ABSTRACTS

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RESEARCHING OF THE DYNAMIC OF HOIST DRAGLINE EXCAVATOR ЕШ-15/90А DRIVE

Using computer simulation environment MATLAB-Simulink, an analysis of the dynamic processes of hoist the ES-15/90 type dragline excavator, taking into account the effect of rope breaking, was performed. It is shown that existing studies of dragline dynamic use only traditional linear models of the elastic part of the rope drive of the excavator. For the study, a well-known mathematical description of sagging processes has been used.

Implementation of the mathematical model of the sagging effect of the rope of the hoist of the excavator-dragline is carried out by means of computer simulation. The system of the electric drive on the Ward-Leonard system and the subordinate principle of regulation with the use of magnetic amplifiers is modelled rather simple structure based on the traditional assumptions and tasks set in the electromechanics.

Comparison of the accuracy of the received computer models of the hoist drive of the excavator-dragline, taking into account and without taking into account the nonlinearity of the coefficient of elasticity of the rope for the mode of hoisting to the moment of separation of the bucket from the ground. Structural models using mathematical libraries MATLAB + Simulink are proposed for solving this problem. The results of the research are illustrated by plots.

It is shown that the use of the nonlinear model of the rope drive with the consideration of the sagging effect of the rope does not give the expected increase of accuracy in the studied modes.

I. R. Havdo

THE INFLUENCE OF SHUNTING FACTOR OF MAGNETIC FLUX OF SHADED-POLE INDUCTION MOTOR ON STEADY-STATES

The influence of shunting factor of magnetic flux of shaded-pole induction motor on steady-states has been considered. The mathematical model of motor with the inserted magnetic shunts is presented. Magnetic shunts are made as an arcuated ferromagnetic plate that is set between the poles shoes. The shunting factor of magnetic flux of excitation winding is determined by the relation of through magnetic flux that passes right through a shunt to the total magnetic flux in an air gap under the pole. The equivalent circuit of magnetic core that is ramified is in basis of mathematical model of motor. This mathematical model takes into account the local saturations of different areas of magnetic core with high accuracy. On the basis of calculation of mathematical model for the set instantaneous values of currents of windings the values of magnetic flux (flux density) are determined in all areas of magnetic circuit and also flux linkage and differential inductances of windings. Calculations are executed for the motor with two poles by input power 2 Watt. For set thickness of shunt and revolutions per minute of motor values of magnetic flux in separate areas of magnetic core, shunting factor of magnetic flux, currents of windings, torque, power output, efficiency of motor are calculated. It is shown that when revolutions per minute of motor increases from starting to non-load operation then the shunting factor of magnetic flux reduced. The steady-states characteristic of motor calculated by the differential harmonic method are presented. Researches showed that the shunting factor of magnetic flux was determined, mainly, by thick of magnetic shunt, and also substantially depends on duty type of motor. The thickness of shunt it is expedient to choose as a compromise between optimal the value of this size for the achievement of maximal torque and maximal efficiency of motor.

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EXPERIMENTAL INVESTIGATION OF A PROCESS OF REGULATION OF A STATIC THYRISTOR COMPENSATION UNIT FOR A POWER SUPPLY SYSTEM OF A MINING LOAD

For the purpose of improvement of metrics of electrical power quality in a 35 kV power supply network of a mining load which is connected to busbars of the 330/220/110/35 kV district substation "Novovolynska" of the Western Energy Grid, there has been a static reactive energy thyristor compensation unit (STCU) installed basing on the existing battery of static condensators (BSC). The given unit has been formed from an addition of a thyristor-reactor group (TRG) to the serial thyristor reactive energy compensation unit (TRECU) and integration of it together with the on-load voltage regulation (OLVR) device into a complex operation mode control system of a power supply of a mining load. A default system of the TRECU regulation is not efficient in case of voltage stabilization in a point of connection of the STCU. Therefore, there has been a structure schema of STCU regulation unit of a proportional action designed, and an experimental instance of the STCU regulation unit developed by the authors. The experimental unit is capable of high-precision voltage stabilization on 35 kV busbars of the substation.

