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DEVELOPMENT OF TECHNOLOGICAL SUPPORT OF QUALITATIVE THREADED JOINTS OF PARTS MADE OF ALUMINUM ALLOYS

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Analysis of existing technological processes of manufacturing parts and assembly of hermetic threaded joints in pneumatic equipment reveals the main factors that determine the quality and productivity of the hole machining. It is shown that for such processes as maintenance of the necessary performance characteristics of the joints, it is necessary to control the parameters of the state of the surface layer in the process of their manufacturing. It is also necessary to be able to calculate them at the design stage of the technological process.

Research results of the technological properties of AK12M2 aluminum alloy obtained by die casting are given, namely, modeling of the surface plastic deformation (SPD) of AK12M2 cast aluminum alloy. Also, the properties of the surface before and after SPD and the effect of the deformation angle are compared, taking into account the number of SPD cycles for the surface quality.

An analytical and experimental study of machining method of threaded holes with the use of a deforming tool is carried out, taking into account the modeling of the shaping process of inch threads in blind holes by a deforming tool. Formation of a dense surface layer from the porous structure of the material is investigated as an option to increase the tightness. The constructive and technological parameters of the deforming tool for blind holes for pipe cylindrical threads (up to 2″) in parts made of aluminum alloys with gas and shrinkage porosity are developed. A possibility of providing a qualitative surface layer of blind holes after PPD of AK12M2 alloy due to the application of a deforming tool in the technological process machining is theoretically proved. New tool designs and practical recommendations on the selection of machining regimes are proposed, ensuring the number of loading cycles – 12–13, the deformation angle – 4 degrees, the deformation rate – ζ=3.77 m/min with a cross-feed rate – S=0.05 mm/rev. A comparison of the quality of threaded joints, obtained by the basic and new machining method and evaluation of economic efficiency is carried out. This allows to reduce the technological cost and obtain economic benefit by reducing the labor intensity of machining and the cost of tools and process fluids.

Keywords: technological process, threaded joint, aluminum alloy, gas and shrinkage porosity, deforming tool.

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PARAMETRIC IDENTIFICATION IN THE PROBLEM OF DETERMINING THE QUALITY OF DUSULFUSATION AND DEPOSPHORATION PROCESSES OF Fe-C ALLOY

page 9–15

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It is established that an algorithm for parametric methods of pattern recognition can be used to build a classifying rule that allows to identify a section of the duplex-melting process «cupola – electric arc furnace», which has a lower index of parametric reliability. It is shown that in this case it is sufficient to build a linear discriminant function.

The resulting classifying rule provides a high recognition rate (91.4 % and 97.1 %) of object belonging to class A (melting in cupola) and class B (melting in electric arc furnace), respectively. This allows it to be recommended for decision support systems for desulphurization and dephosphorization control in the duplex-melting process «cupola – electric arc furnace». The application of this rule opens the possibility of improving the quality of desulphurization and dephosphorization control due to the correct choice of control actions.

Additional opportunities for using the above results in industrial conditions are associated with the use of the classifying rule in decision support information systems. It can be implemented by integration of the appropriate mathematical description into the melting information control system (ICS).

Keywords: parametric methods of pattern recognition, classifying rule, desulfurization, dephosphorization.

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MATERIALS SCIENCE

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INVESTIGATION OF THE CURRENT STATE OF ISOSTATIC GRAPHITE PRODUCTION TECHNOLOGY

page 16–21

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The study of isostatic graphite production process and its development trends in the world market was conducted.

It was established that the isostatic graphite production is a complex and multistage process that requires careful preparation of raw materials, the usage of powerful specialized pressing equipment, the use of elaborate heat treatment modes etc. As a result, it creates a high final price comparing to other brands of graphite materials.

Methods of synthesis, analysis and systematization of available information regarding the isostatic graphite production were used for the study.

The peculiarities of foreign isostatic graphite production technology were determined, which allows to set directions of improvement by Ukrainian producers, namely:

– choice of components and their composition for coke and pitch mixture;
– adding special modifiers;
– optimization of particle size distribution of the filler;
– setting the pressure for pressing moulding powder;
– choice of modes of blanks thermal processing etc.

The level of future growth in global demand is determined for isostatic graphite materials and products based on it, which is more than 5 % of the annual global volume of production.

The results enable further research in order to develop equipment and rational modes of grinding, mixing and pressing coke-pitch compositions using available Ukrainian brand coke and pitch. Furthermore, it will allow in the future to conduct a study of pressed billets heat treatment to reduce the unit cost of electricity and improve the process of isostatic graphite material manufacturing.

Keywords: isostatic graphite, isostatic pressing, photogalvanic industry, heat-resistant material, coke-pitch composition.

