ABSTRACTS

TECHNICAL SCIENCES

Aleksandrov G. A., Kravchenko M. V., Timofeev K. Yu., Sheremet O. I. Analysis of ways of constructing identifiers of induction motor state variables // Scientific Herald of the DSEA. – 2018. – № 1(25E).

To implement the classical principles of vector control, an automated electric drive requires complete and reliable information about the current values of the state variables. However, due to the design features of an asynchronous motor, the electromagnetic variables of its rotor circle (current and flow coupling of the rotor) are difficult to obtain for direct determination using measuring transducers. In these conditions, the current state of the control object is evaluated indirectly using state identifiers representing computing devices that run in real time. As a result of the analysis of modern methods of identifying the variables of the state of the asynchronous motor from the standpoint of the complexity of their technical implementation, an own mathematical model of the identifier is proposed. The developed identifier works on the basis of information about the stator current vector, the angular frequency of the stator voltage smooth component and the speed of the shaft rotation. However, it should be borne in mind that when the stator currents are measured in the identifier, when numerical integration of the equations in the non-ideal digital model, the calculated model values of the variables may differ from the actual ones. Differences can also occur if the initial conditions set in the computing model do not match the initial conditions for the object. Similar effects are caused by the influence of parametric disturbances in the control object associated with changing its parameters in the process of operation. In such cases, the criterion of the adequacy of the information on the output of the identifier should be applied, which would allow us to conclude that the degree of discrepancy between the calculated and true values of the variables.

Keywords: asynchronous motor, identifier, state variables, vector control.

Boltenko O. O., Ivchenkov M. V., Sheremet O. I. Analytical review of state observers used in sensorless vector control systems for electric drives // Scientific Herald of the DSEA. – 2018. – № 1(25E).

There are many different solutions for constructing asynchronous sensorless drives. As a rule, sensorless electric drive is understood as an electric motor that does not contain a speed sensor. Sensors of the same electrical values (voltage or current) in such systems are present. Identical control systems require the use of speed estimation algorithms. The provision of high quality indicators in dynamics is carried out with the help of vector control, in which the mutual location of the vectors of the flow coupling and currents determines the dynamic properties of the automated electromechanical system. The values of the vectors of the flow couplings are most often calculated using the mathematical model of the stator and the rotor of the asynchronous motor. Various mathematical models of the asynchronous motor are used in an electromotive drive with sensorless vector control to estimate angular velocity. Parameters of such models do not always adequately reproduce the parameters of the engine; they can vary considerably when temperature regimes or other operating conditions change. Therefore, the sensorless vector control systems, in addition to the models for determining the speed, should have means for identifying the engine parameters. The article analyzes the state observers used in sensorless vector control systems for electric drives, which showed that they can be divided into two groups: measuring and working on the basis of some mathematical models. Measurement observers carry out measurements of some quantities, while others are obtained by calculation. Observers working on the basis of mathematical models

depend on their accuracy and mathematical apparatus, which is used to calculate unknown parameters. The task of selecting an observer for a sensorless vector control system depends on the specifics of the automated electromechanical system and the process in which it is involved.

Keywords: sensorless vector control, observer, asynchronous motor, electromechanical system.

Inozemtsev O. M., Sheremet O. I. Analysis of technical requirements for electric drives of conveyors for the transportation of goods in metallurgical production // Scientific Herald of the DSEA. – 2018. – № 1(25E).

The system of conveyor lines is an integral part in ensuring the uninterrupted operation of a modern blast furnace, where long downtime is absolutely impossible, which leads to a loss of production and correspondingly to huge costs in the production of finished products. The high responsibility of their work and designation determine the particular degree of importance of the type of mechanisms presented in the overall technological process. The load on modern high-performance belt conveyors is so large that it is not always possible to create the necessary tractive effort with a single drive drum at the permissible tension of the belt. Therefore, high-performance conveyors have two or more drive drums. In this connection, the task of rational distribution of the total traction effort, traction factor and total power on the drive drums interacting through the tape arises. The article analyzes the technical requirements for electric motors of multi-engine conveyors for transportation of cargoes in metallurgical production. Analysis of technical requirements for electric conveyors cannot be carried out without their complicated mechanical parts. The mechanical part is a complex system with a weight conveyor distributed along the length of the conveyor and the elasticity of the traction element. When calculating the dynamic properties of the electric drive of the conveyor it is expedient to find a simplified transfer function of a longitudinally elastic load carrying element with a load distributed across the surface at its various points. It is necessary to adjust the regulators of the vector control system of the electric drive of the conveyor in such a way that no elastic oscillations occur along the traction element, since, if they are present, the starting process will be oscillating.

