ABSTRACT AND REFERENCES

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SUBSTANTIATION OF PROJECTS THAT ACCOUNT FOR RISK IN THE RESOURCE-SAVING TECHNOLOGICAL CHANGES AT ENTERPRISES (p. 6–16)

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The purpose of the study was to model the investment risk of implementation of resource-saving technological changes at enterprises and to develop a method for consideration of risk for the substantiation of projects for introducing resource-saving technologies. Risk management is an important condition for increasing the expediency of technological change activities. In turn, the correct consideration of a risk factor can increase the confidence of owners of enterprises in the expediency of introduction of resource-saving technologies, which will increase the scale of such implementation.

We determined principles, an information base, and a sequence of assessment of the potential of resource-saving technological changes at enterprises.

We modeled an influence of prices for production resources, for which enterprises acquire industrial resources, on the effectiveness of resource-saving technologies implementation. The simulation results showed that the level of such efficiency is quite high only in a certain range of prices for resources. In this connection, we obtained expressions for determining the price ranges for a certain type of resource, which correspond to the three main options for the application of existing technological process. Such options are: to continue operation of the existing technology; to terminate its operation with the replacement of a new resource-saving technology; to stop using the existing technology without replacing it with a new one.

The study substantiates expediency of consideration of a risk factor in substantiation of projects of resource-saving technological changes at enterprises by calculation of a value of the maximum acceptable amount of investments in such an introduction. It proposes to determine the maximum acceptable amount of investments based on a constructed set of scenarios of values of those project indicators that have a low level of predictability. There is no need to substantiate a value of a discount rate, which often has a high degree of subjectivity, for this approach to a risk factor.

Application of the developed method of substantiation of projects for resource-saving technological changes will increase reasonableness of relevant investment decisions due to the comprehensive consideration of a risk factor in the practice of enterprises.

Keywords: project, resource-saving technological changes, risk, modeling of technological changes, prices for resources.

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AN APPROXIMATING MATHEMATICAL MODEL OF INTERACTION BETWEEN A FREELY ROTATING DISK AND SOIL (p. 17–27)

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A generalized mathematical model of disk interaction with soil was built under general assumptions regarding the mode of the disk knife motion in soil, namely, in a mode of slippage, skidding or rolling without slippage and skidding. Previously constructed models follow from it as particular cases at certain values of parameters. However, because of computational complexity of this model for the case of a freely rotating disk knife consisting in the need for a preliminary numerical solution of a transcendental equation to determine the mode of disk motion, the generalized mathematical model has not found wide application. Therefore, an analytical two-dimensional approximation of a generalized model of disk interaction with soil which is a new model of approximation type was constructed on the basis of a computer experiment using the least squares method.

An explicit expression was obtained for the kinematic parameter of a freely rotating disk knife which determines its mode of motion. It was established that this parameter is a rational function of relative depth of the disk penetration and the dimensionless dynamic coefficient characterizing soil properties. Also, explicit expressions were obtained for the projections of the resultant soil reaction forces acting on the blade of the disk knife and its side faces depending on the data of dimensionless parameters. It has been established that the horizontal component of the reaction which determines tractive resistance of the disk is also a rational function of the relative penetration depth and the dimensionless dynamic coefficient. It was established that the magnitude of the kinematic parameter significantly affects the magnitude and direction of the resultant soil reactions to the disk. The expressions obtained make it possible to significantly simplify experiments to determine the resultant soil reaction forces to a freely rotating disk knife and reduce their required number. These expressions make it possible to carry out strength calculations of soil-cultivating working tools with disks and determine their optimal parameters according to the strength criteria and the minimum specific energy consumption with accuracy sufficient for engineering practice. Adequacy of the obtained expressions was confirmed by comparison with experimental data of the disk knife dynamometry.

Keywords: freely rotating disk, interaction with soil, power characteristics, analytical approximation, explicit expressions.

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DEVELOPMENT OF A TECHNOLOGY FOR INTERACTIVE DESIGN OF GARMENTS USING ADD-ONS OF A VIRTUAL MANNEQUIN (p. 28–39)

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The problem of development of the technology of interactive garment designing by engineering methods was studied, which makes it possible to use the passive mode for automated preparation of design documentation. The theoretical background for modular approaches to formalization of the structural design of clothing is the stated principles of coordination of the actions in the algorithms of transformation of the sets of a research object. The technology of construction of a geometric model of an object is represented by three kinds of information models: digital, meshed, and surface. The analytical and experimental research resulted in substantiation of the algorithm of project situations of the transformation of the surface of the original object in the form of an electronic mannequin, into the garment design.