To evaluate operation mode of the implemented STCU regulation unit, and correctness of a proposed method of determining of factors of disconformity by voltage and current, the experimental investigation of the STCU regulation process has been conducted during voltage stabilization on 6 kV busbars of the "Novovolynska" substation. Such a choice of a voltage stabilization point has been taken due to a possibility of artificial invocation of disturbances on the 6 kV busbars by switching taps of the OLVR of the T2 transformer, while voltage disturbances on 35 kV busbars are caused prevalently by occasional disturbances of electric load, or by disturbances in the energy system - which doesn't allow conveying of experiments.

The results of the experiments have proved the operational ability of the designed STCU regulator and correctness of the proposed method of determining of factors of disconformity by voltage and current, and have shown that the designed regulator of the STCU can be successfully applied for voltage stabilization on 6 kV busbars of the substation without readjusting. In the given case, voltage precision is relatively high (0,49% of the regulator's predetermined voltage level).

L.F.Karplyuk, V.I. Moroz, I.R.Golovach, A.Y. Nischyi

AN MODELLING OF THE ELECTRIC DRIVE ACCELERATION OF BALL MILLS

Modern frequency-controlled asynchronous electric drives allow to get high indicators of energy saving and controllability of technological processes. Significant interest is the installation of frequency controlled electric drives on a ball mill – a mechanism with the variable loading torque and variable inertia depending to rotation angle. In this work, the study of the operation features of the frequency controlled asynchronous electric drives for ball mill is made and recommendations for its implementation are made.

The application of sufficiently coarse dosing technique, heterogeneity of the used materials, adhering the mixture to the walls of the mill and lining brings about a significant spread of mill loading, which leads to an excess of the load moment of the projected values. The experience of operation showed that there are emergency interruptions of the mill start at abnormal load of the mill or after prolonged its idle time for settling the rock in the drum.

A model of an electromechanical frequency-controlled electric drive with vector control is developed, which, in addition to the with the variable loading torque and variable inertia depending to rotation angle, takes into account the jump-like load change at the time of the rock fall in the drum. The mathematical description of the periodic change of the load contains a periodic discontinuous

trigonometric function – arctangent, and takes into account the finite mechanical stiffness of the mechanical transmission. Studies have shown that the maximum value of the active current presents during acceleration that provide the maximal torque, which ensures the movement of the mill with increasing load, is supported, despite the decrease in the rate of the speed rising. The actuator develops an engine moment sufficient to start and align the mill. At the moment of a jump-like reduction in the load, which corresponds to the collapse of the mill load, an increase in the angular acceleration of the drum passes. There are such few crashes during the acceleration time to the nominal speed.

The analysis of the oscillograms of the process of the active current changing and the velocity during the speed-up of the real mill shows that the obtained processes by mathematical modelling in milling mode is practically adequate.

Andriy Kutsyk

AN ANALYSIS OF THE MODES OF INITIAL EXCITATION OF TURBOGENERATOR ON THE HYBRID REAL-TIME MODEL OF A POWER GENERATION SYSTEM

The transient electromagnetic processes in the power generation system with turbo-generator and brushless excitation system in a mode of initial excitation of turbo-generator are analyzed in the paper. The research was carried out in the hybrid system that combines a computer model of a power part with the real excitation controller (hardware-in-the-loop technology). The original method of an average voltage on integration step for mathematical modeling of electrical circuits has been used to create the real-time mathematical model of the power scheme. The using of this method allowed to increase the calculation performance and stability, and, also, ensured the continuous operation of the computer model over a long period of time. The influence of setting the automatic control system on quality of voltage regulation and excitation current regulation is analyzed. In particular, according to the research results, it was concluded that the decisive influence on the quality of the transition processes in the initial excitation mode of the turbo-generator has a proportional feedback of the excitation voltage, the absence of which causes oscillation of the generator voltage in the range of about 20% during its rise, as well as significant fluctuations of intermediate coordinates, in particular the voltage and excitation current of the auxiliary generator (exciter). Also, on the quality of the regulation of the voltage and excitation current has an effect the flexible feedback of the field current, the absence of which increases the dynamic errors of the regulation of turbo-generator's excitation voltage and current, as well as the dynamic errors of the regulation of exciter's excitation voltage and current. The technology of hybrid modeling, described in the article, which use of digital real-time models in combination with physical objects allows to diagnose and configure the real control systems in case of absence of control objects. With the use of this technology and the developed real-time model, the automatic excitation regulators of power plant's turbo-generators are testing and turning before its putting into operation.

