TECHNOLOGY AUDIT

MODELING OF ELECTRICAL ACCIDENTS GENESIS PROBLEM AT ELECTRICAL ENGINEERING COMPLEXES AND IRON-ORE MINES SYSTEMS

page 4–8

Investigation of electrical accidents at iron-ore mines involves analysis of such general characteristics as dynamics, specific weight, accident frequency rate, distribution by different factors etc. but also modeling of electrical accidents genesis. In particular modeling of electrical accidents genesis allows determining of causes and conditions, hazard sources, situations and working condition. Therewith electrical accidents models allow performing of probability estimate of electrical plants and electrical engineering complexes, environment, staff states as elements of electrical systems for electro safety support. Statistical analysis of electrical accidents and also experimental laws of distribution of employment term and age of injured at electrical plants of iron-ore mines is given in the article. Using of investigation materials allows further passing to modeling of electrical accidents genesis.

Keywords: electrical accident, genesis, accidents, electrical accident dynamics, electro safety, modeling.

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INFORMATION ANALYSIS OF CONTROL PROCEDURES OF POWER-CONSUMING ENTERPRISE EMISSIONS

page 8–11

A probabilistic model of obtaining information about exceeding the permissable rates in a random pollution process, expected during the emission control, was considered. A mathematical expression for calculating the amount of expected information as a logarithmic function of the emission flow rate, observation time, control risks of the first and second type, as well as the parameter of nonstationary pollution process, was obtained. It was proved that the reduction of control risks of the first and second type increases the amount of information on the availability of emissions in pollution processes obtained during the control. The analysis of the information model shows that increasing the amount of information is larger if the variation coefficient of accidental emissions is higher, equal to the ratio of the root-mean-square deviation of these emissions to the parameter of nonstationary pollution process. The information model allows planning the selection of control parameters, for example its risks, based on the initial uncertainty of possible accidental emissions that may appear on a given observation interval of the process under control.

Keywords: monitoring, analysis, emissions of thermal electric power station.

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CREATING A MATHEMATICAL MODEL OF WAVINESS ON THE RESULTS OF CALCULATING THE ROUGHNESS OF EXTENDED PRODUCTS

page 11–15

Procedure for designing high-technology products in an integrated information environment, defined as a sequence of «mathematical model-algorithm-program», allows to reduce the terms of designing resource control and expenditure systems. Some non-formalizable features of reality may be not reflected in static mathematical models, describing the surface condition of aviation products.

When designing adaptive multi-channel analog-to-digital systems with integrated measuring channels, it is possible to calculate the corrected estimates of roughness parameters. The values of the relative correction factor of processes with a limited range of deviation values of roughness profile ordinates are given. The error of adaptive systems with the correction in surface quality control of extended products is estimated.

The results obtained allow to form the dynamic mathematical model of waviness as a result of approximating the parameters of the

finite number of roughness parameters estimates, calculated on the results of measuring the roughness ordinates in the limited linear surface sections in real time during manufacturing and testing aviation extended products.

Keywords: roughness, waviness, unified measuring channel of roughness profile ordinates.

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BURNING SOLID FUEL IN THE LOW-TEMPERATURE FLUIDIZED BED WITH DETERMINING TOXIC EMISSIONS

page 15–21

In conditions of the unstable economic situation and constant rise in prices of natural gas for utility enterprises in Ukraine, transition to local low-quality fuels is topical. A promising method of burning low-quality high-ash and low-calorie fuels with low level of toxic substances is burning in the low-temperature fluidized bed. Technology for burning low-quality fuel in the low-temperature fluidized bed furnace is environmentally attractive and can allow enterprises to switch to cheaper local solid fuels. However, burning is a complex technological process, which requires additional researches. Burning in the low-temperature fluidized bed differs from the traditional burning of fuel by increased energy efficiency of the fuel use, low pollutant emissions. The results of the experiments, conducted on the developed laboratory setup, on burning various low-quality solid fuels such as brown coal, peat, pellets, coal of rank (*D*), and anthracite culm in the low-temperature fluidized bed are given in the work. A number of experiments, which allowed to obtain the ranges of burning the above solid fuels in the fluidized bed is provided, the critical temperatures, at which it is necessary to add more fuel to the fluidized bed furnace are defined in the paper. Also, toxic emissions when burning these solid fuels in the fluidized bed are determined. The obtained results can be used to configure automatic equipment, regulating the operation of fluidized bed furnaces, working on low-quality fuels, reconstruct and modernize the existing boilers for their transition to the low-quality fuels with reduced pollutant emissions.