The original database for construction and modification of the frame 3D mannequin models was theoretically substantiated with a view to ensuring the reliability of their visualization.

We studied the mechanism of interactive modification of surface shells of clothing in the cycle of its silhouette deformation and of the construction of flat sweeps of clothes, adapted to the vectors of modifying the mannequin surface sections in order to receive the garment designs identical to the original of the morphological structure of the consumer's body.

4 scenarios of design situations of the reproduction and transformation of the 3D-model of the silhouette surface of a mannequin and of the garment by the optimal route were proposed to improve the speed and the quality of processes of computer-aided design of clothing parts for the figures of typical and atypical physique.

The image construction apparatus of the digital model of a three-dimensional object takes into consideration the topology of the geometrical structure of a shape and the morphological field of synergies of the elements in the processes of transition from 3D to 2D designing.

The scenario of the adaptation of silhouette 3D images of a garment to the modified 2D design documents grounded on database verification was proposed. Assessment of the effectiveness of the garment design technology was made by the number of iterations of project operations in design procedures with the quality level check.

Keywords: mathematical model, 3D mannequin, 2D sweep of clothing, surface deformation, silhouette transformation, modeling effect, universal design.

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IMPROVING A TECHNIQUE FOR THE ESTIMATION AND ADJUSTMENT OF COUNTERBALANCE OF SUCKER-ROD PUMPING UNITS' DRIVES (p. 40–46)

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In order to reduce the impact of uneven load on the operation of drives at downhole sucker rod pumping units, it has been proposed, based on the results of this study, to apply an improved technique for estimating and adjusting their counterbalancing. The technique implies determining the required position of crank counterweights based on dependences of change in the active power and the rotation speed of the motor shaft. The experimental research aimed to derive the aforementioned dependences was carried out by using a portable information-measuring complex. Its operation is based on the technology of virtual instruments, methods of digital signal processing, and graphical programming of algorithms for applied software. According to the proposed technique, the optimal position of crank counterweights is determined based on the condition for the equality of maxima of the cumulative torque at the output shaft of the reduction gear. In this case, the diagram of change in the momentum of forces of useful resistance is the difference between the combined torque at the output shaft of the reduction gear, obtained as a result of this research, and a momentum from the crank and counterweights. A possibility to implement the improved technique for adjusting the equilibration of drives was confirmed, with a sufficient accuracy, by results from the repeated wattmeter measurement, performed upon repositioning the crank loads in accordance with the devised recommendations. It has been substantiated that a sufficient accuracy of parameters controlled in order to implement the technique could be achieved under condition that the crank turning angle between measurement points ranges from 5° to 1°. Introduction of the technique would make it possible to minimize the time required for the implementation of the balancing process and to reduce the impact of uneven load on the drive's operation.

Keywords: beam pumping unit, counterbalancing estimation, wattmeter diagram, crank torque, measurement discreteness.

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UNIVERSAL MULTIFUNCTIONAL DEVICE FOR HEAT AND MASS EXCHANGE PROCESSES DURING ORGANIC RAW MATERIAL PROCESSING (p. 47–54)

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The proposed innovative design solution of universal multifunctional device ensures implementation of the maximum number of heat exchange processes. They are: aging, drying, blanching, boiling, boiling soft, infusion, mixing, dissolution and partial extraction. Combination of main heat and mass exchange processes in a single device ensures its technological multioperationality and mobility, due to its location on a mobile platform. On the platform, there are: an engine section; a central support for fixing of the operation technological capacity; a section with a steam generator and a vacuum pump, technical lines. A block with automation tools controls the main operation parameters: speed of rotation of the shaft of the mixer; heating temperature; steam pressure and vacuum pressure is used block with automation. There is also an auxiliary technical retractable lifting rail with a rotating mechanism for unloading and loading of the capacity installed.

The structural solution of the multifunctional device ensures a use of replaceable section-modular elements. Heating of the technological capacity occurs due to a flexible radiating resistive electric heater of the radiating type, which ensures that the device reaches the operation mode in 1.5 minutes, an ease of maintenance and reduction of the metal capacity of the structure.