Keywords: multiple-engined drive, conveyor, distributed load, vector control.

Sagayda P. I., Mikaelian E. V. Research of methods, models and information technologies for forecasting electricity consumption // Scientific Herald of the DSEA. – 2018. – № 1(25E).

The issues of developing a software package for forecasting electricity consumption are considered. Analyzed existing methods for predicting electricity consumption. The main criteria for evaluating the results of forecasting are highlighted. Determined by what parameters need to assess the accuracy and quality of forecasting methods. A project of a software package has been created using an object-oriented approach for implementing two methods for predicting electricity consumption. The approaches and algorithm for constructing a mathematical model for predicting electricity consumption have been developed. During the formation of the project of forecasting electricity consumption, the most accurate result will be identified, which in turn will be close to the actual figure of electricity consumption for a certain period of time. To form a forecasting model, seasonal factors were taken into account that influence the result of forecasting. As an additional study, the forecast is adjusted depending on weather conditions, which in turn may significantly affect the forecast of electricity consumption in general. The methods of forecasting power consumption are compared on the basis of a preliminary analysis of the risks of their use. The article assesses the predicted levels of power consumption, demonstrates the problems and the main approaches to forecasting the volumes of power consumption. Analysis of the correctness of calculations involves the comparison of statistical data obtained at the stage of forecasting electricity consumption.

Keywords: technological process, forecasting methods, electricity, indicators, results, estimates, program-methodical complex, model.

Stashevsky Ye. O., Sheremet O. I., Ivchenkov M. V. Method of the fuzzy control algorithm synthesis for automated electric drives // Scientific Herald of the DSEA. – 2018. – № 1(25E).

Some technical problems that are difficult to solve by classical control methods can be easily solved by applying non-traditional control based on fuzzy logic. The use of fuzzy controls is appropriate where it solves the tasks better or cheaper than traditional methods of control. At the same time, fuzzy control can be either completely independent or additional. To work with data in fuzzy logic, a mathematical apparatus of the theory of fuzzy sets is used. Fuzzy logic processes uncertain data and situations using associative notions of a person – linguistic terms. For a fuzzy controller, the algorithm is not known in advance and its addition at multiple inputs is a complicated, non-trivial task that is solved in an iterative way with the use of computing. With the increase in the number of fuzzy sets for input and output variables, the quality of control improves. The method of fuzzy regulators synthesis for the position contour of the nonlinear observing electric drives is proposed in the article. This technique allows compiling algorithms of phase-regulators for correction of the servo drives in the modes of large disturbing influences and compensation of a static error. In the case of monitoring electric drives, which use a control computer or microcontroller for the contour of the position, it is advisable to apply the program implementation of the phase-control. The program for creating fuzzy regulator can be written in assembler or high-level language with C ++. Monitoring with the help of the proposed implementation of the fuzzy regulator can be carried out both in the program mode, when the trajectory of the motion of the object of observation is known, and in the mode of auto-guidance, that is, on the signal of inconsistency between the working body and the object of tracking.

Keywords: fuzzy logic, synthesis, fuzzy rules, defuzzification, regulator, algorithm.

Tokarev O. V., Boryagin D. O., Sheremet O. I. Analysis of the causes of damage to asynchronous motors and diagnostic tools for their operating modes // Scientific Herald of the DSEA. – 2018. – № 1(25E).

Asymmetry of voltage manifests itself in the sharp deterioration of technical and economic characteristics of electric motors (increase in losses of electric energy, increase of heating of their constituent parts), decrease of operational reliability and shortening of service life of electric motors. In order to increase the operational reliability of asynchronous motors, which are used in industrial production at phase voltage asymmetry of the network, it is necessary to improve diagnostic means. This will allow operating personnel to have accurate data on the mode of operation of the electrical equipment, the state of the working parts, accurately determine the time it is disconnected from the power supply and reduce the wear of insulation, the number of failures and emergency failures of asynchronous motors. The most common are devices for diagnosing, which react to change the value of current in the circle of the asynchronous motor. These include current protection, which is carried out with the help of current relays, whose action is based on the electromagnetic and inductive principle and thermal relays, which react to the amount of heat released as a result of the current flow through special elements. The main disadvantage when using the current relay as a protection device is to shut down the engine when it is started up. To prevent the safety device from disabling the asynchronous motor during normal start-up, as well as short-term load peaks, it should not act instantly, but with time-consuming. Therefore, simultaneously with a current relay, as a rule, a time relay is used. For most asynchronous motors operating in industrial production, it is advisable to use combined devices for the centralized protection of a group of motors, especially those operating in the mass production lines. Analysis of protective

devices and diagnostic tools, performed in the article, shows their imperfection and limited use in difficult production conditions. Improving the reliability of asynchronous motors in difficult production conditions requires the development of new multifunctional diagnostic tools.