Keywords: fluidized bed, coal, peat, pellets, anthracite culm, sulfur oxides, nitrogen oxides.

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WAYS TO IMPROVE THE USE OF NATURAL GAS IN UKRAINE

page 21–26

The article describes new technologies to utilize the oil-well gas and to process it into liquid products. The causes of incomplete utilization of oil-well gas are determined. There were identified the peculiarities of extraction and utilization of oil-well gas during the operation of oil fields and the main factors that influence the choice of methods to utilize the oil-well gas.

The methods and means of utilization of oil-well gas were described and the promising directions of their development indicated. There were developed the criteria of selection of efficient methods to utilize the oil-well gas and of creating the conditions that encourage the implementation of these methods in the fields. The level of utilization of oil-well gas was determined, which occurs on remote and depleted fields and on the fields, which are located in areas with poor infrastructure.

The basic causes of torch burning of oil-well gas were established, namely too high costs of measures for its utilization in the absence of an appropriate regulatory legal framework and the general systematic approach to the selection of cost-effective methods of gas utilization.

There were detected the main factors, which influence the technical and economic efficiency of measures on gas utilization. There were elaborated the suggestions to improve the regulatory legal framework to regulate the production and utilization of oil-well gas, in the form of recommendations to draft legal documents.

Keywords: oil-well gas, gas-oil-chemestry, torch burning, electricity production.

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PREDICTION MODEL OF ELECTRIC ENERGY CONSUMPTION OF AIRPORT LIGHTING EQUIPMENT

page 27–31

A method of using multivariate regression model of predicting electric energy consumption of airport lighting for managing the efficient use of energy resources of airlines is proposed in the paper. Prediction using the correlation and regression methods involves finding mathematical equations, describing the statistical relationship of one indicator to another (pair correlation), with a group of other indicators (multiple correlation) or between the values of one indicator (autocorrelation). For obtaining a general linear multivariate prediction model, a classical method of least squares was used by the authors. Using the developed model will allow to develop a complex of energy saving measures, taking into account plans of reconstructing the existing infrastructure and manage electric energy consumption of the lighting equipment, taking into consideration peculiarities of its operation. The obtained model was tested on the statistical data of Kiev International airport (Zhuliany).

Keywords: electric power, lighting equipment, airport, multivariate regression model, management.

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A PRACTICAL APPROACH TO SELECTING OPTIMAL CONTROL CRITERIA

page 32–35

The studies of the techological processes (TP), process operations (PO) of which have equal cost estimates of input products are conducted. Herewith, time and monetary evaluations of output products for process operations of various technological processes are different.

The approach to selecting process operation enables to compare the cumulative growth of the TP value added within the time interval being investigated.

Carrying out studies with the use of this methodology allows comparing the TP, and accordingly the PO (because the PO are equivalent to the TP) with reliance on the absolute indicator — profit (value added).

As a result of the studies, it was found that the maximum value added (profit) is provided, the TP operations of which have the maximum efficiency.

The established fact allows to consider the index of effectiveness as a single optimal control criterion.

Keywords: efficiency, index of effectiveness, optimal control, optimization criterion.

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CONCEPT OF CREATING ELECTRONIC TEXTBOOK ON HIGHER MATHEMATICS IN ADOBE CAPTIVATE

page 35–38

Transition in higher education system of universities to new educational standards have necessitated changes in educational process, aimed at increasing the time of students' independent study. But the effectiveness of students' self-learning activities depends on their access to new formats of educational materials. Therefore, it is necessary to create electronic textbooks (ET). Availability of hypertext and multimedia (graphics, animation, video, audio) in ET allows to present educational material in an interactive and visual form, provide quick finding of the necessary information. Computer training and control activates a cognition process and provides a rapid assessment of the students' achievement level.

However, each teacher has to create their own electronic textbooks, that causes certain difficulties, outlined in this paper.

The authors considered the basic concept of creation, purpose and use of electronic textbooks by the example of a textbook on higher mathematics that will help any teacher to create their own unique electronic textbooks on technical disciplines.

Keywords: electronic textbook, electronic manual, hypertext, interactivity, higher mathematics, Adobe Captivate.

