditional minimum of the response function for the amount of pollution $G(\tau)$. With the aim of solving the problem, materials, methodologies, and approaches contained in the papers [1-3] were used.

To make a mathematical model of the dependence of the pollution amount $G=f(M_м,C_p,T,\tau)$ (kg), which is transferred from the slurry of the abrasive treatment of metals to the washing solution from the above factors, we use the methodology for planning the experiment for $\kappa = 4$ [4,5]. The constructed mathematical model is represented by the following formula:

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_{12}x_1x_2 + b_{13}x_1x_3 + +b_{14}x_1x_4 + b_{23}x_2x_3 +$$
$$+ b_{34}x_3x_4 + b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2 + b_{44}x_4^2$$

The mathematical model of the process of sinking of abrasive treatment of metals in the washing solution was developed, which permits determining the amount of lubricating oil passes into the washing solution at predetermined time intervals of the sink. This will improve the washing process and minimize the overall measurements (length) of the equipment-washing chute for the processing of sludge abrasive metal processing.

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PHYSICAL MODELING OF INFLUENCE OF NON-METAL FABRICS STEPS TO RUNNING

H.A. Bialik, S.I. Adamchuk, V.V Naumik, R.E. Mokhnach,

Abstract

In the article the brought results over of developments of the use of physical design of processes of destruction are permanent under act of non-metal disseminations of different form and composition. For practical realization designs worked out and made the special setting.

Research of micromechanisms of origin and distribution of cracks near non-metal disseminations by means of physical design allowed to perfect the technological processes of smelting permanent and to minimize harmful influence of non-metal phase on operating properties of steel, as construction material. Visualization of tensions showed directly near non-metal disseminations, that a main factor for the origin of microcracke is a geometrical form. Research was executed by a polarization-optical method on the specially worked out and made setting with the use of transparent optically-anisotropic models. The set features of origin and distribution of cracks are from non-metal disseminations of different geometrical form. Most dangerous are disseminations with acute angles, near that there are high local tensions. The optimal form of disseminations is globular, near that local tensions far fewer. A local flowage that is fixed on the diagrams of load-deformation of model

standards was preceded destruction of model standards. The set features of origin and distribution of cracks are from non-metal disseminations of different geometrical form. For practical realization of design the special setting is worked out and made. Undertaken studies allowed to specify the processes of origin and distribution of crack near non-metal disseminations on the initial stage.

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THE CALCULATION OF INTERATOMIC POTENTIAL DENSITY DISTRIBUTION IN THE STRUCTURAL UNITS OF MATTER

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Abstract

Introduction. Theoretical study of the physical properties of matter at the nano and micro level, is an urgent task of modern science: currently computing capabilities allow to develop new methods for studying the physical properties of solids at the micro level, as well as directly to investigate the interatomic interaction. One of these methods is the method of structural units, which can be used to study and predict the physical properties of materials [1—6].

Methods of calculating density. As the simplest structure will consider the cubic structural unit whose atoms are arranged in crystal lattice parameters with a×b×c. Interatomic force and constant of the interatomic bonds are linked with an interatomic potential relations: [7]

$$\frac{d\Pi(\Delta r)}{d\Delta r} = -F(\Delta r) = k(\Delta r)\Delta r\,;\ \frac{dF(\Delta r)}{d\Delta r} = \frac{dk(\Delta r)}{d\Delta r}\Delta r + k(\Delta r).$$

We divide the amount of the structural units in the elementary volumes $\Delta V = \Delta a \cdot \Delta b \cdot \Delta$. We assume that the resulting value in interatomic potential of each point of the structural unit amount *P* (*x*, *y*, *z*) is a superposition of all atoms potentials included in the structural unit.

$$\Pi(x,y,z) = \sum_{\gamma=1}^{N_a} \Pi_\gamma, \gamma = 1,2 \ldots . N_a;$$

equation relationship space coordinates of points P (x, y, z) with considering can be written as follows:

$$\Delta r = \overrightarrow{p^i} + \overrightarrow{p^{ii}} + \overrightarrow{p^{iii}} = \sqrt{x^2+y^2+z^2} = \sqrt{(\Delta a \cdot i)^2 + (\Delta b \cdot j)^2 + (\Delta c \cdot k)^2};\ x = \Delta r\ sin\theta \cdot cos\varphi;$$

$$y = \Delta r\ sin\theta \cdot sin\varphi;\ z = \Delta r\ cos\varphi cos\varphi = \frac{z}{\sqrt{x^2+y^2+z^2}};\ tg\varphi = \frac{y}{x}.$$

The current value of the coordinates of the point: $P(x,y,z) = P(\Delta a \cdot i, \Delta b \cdot j, \Delta c \cdot k)$.