V.R. Levoniuk , G. M. Lysiak, A.V. Chaban

MODELING CIRCUIT-BREAKER ULTRA-HIGH VOLTAGE FOR ANALYSIS TRANSIENTS PROCESSES IN ELECTRICAL ENGINEERING SYSTEMS OF ENERGY TRANSFER

The paper analyzes scientific publications and available software systems, which showed that in most cases research switching transient processes in electrical engineering systems transmission of electricity spend without taking into account the influence on them electromechanical processes during operation the mechanisms of moving contacts circuit-breaker, though, the velocity of their flow is commensurate with the velocity of electromagnetic processes. Substantiated the scientific and practical need to build effective, sufficient enough and relatively simple models of switching devices for the study of switching processes in electric power transmission systems. On the basis a generalized interdisciplinary (interdisciplinary) method of mathematical modeling, which is based on modifications the integral variational principle of Hamilton-Ostrogradsky, proposed the mathematical model of the ultra-high voltage circuit-breaker, the main emphasis on which is put on modeling the mechanism of moving his contacts. This model makes it possible take into account dynamics mechanism of moving contacts and, in the first approximation, burning arc between them. This makes it possible to explore real transient processes in the line without a complicated procedure for finding the initial switching conditions. This is especially true in practice during the study of processes in electrical systems with multiple circuit-breaker.

In addition, in the article given the results verification model mechanism switching contacts of the circuit-breaker and computer simulation of the established modes and transient processes as in the case of short circuits in the electric power transmission system, so when switched off by the circuit-breaker, which fully confirmed correctness and adequacy of research conducted in the article.

Confirmed, that the development of interdisciplinary research methods enables, based on a single energy approach build effective and adequate mathematical models dynamic systems of various physical nature (in our case of electrical engineering and applied mechanics), which significantly expands the research capabilities of the eventual user.

Ya. Marushchak, B. Kopchak, L. Kasha

ROBUST STABILITY OF FRACTIONAL ELECTROMECHANICAL SYSTEMS

In the control systems of different objects, and in particular, in electromechanical systems (EMS), there are problems associated with their robustness. The use of non-integral order regulators for whole-order control objects provides better flexibility in debugging than regulators of integer order. This flexibility makes fractional order control a powerful tool, but there are problems, including frequency effects. For most EMS typical parametric uncertainty is characteristic, and therefore the stability problem of the system can be reduced to its robust stability by analysing the corresponding characteristic polynomial.

The positive result of the previous researches is confirmation of the informativeness of the parameter $|f_{wi}|$ for finding EMS in the zone of stable/unstable mode. So, it was developed engineering techniques for EMS constructing, which provides the desired supply of stability, as a result was realized robust control.

The development of an engineering method for calculating robust stability is described in the article on the example of the linear system LTI. Investigations on robust stability were performed by simulating the transients of the transmitting functions with fractional order investigations and confirmed the results obtained for the use of the complex w_R - Riemann's surface plane. This allows concluding that the

parameter $|f_{wi}|$ is informative regarding the EMS location in the zone of stable/unstable mode or at the boundary of these zones, and with the approximation of this parameter to one of these zones, one can predict the nature of the transition of the EMS, which are described by both - fractional and integer transmission functions. However, the use of such method for the operational analysis of the robust stability of EMS is complicated by the high labour requirement of the calculating the of polynomials' roots in the complex w_R-plane of the Riemann surface, which negatively affects the efficiency of the process of self-adjustment.