Keywords: asymmetry of voltage, asynchronous motor, diagnostics, combined diagnostic device, current protection.

Troshchyi O. O., Launikonis V. V., Ivchenkov M. V. Comparative analysis of modern multi-motor feed drive synchronization techniques // Scientific Herald of the DSEA. – 2018. – № 1(25E).

Nowadays the multi-motor electric drive configuration is implemented in the textile industry, conveyors, printing equipment and machine tools. Using several motors on the guides of one axis can lighten the structure; however, a challenge of synchronizing speed and position occurs. A review of existing mechanical coordinates synchronization techniques in multi-motor electric drives, and systems based on these techniques, has been made. The most commonly used in modern industry are: the Master-Slave configuration, the Cross-Coupling technique, and the Electronic Virtual Line-Shafting. The main features of structures and regulation principles of the selected multi-motor synchronization techniques have been reviewed. Simulation of the above-said systems has been performed in MATLAB Simulink. The mechanical coordinates' transient responses of a multi-motor drive with the standard perturbing factors were obtained. As a result of analysis of these transients, conclusions were made about the control quality of each system. Based on the obtained results, one might say the Master-Slave configuration, although the easiest to implement, has robustness insufficient for use in high-precision electric drives. The Cross-Couple technique, although simple, has limited performance and is not suitable in cases where the relative angle is the main coordinate. The value of the cross-coupling feedback gain significantly affects the magnitude of oscillations in the moment loop and the speed loop. Due to the highest moment of inertia influence of the master drive of the virtual line shaft and its torque reflection, the proposed method is easiest to implement.

Keywords: simulation, automatic control system, feed drive, multi-motor drive, position synchronization, Master-Slave configuration, Cross-Coupling technique, Electronic Virtual Line Shaft, transient responses, machine tools, comparative analysis.

Shapovalov V. A., Komesarenko V. O. Analysis of circuit decisions of motor control by a frequency converter // Scientific Herald of the DSEA. – 2018. – № 1(25E).

The article discusses options for connecting high-voltage motors to the mains through: direct connection to the network through a high-voltage cell with a vacuum switch; connection to the network through a soft starter and connection via a frequency converter. Among these circuit solutions highlighted the disadvantages regarding the conditions of the overload capacity for starting current relative to the nominal values of the motor; engine starts at maximum speed more than once per hour; limited service life of vacuum chambers; lack of ability to control engine speed. Highlighted the method of connection through a frequency converter, which are considered relatively schematics connections of frequency converters for high-voltage electric motor: by means of a low-voltage frequency converter using step-down and step-up transformers; medium voltage frequency converter. The considered circuit solutions allow achieving a smooth sinusoidal output voltage and, as a consequence, an increase in the stability of the engine control system; transient time is comparable with the characteristic of engine acceleration, when reaching a set speed. However, with this type of connection, the disadvantages of relatively high currents in the section "step-up transformer-electric motor" are highlighted, which leads to a lot of noise in the system, until the failure of the frequency converter. Using the circuit solution of a frequency converter of the type-setting type, it is available: obtaining the output voltage of a given value by turning on the required number of cell elements; replacement of a broken cell by shunting without stopping the

operation of the frequency converter; application of motor control laws in a wide frequency range. Conclusions are drawn regarding the analysis performed and the information provided regarding the issues discussed in this article.

Keywords: electric motor, frequency converter, output voltage, transformer, transition process, element cell, control scheme, output filter.

Sheremet O. I., Zaporozhets V. S. Application of recurrent neural networks to perform machine text rewriting // Scientific Herald of the DSEA. – 2018. – № 1(25E).