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KINEMATICS OF A COMBINED MODULAR DYNAMIC SIMULATOR

page 38–41

Developing the methods and systems for reproducing accelerative sensations of vehicle operator when performing emergency maneuvering is an actual scientific and practical problem. The aim of the research is to create a dynamic model of the combined modular simulator for ensuring linear and angular velocities and accelerations during drift, pitch and instant emergence of obstructions. The combined simulator with linear motors of basis, on which the hexapod-type parallel structure mechanism with rods of variable length is installed, is proposed. Using mathematical models of kinematics and dynamics of industrial platforms, worked through by the authors on the standard samples of engineering products, has allowed to create the calculated dependences for modeling the level of overload on the vehicle operator. A method for determining the parameters of the working motion and assessing the capacity of the drive and individual drive units when practicing the specified maneuver by the simulator is proposed.

On the example of reproducing the «pitch» type maneuver by the simulator, modeling specific accelerative information of the vehicle operator in the wide range of accelerations when passing the path at different speeds for different time intervals is demonstrated. The research results can be used in training operators of vehicles how to drive and act when taking off, speeding up, braking and overcoming the obstacles such as ramps, lifts, hillsides.

Keywords: combined electro-mechanical drive, vehicle operator, hexapod, the simulator, maneuvering.

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DEFINITION AND CONTROL OF CONCENTRATION OF COMPONENTS OF MULTICOMPONENT LIQUID BY ONE ELECTRICAL PARAMETER

page 41–45

Using the measured value of the reactive component of liquid conduction in certification testing of products and safety control of production impact on the environment is discussed in the paper. The main purpose of the research is to develop electrical methods and techniques for rapid and objective definition of the controlled concentration in finished products and environmental objects. With the development of experimental techniques, the opportunity to elaborate the electrical method, which replaces multistage laboratory studies and ensures accuracy and speed of obtaining the result has appeared. The analysis of the results of experimental studies of multicomponent liquids in a wide frequency electromagnetic field is given in the paper. Individual spectral characteristics for the liquids, which depend on the chemical nature of components, their concentrations and the primary converter design are identified. The method for fast determination and control of liquid component concentrations using one measuring index of the conduction reactive component is proposed. The method allows to obtain necessary information without laboratory facilities and expensive equipment. For voting, we propose to use the principle of seeking consensus based on various expert opinions of physical chemists and metrologists. The research results can be applied to liquids in production diagnostics, finished products composition control, waste and environment monitoring in the food, pharmaceutical and other industries.

Keywords: multicomponent liquid, component concentration measurement and control, complex conduction, conductometric cell.

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TECHNOLOGY AUDIT IN THE CONTEXT OF INCREASING THE EFFICIENCY OF AMMONIA PRODUCTION CONTROL SYSTEMS

page 45–48

In the context of the general problem of increasing energy efficiency of domestic large-scale ammonia synthesis plants of the AM-1360 series, the problem of improving the hardware-technological design and control system of monoethanolamine purification unit is solved in the paper. The possibilities of solving this problem by the technology audit method are considered. Operating conditions of monoethanolamine purification unit are analyzed. Using static processing of experimental data on the unit operation, the main indicators, characterizing the process accuracy factor, setting accuracy and stability were determined that has allowed to determine the cause of instability and displacement of temperature flow formation centers from normative values towards their increase. Based on these indicators, technical solutions on improving technological design and control system are developed, which have provided, due to their implementation, decrease in temperature mode of material flows of monoethanolamine solution and carbon dioxide, emerging from the regenerator in the form of gas-vapor mixture. Implementing technical solutions has allowed to reduce the corrosion rate of the regenerator pipe still and reduce consumption rates of monoethanolamine, vapor in the regenerator, demineralized water for air cooling and energy units at the carbon dioxide cooling node. Based on the research results, the technology audit algorithm is proposed.

Keywords: ammonia production, monoetanolamine purification, technology audit, control system, energy-saving.

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INTELLECTUAL DATA ANALYZING IN AUTOMATED MANAGEMENT SYSTEM OF BRAGORECTIFICATION SETTIN

page 49–52

This article tells about Data Mining technology using for analyzing data and extract information from data set on the example of bragorectification setting. The main task of exploration is the automatic analysis of methods and systems, data connections developping between amounts which can be seen as a kind of summary

of the input data and may be used in further analysis, modeling or forecasting. This article considers the main influencing factors of technological processes and interconnection between input and output data based on Bragorectification setting operation (BRS). One of such methods is neuro-uncertain technology. To achieve the aim we have got information and statictics about management object operation and controlling. It was built parametric structure of Bragorectification setting neuro-uncertain model. It was formulated uncertain structure data base model and received the surface response as graphical dependencies for operator decisions. Using these methods of information processing in sub-decisions, the effectiveness of Bragorectification setting control will significantly increase.

