ABSTRACT AND REFERENCES

ENGINEERING TECHNOLOGICAL SYSTEMS

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IMPROVING THE METHOD OF ROTATIONAL BROACHING IN THE PRODUCTION OF PROFILE OPENINGS ON THE LATHES OF TURNING GROUP (p. 4–9)

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We examined methods of manufacturing profile openings on the metal-cutting machines by the rotational broaching method. Based on the generalized results of analysis of the methods for manufacturing profile openings, we proposed a method of rotational broaching. Bits for drilling machines or screwdrivers are used as the tool. Hardness of the bit is quite high; therefore, making a centering opening in it is difficult. The problem is solved by pressing a transition bushing onto the bit, with a centering opening made in advance. Implementation of the method requires a Morse cone with a welded plate. This allows fixing the rotating centre in a tool carrier. The proposed method makes it possible at minimal financial cost to perform the shaping of profile openings within a wide range of both the shape and nominal dimensions. The method is based on the effect of self-centering and, therefore, does not require preliminary adjustment. Adjusting tool entrance angle is achieved by displacing a transverse support of the lathe and by tool carrier rotation. In addition, in the production of profile opening, its input cone is formed, which provides for easy installation of the wrench to transmit rotational moment without losing load capacity. The studies conducted defined suboptimal values of the input variables that are accepted as rational in the examined technological process of rotational broaching. These are: a tool entrance angle (1.5...2.5 degrees), its supply (0.1...0.3 mm/rev) and the rate of processing (15...25 m/min).

Keywords: profile openings, threaded connections, drifting, broaching, rotational head, bit, lathe.

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DEVELOPMENT OF THE EVALUATION MODEL OF TECHNOLOGICAL PARAMETERS OF SHAPING WORKPIECES FROM POWDER MATERIALS (p. 9–17)

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High efficiency of the technological process of shaping workpieces from powder materials using vibratory and vibro-impact treatments was defined. High degree of intensification of the process of workpiece sealing is achieved using original inertial vibration press-hammers with hydropulse drive.

The explored systematic approach to technological process of shaping (process, machine, and workpiece) and sets of design parameters of technological equipment allowed us to create a mathematical model of determining average density of a workpiece. Extremum of array of values of membership function as a determinant of completeness and effectiveness, was selected as the criterion of estimation of functioning efficiency of technological process of shaping workpieces

Assessment of efficiency of functioning of technological complex was made based on fuzzy sets. Relationships between parameters of average density of a workpiece and function of the mode of vibroimpact loading of a workpiece were defined.

Performed analysis of technological parameters of workpieces demonstrated adequacy of the developed complex mathematical apparatus for evaluation of dynamic changes in average density and uneven density of derived products. Expediency of time restriction of shaping a final product by vibroimpact pressing method for quality maintaining was established.

Development of a promising method of evaluation of production complex condition based on vibropress equipment with hydropulse drive will allow an increase in efficiency of the technological process of shaping workpieces from powder materials.

Keywords: fuzzy sets, shaping, equal density, hydropulse drive, vibropress equipment, powder material.

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DEVELOPMENT OF THE COMPREHENSIVE METHOD FORQUALITY ASSESSMENT OF PLASTIC PARTS (p. 18–26)

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In present work we constructed the tree of quality indicators of plastic parts. A generalized algorithm is proposedto estimatethe quality level of plastic parts, which is the basis for the developmentof method forassessing the quality level of plastic parts. The designed algorithm, in contrast to those existing, includes a stage for the estimation of error in quality level, which will make it possible to improveaccuracy of determining thequality level of plastic parts. We devised acomprehensive method for evaluating quality of plastic parts. Its essence is in the fact that the obtained method allows us to determine anintegratedindicator of quality of plastic part, which includesa proposed nomenclature of quality indicators, represented in the form of the tree and the proposed generalized indicator of quality of plastic part.

The developed comprehensive method differs from those existing by the proposed additional stage – the estimation of error in quality. Its essence is that it is necessary to determine: error in the number of properties that characterize quality; error in determiningthe weight coefficients;wear and aging of the materials that the MD are made of; error in the calculations of quality indicators;and permissible instrument errors. All these components will in turn make it possible to increase accuracy in the quality assessment of plastic parts.

Results of present researchinto quality indicators ofpart's PM-demonstrated that for the selected part, one part of the values of relative quality indicators is larger than unity, and another part is lower, which does not make it possible to unambiguously estimate the quality level for the givenpart. The designed method is useful in the development of mathematical and CAD software for technological equipment. It might be applied in the fabrication of thermoplastic parts for radio-electronic equipment.

Keywords: comprehensive method, quality assessment, quality indicator, basicindicator, plastic part.

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ANALYSIS OF THE MODEL OF INTERDEPENDENCE OF THERMOELEMENT BRANCH GEOMETRY AND RELIABILITY INDICATORS OF THE SINGLE-STAGE COOLER (p. 26–33)

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The effect of the thermoelement branch geometry on the main reliability indicators of the single-stage thermoelectric cooling device for a variety of temperature gradients in the range of practical use of coolers in various operation modes has been considered. To achieve the assigned objective of bettering reliability indicators of thermoelectric coolers, a reliability-oriented model has been developed. The model relates the failure rate and the probability of failure-free operation with the geometry of thermoelement branches, energy indicators and operation conditions. The analysis was performed for a variety of temperature gradients, a fixed tempo load and various modes of operation.