Machine learning is an actual area of scientific knowledge, which is intensively developing and has very significant prospects. In a narrower sense, machine learning is understood as a class of methods of artificial intelligence, the characteristic feature of which is not the direct solution of the problem, but the application of a specially trained mathematical model for this. This model learns by solving a large number of similar tasks in the desired area. One of the most promising modern technologies of machine learning is using of deep neural networks, which is based on the application of deep training. Deep learning is a set of machine learning algorithms that allow creating models with a high level of abstraction in the source data, using the architecture of neural networks that contain nonlinear signal transformations. The article demonstrates the possibilities that the application of recurrent neural networks provides for solving one of the most difficult tasks facing web content developers – the rewriting of textual information. The meaning of the use of machine learning for the processing of natural languages is that the deep neural networks perform work for which, within an acceptable period of time, dozens or even hundreds of teams of professional linguists would have to be used. Traditional neural networks do not have the ability to make current decisions based on their previous judgments. A large number of tasks solved by machine processing of natural languages requires a step-by-step analysis of data taking into account previous results. The neural network should "read" the sentence word by word, "comprehending" its meaning from the context. Recurrent neural networks contain feedbacks and allow you to store information for a short time, so that they are perfectly suited for processing sequences of words and symbols, which are natural language sentences. The technical implementation of the rewriting is proposed to be implemented using the seq2seq library, which is part of TensorFlow, software developed by Google to solve the problems of building and training neural networks.

Keywords: recurrent neural network, rewriting, feedback, short-term memory.

Vlasov A. F., Gritsay T. S. Investigation of the influence of high current density on the process of welding in the environment of protective gases // Scientific Herald of the DSEA. – 2018. – № 1(25E).

One of the ways to solve the problem of improving the quality of the welded metal in automatic welding in protective gas is to increase the current density. In recent years, due to the increased use of argon-based mixtures, interest in welding at higher currents is noticeably increasing. Under the influence of electromagnetic and other forces, it is heated and melted the end of the electrode begins to rotate. The strength of the welding current, the overhang and the diameter of the electrode specify the conditions for the transition from jet transfer to jet - rotational. Quarreling processes at high current densities in the drip-drop or jet-rotational transfer mode require high-quality welding materials and reliable electrode wire feeding systems with speeds of 10-50 m / min. It has been established that the current density and the arc voltage significantly affect the nature of the metal transfer. It was established experimentally that when welding with electrode wire with a diameter of 1.2,; 1.6 and 2.0 mm in increased current density increases the melting capacity $G_н$ (14.6 kg/h) and the deposition coefficient $\alpha_н$ (28 g/A·h), which is 1.5 ... 4 times more than when welding with the usual density of welding current (90 ... 230 A/mm^2). With an increase in the strength of the welding current from 350 to 700 A, the depth of penetration increases from 5 to 11 mm, and the weld width increases from 12 to 21 mm, the height of the gain from 1.5 to 4.5 mm.

When welding in mixtures with a high content of argon is characterized by a sharp decrease in spatter, improving the formation and appearance of the seam. Experiments have shown that with currents greater than 200 A, the quarrel process becomes more stable with increasing current, the transfer of the transition metal into the drip drop, and the splashing decrease. Given the sensitivity of the welding process at high currents to a change in the arc voltage and the length of the electrode overhang, the main advantage should be given automatically and robotic welding.

Keywords: mechanized welding, strength-obertal transmission, clear-pelned transmission, density of current, protected gas, discontinuation.

Kovalevsky S. V., Savchenko S. S., Kostyukov I. A. The development and research of the method of reducing residual stresses in welded structures // Scientific Herald of the DSEA. – 2018. – № 1(25E).

The publication presents the results of the creation and research of a new method of frequency vibration field treatment of welded structures. It is shown by the example of the welded structure of the basic parts of the nodes that they undergo inevitable warping in the aftermath of residual stresses, which can have a diverse nature of distribution, both in individual parts of the welded structure and directly in the weld. The technique of experimental studies is presented, which involves fixing the amplitude-frequency characteristics of the acoustic spectrum of free oscillations of individual sections of the welded structure. The stages of measurements and processing of the obtained results are shown, which indicates the efficiency of the field of frequency impact on the structural elements to reduce the peak values of residual stresses. The results of experimental studies confirm the need for vibration treatment of the welded structure by acting on each element by vibration at resonant frequencies, respectively, to each element. The economic efficiency of the application of the principles to the design of the complex, using the latest mechanical Assembly equipment, considered safety measures on the mechanical section.

Keywords: residual stresses, warping, welded construction, acoustic control.

Kovalevsky S. V., Kovalenko D. V. Investigation of connection spectrum with diagnostics of nanoclay machine parts// Scientific Herald of the DSEA. – 2018. – № 1(25E).