Keywords: bragorektification setting, data mining, neuro-uncertain technology, automatic analysis.

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PRODUCTION RESERVES

SILICON REFINING AT THE FLOAT ZONE MELTING

page 53–56

The research results of silicon refining in the process of induction float zone melting are given. The possibility of adjusting the degree of silicon purification, taking into account the growth rate, operating current frequency in the inductor and remelted crystal diameter, is shown. The influence of the degree of the main dopant impurity compensation on the uniformity of impurity distribution in silicon crystals is shown.

Based on the developed dependencies, the required degree of ingoing material purification is determined. Herewith, the degree of purification of the initial silicon rods is determined by the quantity of melt zone passes along the initial rod. The influence of the degree of the main dopant impurity compensation, related to a residual content of boron and phosphorus in crystals on the distribution of electrical resistivity in silicon monocrystal is considered. The obtained research results can be used for growing silicon monocrystals from the melt by the float zone melting method and the Czochralski method.

Keywords: silicon, purification, float zone melting, growth rate, current frequency, uniformity, compensation, dopant impurity.

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PROPERTIES OF WELDED JOINTS OF METAL STRUCTURES AFTER HARDENING DEFORMATION-HEAT TREATMENT

page 57–61

The influence of deformation-heat treatment of welded joints from separate heating and using welding heat on the structure and properties of low-carbon steels for metal structures is considered in the paper. Some results of our research in this field are given. The main purpose of the research is to study the influence of the temperature gradient during welding and chemical composition of the structure formation in the basic and the weld metal, the possibilities of using welding heat for hardening welded joints of metal structures. Using technology for deformation-heat hardening of welded metal structures using welding heat will allow to reduce energy and labor expenditures, their manufacturing duration and increase the working efficiency on average by 1,2 times. The positive influence of deformation on forming an equilibrium structure in both the welded seam, and the heat-affected zone depending on the chemical composition of the weld metal is shown in the paper. The effect of carbon equivalent on the mechanical properties of welded joints is demonstrated. The research results can be used in manufacturing butt-welded joints of different designs, in particular pipelines at construction sites and plants. Using the obtained results will allow to improve the toughness of metal structures while maintaining sufficient hardness.

Keywords: deformation-heat treatment, steels for metal structures, welded joints, properties.

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WORK ORGANIZATION AT LOCAL RAILWAY STATIONS IN CREATION OF TRANSPORT AND LOGISTICS CLUSTERS

page 61—64

As part of the creation and development of transport and logistics clusters in Ukraine, there is a need to develop an optimal scheme of composition and placement of railway transport objects. It was found that special attention should be given to mining and metallurgical complex enterprises on the development of iron ore deposits of the Kremenchug magnetic anomaly in Poltava region. Today, it is one of the most promising and profitable industries in Ukraine. For the improvement of technological processes at the mining and metallurgical complex enterprises for developing iron ore deposits, the possibilities of maintaining access lines by railway transport are analyzed. Current and predictable traffic volumes for each enterprise are revealed. The prospects of the transport service enterprise system, as well as crossing capacity of railway sections of the unified network are considered. Calculations of the required number of cars for the 2015—2021 are made. Recommendations for the development of interaction technology of the mining and metallurgical complex enterprises and railway, and reconstruction of the adjacent railway stations taking into account planned traffic volumes.

Keywords: transport and logistics cluster, access line, mining and metallurgical complex, crossing capacity, technological process.