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EFFECT OF SURFACE ROLLING ON MECHANICAL PROPERTIES OF Ti–Al SYSTEM ALLOY

page 21–24

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Taking into account the problem of modern aircraft engine building, new materials are being actively introduced to increase the service and reliability of products while reducing their material consumption. Namely, nickel alloys are replaced by lighter intermetallic alloys of the Ti–Al system, which is the object of the research. However, the use of a new class of alloys is complicated because of the high demands placed on these materials. Consequently, the intermetallic alloys used in the critical components of the aircraft must be not only strong, but super-strong.

To solve the problem of increasing the level of strength, it is suggested to use the roller burnishing, which consists in the fact that the rollers are pressed against the surface of the processed material, which leads to plastic deformation in the surface zone. As a result of deformation, changes in the structure of the surface layers of the material occur, which, in turn, leads to an increase in the mechanical characteristics.

Experiments have been carried out to strengthen the alloy of the Ti–Al system. The effect of roller burnishing on alloy Ti-45Al-5Nb (at %) is studied and it is established that after surface roller burnishing, the fatigue strength of alloy Ti-45Al-5Nb (at %) is increased by 4 %, from 675 to 725 MPa. It is shown that surface roller burnishing reduces the maximum surface roughness by 0.4 μm (from 2.4 μm to 2.0 μm).

Keywords: roller burnishing, intermetallic alloys, Ti–Al alloys, fatigue cracks.

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EFFECT OF PIECEWISE LINEAR CURRENT WAVEFORMS ON SURGE ARRESTER RESIDUAL VOLTAGE

page 25–31

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The object of research is the magnitude and shape of the residual voltage that arises between the terminals of the surge arrester models when they are subjected to current and voltage pulses of a piecewise linear waveform. One of the most problematic places in this problem is the approximation of current switching pulses with a short duration and also steep front current pulses. With the help of the well-known double-exponential pulse, it is impossible to describe a pulse whose time-to-half duration T_2 is twice bigger the time-to-crest duration T_1. At the same time, current pulses in the manufacturer catalogs of the surge arresters have exactly this ratio (1/2, 30/60 or 45/90 μs).

With the help of piecewise linear approximation, it is possible, bypassing complex calculations, to describe pulses of almost any shape, including switching current pulses and steep front current pulses.

By means of evaluation version of Micro-Cap 11 circuit simulator the residual voltage on the surge arrester terminals is computed during a passage of the current pulses with different amplitude and wave shape. Current sources used in this research represent sources of simplified triangular (piecewise linear) current pulses. It is considered that the current wave rises linearly to its maximum value, and then also decays linearly to half its amplitude value. Comparison of the results suggests that proposed simplification of discharge current waveform has no significant effect on relative calculation error of residual voltage on surge arrester.

If it is necessary to estimate only maximum value of residual voltage on surge arrester, it is possible to use piecewise linear approximation of switching and lightning currents with any amplitude and shape without loss of accuracy.

Keywords: circuit simulation, surge arrester, residual voltage, piecewise linear waveform.

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INVESTIGATION OF PECULIARITIES OF DECOMPOSITION OF TRACTION ELECTRIC DRIVES OF MOBILE ELECTROTECHNICAL COMPLEXES

page 31–38

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The object of this research is traction electric drive systems of mobile electrotechnical systems based on various types of motors. As a result of the system analysis of the object of research, it is established that it is possible to solve the problem of increasing the energy potential of an electromechanical system only in a complex manner. It is revealed that it is necessary to consider the established mode of operation of the entire system as a whole, taking into account the conditions for the rational operation of its individual components, provided that the interconnection between them is taken into account. It is shown that a practical situation is quite frequent where the rational operating mode of individual elements of an electromechanical system and optimal control of them does not lead to the operation of the entire system on the economic characteristics. This, as a consequence, increases the consumption level of diesel fuel. Conversely, the artificial compulsion of diesel operation on the economic characteristics leads to the operation of these electrical elements of the whole electromechanical system with significant power losses. To achieve the tasks of controlling the electromechanical system, the potential method is used. According to it, it is shown that the potential of not every individual element of the electric drive is important, but the potential of their aggregate in the interaction. With a successful combination of interaction and operating modes of each element and the whole structure in general, the total energy saving potential of the whole is greater than the sum of the energy saving potentials of individual elements of the electric drive. As a result, a synergy effect is obtained. It is also shown that the task of the control algorithm is to optimize the interaction of resources to obtain a positive synergy effect, the effect of reducing the level of losses in the system. As research result, a method of increasing energy efficiency for static and dynamic characteristics is proposed. The advantages of this method are the use of the synergetic properties of the system, the integrated provision of an energy-efficient operating mode. This leads to the achievement of the most rational specific level of fuel consumption and efficiency maximization of the electromechanical system.