The paper analyzes the literature, methods of measuring the thickness of coatings. The problem of measurement of coatings of small thickness, nanocoatings is revealed. To solve the problem, a new method of measuring coatings of small thickness with the help of the created measuring device, which fixes the values of the amplitude-frequency characteristics of the piezoelectric element, is proposed. Analyzed a spectrum of the acoustic signal with a coating of small thickness, of the coating. A hypothesis is proposed to predict the coating thickness based on the values of the frequency response (amplitude-frequency characteristics) of the obtained acoustic signal spectra. The principal scheme for measuring the coating of small thickness due to the proposed measuring device is given: the signal-generator delivers exciting radiation in the form of "White noise" to the measuring device, the piezoelectric sensor composes the exciting radiation, the frequency response of which has a constant amplitude over the entire radiation range of 20–20 000 Hz and radiation, which refers to the object of measurement, that is a coated sample. The sequence of the experiment is given. In the course of experimental studies, the connection of the acoustic signal spectrum with the input and output data was revealed. The model of neural network is created on the basis of input data of amplitude-frequency characteristics and initial data of coverage thickness. Based on this model, the values of the coating thickness are predicted. When toreros measuring device calculated deviations from the actual values of the thickness of the coating and graphs.

Keywords: nano-coating, coating of small thickness, of the amplitude-frequency response, piezoelectric transducer, piezoelectric sensor.

Kovalevskyy S. V., Korolevskyy D. M. Production of metallurgical equipment for the manufacture of casting molds using three-dimensional prototyping // Scientific Herald of the DSEA. – 2018. – № 1(25E).

This paper presents the results of replacing the existing technological process of making model equipment manually from wood using auxiliary equipment for a three-dimensional prototyping method. The features of the existing technology of manufacturing models and elements of the model kit are considered, the required equipment, material and types of work are listed. Revealed the disadvantages of traditional technology. It is shown that using the technology of three-dimensional prototyping it is possible to print shell models, with minimal filling of the model array, while maintaining quality and resistance to fracture during molding. This saves printing time and material from which the model is made. The production of model equipment by technology (FDM) for building a model by layer-by-layer welding, which follows the contours of a digital model, is demonstrated in stages. The calculation of the time and amount of material for the manufacture of a model kit using the software Ultimaker Cura. Also with the help of this software, the STL model was translated into a control G-code and prepared for printing. Comparison of two materials for the manufacture of models of ABS and PLA is made, the advantage and the possibility of using ABS plastic in the foundry for the manufacture of molds by model is demonstrated. The analysis was carried out and conclusions were drawn based on two comparative technological calculations for the production of model sets by hand and using three-dimensional prototyping. The existing technological process of manufacturing the “Cap” model kit was taken as an object. The analysis showed a reduction in cost due to a decrease in labor intensity, the amount of material, electricity costs and technological time for calculating costs.

Keywords: three-dimensional prototyping, model kit, shell model, Ultimaker Cura, 3D printing, FDM techno-logy.

Kholodniak Yu. S., Podliesnyi S. V., Kaporovych S. V. Development of the methodology of power calculations of flat frames in the conditions of forced oscillations // Scientific Herald of the DSEA. – 2018. – № 1(25E).

Analysis of existing methods of power calculation of beams and plane frames under the influence of forced oscillations is performed. It is shown that calculations of beams are not problematic. For such calculations there have been developed both simplified methods, which use mathematical models of weightless beams with point masses fixed to them, as well as more complex ones, which take into account the masses of the beams. The existing techniques for power calculations of plane frames are based on complex two-dimensional mathematical models. Their implementation requires in-depth mathematical training and complex computing facilities. Therefore, they are difficult to apply in ordinary engineering practice. There are no simplified methods of power calculation of oscillating frames. The purpose of this paper is to develop a simplified two-dimensional mathematical model of forced oscillations of plane frames with subsequent application of this model to power calculations. The mathematical model proposed in this paper describes oscillations of a weightless frame with a point mass and simultaneous action of vertical and horizontal harmonic disturbing forces. The model is based on the method of forces, which establishes the relationship between the movement of the frame and the forces acting on it. Together with the model, dependences were obtained for calculating resonant frequencies of the oscillating system. The completed developments allow to determine dynamic characteristics of the oscillation process and to calculate frames for strength and rigidity. The methodology for this calculation is implemented in the Mathcad 15 environment and has been successfully tested on a number of learning tasks. The results of the work may be useful to students and teachers of technical universities, as well as practitioners who perform power calculations.

Keywords: plane frame, forced oscillation, mathematical model, resonant frequency, power calculation.