Absolute phases $|f_{wi}|$ of the roots of the characteristic polynomial in the complex w_R-plane of the Riemann surface are an informative parameter for controlling robust stability and quality of the EMS. If parameter $|f_{wi}|$ equal 0.314 radian then in the transition function of the initial coordinate of the EMS there is no excessive correction. As decreasing $|f_{n-1,n}|$ from 0.314 radian overregulation increases and at $|f_{wi}|$ = 0.157 radian an oscillatory conditions indicated. That is, value of the parameters $|f_{wi}|$ can obtained information about robust stability, volatility and in the first approximation of the quality of the transition process of the initial coordinate of EMS.

V. Misurenko, M. Semeniuk

AN APPLICATION OF THE ALTIVAR 320 FREQUENCY INVERTER AS A PROCESS AUTOMATION TOOL

The article analyzes the efficiency of application of the ATV320 frequency inverter as a automation tool in case using of integrated ATV logic controller on the example of the practical implementation of the control system for the electric drive of crusher.

The crusher is used for metal waste grinding of turning metal processing, which enter the receiving crusher hopper through the conveyor where they fall on two drums, which are rigidly connected between them through the gears. The drums are positioned horizontally and rotate towards each other. The milling cutters are on the surface of the drums for grinding waste metal turning.

The control system of the electric drive of crusher with using the ATV320 frequency inverter and the ATV Logic integrated logic controller provides two operation modes: manual and automatic. Manual operation is used to install and test the mechanism. Control system in manual mode is provide reversible mode of the electric motor with two different fixed speeds of work "forward" and "back".

The automatic mode of control system of the crusher is the basic working mode. The permission to turn on crusher is formed by a dry contact of the lathe control equipment.

ATV Logic controller of the ATV320 frequency inverter provides the implementation of an algorithm for the operation of a crusher in case of falling into the crusher of objects that can lock the drum rollers. In this case, the implemented electric drive control system, the crushers automatically determine the start time of blocking the crushers and transferring the electric drive to a reverse mode at a reduced speed to unlock the drums. The operation of the electric drive in a reversal mode provides a specified time, after which the start and work of the drive "forward" is automatically started. If there is a re-lock, then the cycle repeats itself. Three cycles of such work are allowed, after which the control system should accidentally stop the crusher. If during the execution of the command "back" there is no unlocking of the drum robot, the crushers are immediately blocked by an accident.

The above described algorithm for controlling the electric drive of crusher can be realized on conventional frequency inverter with using the additional intelligent relay Zelio Logic. However, it should be noted that such an alternative solution is significantly more expensive.

The implementation of the control algorithm using the ATV320 frequency inverter with integrated logic controller ATV Logic has practical value for creating and modernizing already existing control systems for frequency controlled electric drive of crushers in case value by money point.

Ihor Shchur and Yurii Biletskyi

POWER-EFFICIENT DIRECT TORQUE CONTROL IN A TWO-ZONE PMSM DRIVE FOR ELECTRIC VEHICLE

The work is devoted to the industry of electric vehicle, which for today has become the leading branch of modern applied science and technology. The main subsystem in electric vehicle is a propulsion electric drive, which is mostly often implemented based on permanent magnets synchronous motor (PMSM). The advantages of these machines are higher, compared with other machines, values of energy efficiency, specific power and torque, overload, good controllability, and wide range of angular speed regulation. The quality of the propulsion subsystem of electric vehicle depends greatly on the control dynamics of its electromagnetic torque. The highest value of this future can be achieved by applying a direct torque control (DTC) strategy, which has been recently developed for PMSM. This strategy allows you to form quickly the required values of the electromagnetic torque and the armature flux linkage of PMSM, but does not provide the possibility of forming an armature current vector, on which the energy efficiency of a machine depends. The latter is particularly important for an electric vehicle, given the power constraints of an on-board power supply system. In order to ensure the high value of the energy efficiency of PMSM, in this paper the reference for the armature flux linkage in the first zone of angular speed regulation is formed in an optimum dependence on the current value of the electromagnetic torque of the machine. The feature of electric transport is the ability to reduce the torque at high speeds. This allows using the two-zone angular speed control and reducing the installed motor power. For the energy-efficient control, according to the DTC strategy of the angular speed of PMSM in the second zone, a method is proposed, according to which the initial value of the angular speed for this zone depends on the current value of the electromagnetic torque and the value of the on-board voltage of the electric vehicle. Previous theoretical studies made it possible to determine the numerical dependencies between the main coordinates of the PMSM, which were composed in the corresponding look-up tables behind the developed system of two-zone speed control. The conducted computer simulation studies showed the effectiveness of the proposed solution and the high dynamics of the developed electric drive control system for an electric vehicle.