We established that the universal multifunctional device provides a reduction in duration of heat exchange processes during its approbation. Namely: aging of organic raw materials by 22 %, blanching – by 25 %, extraction – by 21 %, boiling – by 32 %, drying – by 13 %, infusion – by 43 % and dissolution of the fine dispersed fraction – by 20 %. The cost per unit expended on heating of a unit of product is less by 10 % and 19 % compared to UPTODS-150 and KVM-150 caldron, respectively. This confirms the effectiveness of the accepted innovative solution to ensure mobility, energy and resource efficiency, ease of operation and maintenance of the device.

Keywords: universal processing, organic products, multi-operability, farming enterprises, resource efficiency, flexible film resistive electric heater.

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MODERNIZATION OF THE TECHNIQUE FOR ROTARY SHAPE-FORMATION OF OUTER PROFILED SURFACES (p. 55–61)

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We have proposed a technique for obtaining outer profiled surfaces, which is characterized by affordability and low cost of equipment used. The technique is based on that a regular rotating center is fixed in a lathe's tool holder in a special way. A basic socket head of the required profile is applied as a profile-forming matrix. A tool holder's rotation angle ensures a fracture angle of the rotating center's axis relative to the axis of a workpiece rotation. A value for the fracture angle reaches 1.5°. The end surface edge of the matrix executes a reciprocating motion per every rotation of the lathe chuck along the surface of a workpiece. In this case, the end surface of the matrix and a workpiece are in contact at a single point, going deeper by the magnitude of feed per every rotation of the chuck.

Application of a given technique is an alternative to existing technique of rotational shape-formation of outer profiled surfaces, whose implementation requires specialized equipment and specialized cutting tools, the price for which is quite high (UAH 57,000 and UAH 6,000, respectively). In addition, changing the size or shape of the required profile necessitates installing a new cutting tool, replacing which requires additional adjustment.

The tests were carried out when manufacturing the twelve-point outer surface the size of S10. An analysis of vibrograms from the shape-formation process has established the most rational variant of equipment for manufacturing profiled outer surfaces. We have manufactured pilot outer profiled surfaces, such as hexagon the size of S10, the TORX surface the size of E14, and others. They confirmed a possibility for successful manufacturing of different profiled outer surfaces using the proposed tooling.

Using the proposed technique, which implies low cost and does not require specialized equipment, could significantly expand the scope of application of conjugated surfaces with a profiled shape in mechanical engineering.

Keywords: profiled outer surfaces, rotating center, rotary broaching, socket head.

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RESEARCH INTO THE PROCESS OF LOADING THE SURFACE OF A VIBROSIEVE WHEN A LOOSE MIXTURE IS FED UNEVENLY (p. 62–70)

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The work examines the influence of uneven feeding of a loose mixture on the process of loading a vibrating sieve. In this work, we established regularities of layer thickness, longitudinal and trans-

verse components of velocity, density of loose mixture and specific load on the entire area of a vibrating sieve at uneven feeding at the inlet. The uneven feed was assigned by using a convex profile, a concave profile, and a triangular profile of the initial velocity for width at the inlet of a sieve.

Flow characteristics change equally along the length of a sieve for the profiles considered. Flow characteristics change according to the initial velocity profile for width of the sieve. For a convex profile, the thickness is constant, the surface density and the longitudinal component of the velocity are the greatest along the longitudinal axis of the sieve, and they are the smallest near the side walls, the direction of the transverse component of the velocity is from the longitudinal axis to the side walls. For a concave profile, the thickness is constant, the surface density and the longitudinal component of the velocity are the greatest along the side walls, and they are the smallest along the longitudinal axis, the direction of the transverse component of the velocity is from the side walls to the axis. For a triangular profile, the thickness is constant, the surface density and the longitudinal component of the velocity are the greatest along one side wall, and they are the smallest along the opposite wall, the direction of the transverse component of the velocity is toward the first mentioned side wall.

For a convex profile of the initial velocity, the surface is overloaded along the longitudinal axis of the sieve and it is underloaded along the side walls. For a concave profile, the surface is overloaded near the side walls, and it is underloaded along the longitudinal axis of the sieve. For a triangular profile - the surface is overloaded along one side wall and it is underloaded along the opposite one. The largest deviations of the specific load occur near the inlet section of the flow, the smallest ones - near the outlet section.