Coordinates of the atoms in the structural unit: $\Delta r_{10} = (0,0,0), \Delta r_{20} = (0,0,l), \Delta r_{30} = (0,m,l), \Delta r_{40} = (0,m,0)$, $\Delta r_{50} = (n,0,0), \Delta r_{60} = (n,0,l), \Delta r_{70} = (n,m,l), \Delta r_{80} = (n,m,0)$.

The magnitude of the radius vector to the structural units of atomic drawn from its place:

$$\Delta r_\gamma(x,y,z) = \left[(x-x_{\gamma o})^2 + (y-y_{\gamma o})^2 (z-z_{\gamma o})^2\right]^{\frac{1}{2}}.$$

Substituting the value in interatomic potential find potential contribution to the output potential:

$$\Pi(x,y,z) = \sum_{\gamma=1}^{N_a} \Pi_\gamma(x,y,z).$$

Local potential density in a volume element is determined from the relationship: $\Delta V = \Delta a \cdot \Delta b \cdot \Delta c$

$$\Delta\Pi = \frac{\left[\begin{array}{c}\Pi(i,j,k) + \Pi(i,j,k+1) + \Pi(i,j+1,k) + \\ +\Pi(i+1,j,k+1) + \Pi(i,j+1,k+1) + \\ +\Pi(i+1,j+1,k) + \Pi(i+1,j+1,k+1) + \\ +\Pi(i+1,j,k)\end{array}\right]}{\Delta V}.$$

Integral potential density in the structural unit:

$$\Pi_{\text{structural unit}} = \Delta\Pi \cdot N = \Delta\Pi \frac{V_{\text{structural unit}}}{\Delta V}.$$

Variants of the structural units in the case of a face-centered and body-centered structure is also possible to calculate with the proposed model by adding relevant atoms to a structural unit. In case of external influences on the structural unit: heat input, deformation by an external force, the values will vary with the change of interatomic distances and axes - this must be considered when studying the effect of external influences on the structural unit.

The stiffness coefficient value in the directions x, y, z can be represented as matrices:

$$k_{ij} = \left|\begin{array}{ccc} k_{11} & k_{12} & k_{1m} \\ k_{i21} & k_{i22} & k_{2m} \\ k_{31} & k_{32} & k_{3m} \\ \hline k_{n1} & k_{n2} & k_{nm} \end{array}\right|; \; k_{ik} = \left|\begin{array}{ccc} k_{11} & k_{12} & k_{1l} \\ k_{i21} & k_{i22} & k_{2l} \\ k_{31} & k_{32} & k_{3l} \\ \hline k_{n1} & k_{n2} & k_{nl} \end{array}\right|; \; k_{jk} = \left|\begin{array}{ccc} k_{11} & k_{12} & k_{1l} \\ k_{i21} & k_{i22} & k_{2l} \\ k_{31} & k_{32} & k_{3l} \\ \hline k_{m1} & k_{m2} & k_{ml} \end{array}\right|;$$

expression make it possible to calculate the forces arising during the deformation of the structural unit of the directions x, y, z, their interconnection and the flow of electrons through a volume element by placing the structural unit in an electric field. To do this, we use Schrödinger equation. The probability flow passage of the electrons through the cross-section volume:

$$q = \frac{i\hbar}{2m}\left[\psi^*\left(\frac{d\psi}{dx} + \frac{d\psi}{dy} + \frac{d\psi}{dz}\right) - \psi\left(\frac{d\psi^*}{dx} + \frac{d\psi^*}{dy} + \frac{d\psi^*}{dz}\right)\right].$$

Use the law of conservation of probability, which can be interpreted as the law of conservation of the number of particles which are in a given quantum state, then the density of the particles (electrons) at every point of the structural units may be expressed in terms of the wave function: $W_{\Delta V} = N_{\Delta V}|\psi|^2$

Integrating this equation define the number of particles in the volume: $N_\Sigma = N_{\Delta V}\int_0^{\Delta V}|\psi|^2 dV$

The flow of particles through a surface bounded by the volume will be equal to decrease the probability of finding the particles in this volume: $\frac{dW_{\Delta V}}{dt} = -N_{\Delta V}\oint_S q\, ds$.

Conclusions. Using the proposed method of calculating the density of interatomic interaction potential in the structural unit allows the Schrödinger equation for calculating the particle density, particle flow over time at a given point of the structural unit. Knowing the value of potential at this point and using these expressions allows to investigate the physical properties of a material consisting of structural units of data. Given that a particle can involve (in a broad sense): electrons, phonons, photons. Accordingly, electrons characterize *conductivity, phonons - heat distribution in the structural unit (i.e., thermal conductivity), photons - light dissemination. Changing the integral value of the interatomic interaction potential characterizes the deformation of the structural unit, stationary distribution* and local stiffness coefficient allows for explaining high-frequency currents in the surface layer of the metal, the phenomenon of diffusion in metals etc.

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