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CAVITATION AND ABRASIVE RESISTANCE OF LOW-MELTING METALS

page 65—67

Results of experimental studies of resistance of low-melting metals Pb, Sn, Cd, Zn, Al, Cu with the melting point up to 1100 °C exposed to cavitation and rigid abrasive particles are given in the paper. Cavitation was created in a volume of distilled water using ultrasonic waves, emitted by the vibrator of exponential profile, which is connected to a generator. The oscillation amplitude of the vibrator surface was 30 ± 2 mm, frequency — 20 kHz. Under the influence of cavitation, samples destruction, the magnitude of which was measured by gravimetric method, occurred. Abrasive wear of the samples was measured according to the scheme «plane — disc». The disc is made of rigid abrasive particles. The motion velocity of the disk surface, which is in contact with the sample surface is 4,38 m/s at a sample load of 2,2 N. The mass losses were measured for a fixed time interval. Microhardness was determined using the device PMT-3. It was found that cavitation (Z_k) and abrasive (Z_a) resistances are connected with microhardness (H_μ) of metals by ratios $Z_k = 2{,}48 \cdot 10^{-2} \cdot H\mu^{1,7}$ and $Z_a = 2{,}4 \cdot 10^4 \cdot H_\mu^{0{,}92}$ when measuring H_μ by GPa. For both regression equations, the Pearson correlation coefficient is about 0,99. The data obtained are of scientific and practical importance, especially when selecting materials to create protective coatings for machine parts and mechanisms, operating under the influence of cavitation and abrasive particles.

Keywords: metals of 1A-IVA groups, resistance, cavitation, abrasive wear, microhardness, ratio, correlation coefficient.

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INFLUENCE ON HYDROLYSIS PRODUCTS OF ADSORBENT ON ITS ABILITY FOR LOW-POLAR LIQUIDS DEHYDRATION

page 68—70

The paper deals with analyzing currently used dehydration methods and techniques, their weaknesses, which, in particular, relate to their application in both the laboratory conditions and industry

are evaluated. The emphasis is placed on the problems, caused by the residual water in hydrophilic organic liquids (such as alcohols or aldehydes, ketones or carboxylic acids), and disadvantages of known dehydration methods are assessed. Using solid-phase adsorbents for dehydrating organic liquids, capable of forming crystalline hydrates is proposed and some attention is paid to another type of interaction between solid-phase adsorbent and water — its hydrolysis. It is proposed to use acid salts, which are much less susceptible to hydrolysis than neutral salts due to the presence of hydrogen ions. Calculation of tribasic orthophosphate acid salt hydrolysis constants is given as an example. Since salt hydrolysis may lead to undesirable consequences, in particular, organic liquids contamination by its products (e. g., alkalies or acids), the possibility of selecting such salts, which would be practically unsusceptible to hydrolysis is estimated. In particular, salts of s^1-elements, which are insoluble in organic low-polar liquids, and at the same time effectively formed crystalline hydrates when interacting with water, adsorbing a large amount of water moles were used. Using such salts in the industry would help to eliminate the need for applying distillation columns or vacuum, or azeotropic distillation with the component, shifting an azeotropic point.

Keywords: adsorbent, ethanol, crystalline hydrate, water, treatment, hydrolysis, concentration.

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THE CHOICE OF AN EFFECTIVE FORM OF A BOTTOM REFLECTOR FOR UNIFORM HEATING OF HIGH-TEMPERATURE PITCH

page 70–73

The article presents the results of a comparative analysis of the use of reflectors of various shapes on the uniformity of the temperature field of high-temperature pitch. Efficiency of the pitch heating system is regulated by strict requirements for the uniformity of temperature distribution in the tank. The decisions to intensify heat exchange alongside with the employment of the circular method of heating is justified. Numerical modeling of heat exchange in the tank using bottom reflectors is performed. It is proved that bottom reflectors will allow intensifying heat exchange in the tank and ensure heating uniformity without additional energy expenditures. It is shown that the use of a bottom reflector shaped like an inverted truncated cone will make it possible to reduce the temperature gradient throughout the tank height. The achieved results can be used for developing energy saving modes of the pitch storage site PJSC «Ukrgrafit»

Keywords: bottom reflector, circulation method of heating, high-temperature pitch, vertical steel tank.

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PARAMETRIC ANALYSIS OF PAPER MACHINE AS OBJECT OF AUTOMATIC CONTROL

page 74–78

The results of analyzing the process of paper manufacture on the paper machine (PM) in terms of automatic control problems are given in the paper. They are presented in the form of parametric schemes of each part of the PM indicating the main input and output variables, as well as control and perturbation effects. Wire, drying and press parts, sections of pulp preparation, wet washing, screening, inlet and calender are considered in the paper.

Construction of parametric schemes is the first step in creating an automatic control system. Based on the obtained results, it is concluded that the most attention from the point of view of control should be given to the PM drying section and calender. The conclusion is associated with a large number of perturbations, acting on these processes and negatively affecting the quality of the finished products but also lead to increasing production costs. With the set parameters of the PM processes, it is possible to formulate an optimal control problem that is the next step in creating an automatic control system.

Keywords: paper manufacture technology, paper machine, automation, control effects, perturbation.

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