Analysis of the developed model has shown the possibility of improvement of the reliability indicators of the single-stage thermoelectric coolers by selection of the thermoelement branch geometry. Analytical relations between the failure rate and the geometry of thermoelements, energy indicators of the coolers have been established. It was shown that the choice of the thermoelement geometry can give more than a two-fold reduction in the failure rate.

The developed model which can be used in computer-aided design enables development of single-stage thermoelectric coolers with consideration of restrictive requirements to size, weight, power consumption with a possibility of choice of a compromise design variant.

Keywords: reliability indicators, failure rate, thermoelectric cooling devices, model, geometry of thermoelements.

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MATHEMATICAL MODELING OF AIR COOLERS OF INDIRECT EVAPORATIVE TYPE (p. 34–42)

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The method of integrated modeling of interconnected heat and mass transfer processes in air coolers of evaporative type has been developed.

Air cooler of indirect evaporative type was taken as the object of research. Water was used as the evaporating agent. Basic schemes of airflows were considered: cross-flow and counter-flow. Partitioning of the problem into a number of subtasks (air flow distribution among channels, heat and mass transfer in the channel system) was proposed. Decomposition of the device structure into a number of elements was done. Mathematical models of interconnected processes of heat and mass transfer are given as a system of nonlinear ordinary differential equations in a one-dimensional statement. The developed efficient methods of joint solution of the mathematical model equations were used in simulation. A modified robust method for simulation of media flows in the channels of a complex profile (two-dimensional fields of velocity and temperature) was proposed. Joint solution of continuity equations, Navier-Stokes equation (in projections to the coordinate axes), Fourier equation and pressure equation was carried out. The method is invariant as to the channel shape and the properties of the working media. The method of calculation of heat exchange coefficients with the use of the obtained velocity and temperature fields is set forth. This enables to refine results of modeling of the processes proceeding in coolers. Computational and full-size experiments for a number of designs and operation conditions of air coolers were conducted. Comparative analysis of the obtained results has shown reliability of the proposed methods of mathematical modeling. Discrepancy between the calculated and experimental values of the cooled air temperature did not exceed 0.5 °C.

The described method of mathematical modeling enables obtaining reliable information necessary to optimize the design and working conditions of coolers. The developed method of mathematical modeling of the heat and mass transfer processes can be used for a detailed study of various types of heat exchangers.

Keywords: indirect cooling, evaporation of water, heat and mass transfer, cross-flow, channel of a complex profile, counter-flow.

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DEVELOPMENT AND APPLICATION OF COMPUTER MODEL TO STUDY THE MODES OF DYNAMIC LOADING IN MECHANICAL OSCILLATORY SYSTEMS (p. 42-49)

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A simulation computer model was developed with a view to conducting the simulation of modes of dynamic loading of mechanical oscillatory systems of the single-stage evolvent helical tooth gears class. The model implementation was carried out by means of the MatLAB-Simulink simulation environment, based on the principles of analog simulation. Schematics of the computer simulation model and the generator of external loading functions were presented. Internal structure of the block for solving one of the equations of mathematical model in mechanical oscillatory systems was established.

In the course of modeling experiment, we performed simulation of the modes of dynamic tooth gear loading by force, the loading

moment of which is simulated by the function of stepwise or linear-increasing character. Results of the simulation results were obtained in the form of combined oscillograms of the alternating moment of external loading and reactions in the form of oscillations of one of the elements of the tooth gear structure. The simulation was carried out with the assigned values of weight and rigidity, damping, geometric, structural and dynamic parameters of mechanical oscillatory systems. Obtained experimental results allow assessing the values of dynamic forces in tooth gear nodes depending on the ratio of rotation periods of the shaft, and function of changing the external loading moment, subject to the action of stepwise and linear-alternating forms of the force.

Keywords: simulation Simulink model, dynamic loading, analog modeling, mechanical oscillatory system.

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EXAMINING ENERGY-EFFICIENT RECUPERATIVE BRAKING MODES OF TRACTION ASYNCHRONOUS FREQUENCY-CONTROLLED ELECTRIC DRIVES (p. 50-56)

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Energy efficiency is an important task of modern society due to the finite amount of mineral resources and environmental problems. Even more important this task is for electric transport vehicles with autonomous energy sources since its successful solution affects performance indicators of these systems. Particularly promising in the context of this problem is the question of energy optimization in the recuperative braking modes because it makes it possible to return kinetic energy, accumulated by transport vehicle, to the source.

In present paper we analyzed equations of state of asynchronous motor under static operation mode in order to obtain analytical dependences that describe motor performance under recuperative braking mode. Conducted analysis allowed us to establish an interrelation between the limits in magnitudes of voltage and current, parameters of equivalent circuit and the torque generated at such work. By examining the received patterns, we calculated the magnitude of minimum angular velocity at which it is possible to realize the mode of recuperative braking, that is, the generation of electrical energy by motor to the power supply.

A special benefit of present work is that the obtained dependences were explored both for the work at angular velocity that is lower than the base one and for a field weakening mode since in electric drives of transport vehicles of alternating current the use of two-zone control is quite common. By applying mathematical modeling, we confirmed the results received in present work.

Keywords: asynchronous motor, recuperative braking, electromagnetic torque, flux linkage, energy efficiency, vector control, stator current, angular velocity, braking torque.

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