Keywords: decomposition of electric drive, electrotechnical complex, traction drive, autonomous system, diesel-generator system.

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TECHNOLOGY AND SYSTEM OF POWER SUPPLY

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INCREASING THE ENERGY EFFICIENCY OF WAREHOUSES USING DEMAND-SIDE MANAGEMENT MECHANISMS

page 39–45

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The complex approach and expansion of the functionality of DSM programs is offered due to the application of services and criteria for classification of warehouses in terms of energy efficiency. When analyzing the effectiveness of the application of DSM programs, namely the optimality of power consumption modes, it is suggested to assess the power supply mode during the entire technological period.

Considering the electrical supply of warehouses as an electricity supply to the consumer with sharply variable nonlinear characteristics, the power of which is supplied from the generators, the operating voltage and current values of which are variable, it is proposed to use the modified Frieze inactive power index. The use of the Q_F index is advisable, since it will be located even in the absence of reactive elements in the consumer system. The influence of the consumption mode on the first harmonic is analyzed. The received characteristics are caused by presence of influence of consumption mode on the general characteristics of electricity supply mode optimality. The analysis of higher harmonics can also be used to assess the effect of unevenness. Such

analysis requires additional studies, but it can be argued that the use of the Frieze inactive power index allows to assess the degree of uneven electricity consumption in accordance with a given optimal level.

Keywords: demand-side management for energy resources, energy efficiency of buildings, transport and logistics infrastructure.

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OPTMIZATION OF «FUEL ELECTRIC GENERATOR – ELECTRIC MOTOR» SYSTEM IN CAD

page 46–50

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The main problems of computer-aided design of «fuel electric generator – asynchronous electric motor» systems stem from the fact that these systems canet be considered separately during optimization. Theoretically, the increase in production efficiency due to CAD, which ensures the optimization of equipment parameters for global connectivity, is proved.

A computational model of «fuel electric generator – asynchronous electric motor» system with comparable energy parameters of the source and the consumer, which takes into account the processes that occur not only in the electric motor, but also in the generator is proposed. The concept of a «global connectivity» between the arguments of a projected object as a characteristic of the relationship between the parameters of subsystems is suggested, when such connection dominates over others. In the sense that it is present in the largest number of computational models, in connection with which, its calculation has a decisive influence on the design object as a whole. The method of calculation of «fuel electric generator – asynchronous electric motor» systems in CAD is proposed, in which the intermediate objective function is not one of the consumer qualities of the object, but the nominal global connectivity between the elements of the system.

In Odessa, LLC «Specialized Energetic Enterprise «EnergoKOM» (Ukraine), a CAD test of electrical equipment «OPTIGLOC» is conducted, which is based on the proposed models and methods. As the object of computer-aided design, «diesel generator – asynchronous induction motor» system is used. As a result of the tests it is found that the use of the CAD «OPTIGLOC» allows to reduce the specific fuel consumption in the generator by 5.3 %. At the same time, the service life of the system and the stability of its technical tasks do not change, and the design time is reduced by an average of 13.7 %.

Keywords: fuel electric generator, slip of asynchronous electric motor, optimization in CAD, global connectivity.

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RELIABLY-ORIENTED ANALYSIS OF A SINGLE STAGE COOLER THERMOELEMENT CONSTRUCTION

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The object of research is a model of the relationship between the reliability indicators of a single stage thermoelectric cooler and the geometry of the thermoelement, i.e., the ratio of its length to the cross-sectional area. Existing studies are limited to analyzing the influence of the geometry of thermoelements on the performance of cooling capacity, so the aim of the analysis is to determine the possibility of improving reliability in various modes of cooler operation. As a method of research, mathematical modeling is chosen, which allows to predict the reliability of coolers at the design stage. The influence of the geometry of thermoelements in the range from 4.5 to 20 on the power and structural parameters of the thermoelectric cooler is analyzed to select the best option for the criterion of the minimum failure rate. The analysis is performed for temperature differences in the range of the device's operability from 0 K to 60 K and operating modes from the maximum of the cooling capacity to the minimum of the failure rate taking into account energy and design constraints. An example of the use of the proposed analysis using unified thermoelectric modules is presented, which shows the possibility of reducing the relative failure rate of a thermoelectric cooler by more than 3 times due to the choice of the geometry of thermoelements. The main advantage of the proposed approach is that

it is possible to increase the reliability of thermoelectric coolers without changing the production technology and used materials.

Keywords: thermoelectric coolers, operating mode, reliability indicators, geometry of thermoelement branches.

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