The regularities of distribution of the specific load of the sieve are decisive in the design of feeders and distributors of loose mixtures, as well as in calculation of separation modes.

Keywords: vibrating sieve, loose mixture, specific surface load, uneven mixture feeding.

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STUDY INTO THE ROLLING OF A DOUBLE-LAYERED POWDERED CORE IN A METALLIC SHEATH (p. 71–79)

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We have developed an analytical model of the stressed-strained state of the two-layered powdered core in a metal sheath in the deformation zone when fabricating a composite material by rolling. Based on the constructed mathematical model, we performed a theoretical analysis of the influence of starting parameters on the course of the process of rolling a composite material. By using a finite element method, we simulated the process of rolling diverse powders in a metal sheath. The result of the theoretical research is the established effect of a material and the thickness of a sheath on the geometrical characteristics of a deformation site, as well as the influence of an asymmetry factor on a change in the zone of plastic shape alteration and the density of a powdered material. We have determined the distributions of normal contact stresses and relative density over a deformation site under different clamping. We calculated the components of rolling forces under deformation of a powdered core and a metal sheath. It was established that an increase in the thickness of a sheath leads to an increase in energy-force parameters of the process. In this case, the component of a rolling force due the sheath deformation can be both comparable to the component from the deformation of a powdered core, and exceed it by several times. The undertaken experimental study into the process has confirmed the validity of the constructed mathematical model that could be applied for determining the optimal technological regimes for rolling a 2-layer powdered core in a metal sheath.

A technology for rolling a 2-layer powdered core in a metal sheath has been proposed, which includes rolling in two runs, filling the metal sheath consistently with components. It was established that at rolling based on the proposed technology the core's relative density increases under the same rolling modes. In this case, the size of a powder's fraction is retained, which is a prerequisite for a given production technology.

Keywords: powder metallurgy, powdered tape, powder, mathematical model, stressed-strained state.

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DEVELOPMENT OF A METHOD FOR ESTIMATING THE RESISTANCE OF FIBERS AND THREADS TO A SLIDING BEND BASED ON ENERGY CONSUMPTION FOR EXTERNAL AND INTERNAL FRICTION (p. 80–87)

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We present materials for constructing an instrumental method for assessing resistance of threads to the sliding bend relative to cylindrical surfaces in order to solve tasks on control and prediction of conditions for their processing at minimal cost of production. Underlying the method is the differential accounting of energy consumed to overcome the internal and external friction.

The main objective of this study was to improve informativeness of the results obtained in the analysis of fires and threads through

manifestations of physical- mechanical properties predetermined by patterns in their structure and composition, as well as by characteristics of the streamlined surfaces. It has been proposed to test the thread based on the simulated actual conditions for frictional interaction when bending radius r of the working bodies' edges should be commensurate with the thickness of the thread. Given such a variant of testing, we have identified conditions that ensure the manifestation of parameters for the internal and external friction, which made it possible to devise a technological scheme of tests and to conduct comparative analyses of threads in materials with different structure and properties.

We have proposed, as an estimate that characterizes the manifestation of only the external friction at a cylindrical surface of curvature $1/r$, the magnitude of energy $A_{ext.}$ consumed to displace a thread (of rigidity EI and with a stretched force) under condition $2T(r)^2/EI \geq 1500$. To account for the total energy A due to the external and internal friction, as an estimate that characterizes the resistance of a thread against a sliding bending, the test conditions imply the application of a bending surface with elevated curvature $1/r_1$, that is $r_1 \ll r$.

In order to calculate the estimate D as the proportion of energy A_{intern} required to overcome the internal friction, the dependence $D=[(A-A_{ext.})/A]\cdot 100, \%$, is used. It has been proposed to perform tests in two stages, each of which implies that a thread, stretched by a constant force, should streamline cylindrical surfaces at an unchanged capture angle, while the radius of the curvature varies at each stage.

Effectiveness of the proposed method for assessing resistance against a sliding bend has been confirmed by the results of experiments. We have established a possibility to differentiate the tested threads and yarn based on the magnitude of estimates A_{ext} and D under different conditions for interaction with a cylindrical surface. The results obtained allow us to recommend the proposed method for practical implementation, specifically, to control the degree of thread passability through the machine thread-guiding gear.

Keywords: thread, rolling, sliding bend, thread-guiding gear, consumed energy, external and internal friction, control method.

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