M. A. Yatsun

CONSTITUENTS OF MAGNETIC INDUCTION OF PUTTEE OF EXCITATION OF COMMUNICATING EDDY CURRENT TRANSFORMER ARE IN A LEADING PIPE

Question of monitoring of the technical state of pipelines for providing of reliability and safety of supply of power mediums (natural gas) acquires all greater actuality main pipelines through the considerable degree of wearing out and senescence of equipment of domestic oil-gas complex.

The basic task of the technical diagnosticating of pipelines is establishment of actual thickness of wall of pipeline and exposure of defects as violation of wholeness. Most effective for the leadthrough of works from the technical diagnosticating after all length of pipeline with minimum outages in-process pipeline there is realization inwardly pipe diagnostics with the use of intellectual pistons which move under pressure of the transported

product. However inwardly pipe diagnostics with the use of magnetic pistons, needs improvement, for providing of higher authenticity and control exactness.

Advantages of eddy current method of control is a contact free, absence of remaining magnetic effects and possibility to find out superficial cracks with the small opening and defects of stratification of metal of pipeline.

Therefore actual is a task of determination of statement and transitional parameters of internal clock-houses of eddy current transformers of self-reactance and transformer types at an impulsive feed for the receipt of multi-parameter information about the object of control, that largely depend on character of distribution of magnetic induction near his surface.

The converted on Laplace radial and axial constituents of magnetic induction screened circular cylinder spool of rectangular transverse section with the current of free-form is certain, which are used as a puttee of primary indoor internal transformer at diagnosticating of the technical state of internal surface of pipelines.

The brought graphic arts over of distribution of brought in by a control object and total radial and axial constituents of magnetic induction on the internal surface of pipe in initial moment of time and at a withstand mode at excitation of primary transformer by the impulses of rectangular form.

E. O. Chaplygin, S. O. Shinderuk, O. S. Sabokar, V. V. Dzuba

DEND REMOVAL FOR CAR BODY PANELS VEHICLES BY THE "INDUCTOR SYSTEM WITH ATTRACTIVE SCREEN"

Introduction. Developments in the field of magnetic-pulse metals forming (MPMF) are increasingly used in the modern technologies of production and repair of the aviation, automotive and other machinery, as they are environmentally friendly and energy-efficient in comparison with classical approaches. One of the main components of the device MPMF is a tool – inductor or the inductor system with an attractive screen (ISAS).

Experimental testing of "ISAS" with external excitement using a multi-turned circular solenoid, was conducted in the production operation of contactless removal of dents in work piece of sheet metals. The principle of the attraction tool at low frequencies allows to effectively carry out the operation of attraction of metals of any physical nature.

Purpose. Experimental testing of the "inductor system with attractive screen" with external excited with the multi-turned circular solenoid, without an additional source of magnetic field, in the production operation of contactless removal of dents in samples of sheet metals.

Methodology. The coil of the solenoid is connected to the power source – a magnetic pulse plant of МІУС-2, the distinctive feature of which is the work in serial mode, that is, in the mode of continuous repetition of a given number of current pulses. Coil of the solenoid, excite currents in the screen and blank, which leads to the force of attraction of metal dents to the screen. In the form of experimental samples were taken sheet blanks of magnetic and non-magnetic metals. After a force operation, a gradual reduction of dents is observed.

Results. The results of practical efficiency of "ISAS", excited by the low-frequency field of an external multi-turned coil, are presented. At real values of output quantities of the amplitude of the attraction forces reach ~ 2.0 MPa. Averaging over the area of force influence gives a value of ~ 1.0 MPa. Insignificant and quite realistic for the practice of increasing the current of the inductor, for example, to ~ 15 kA, increases the attraction forces more than ~ 2 times.

Practical value. It is shown that in the production operation of contactless removal of dents in blanks of sheet metals, the inductor system with attractive screen demonstrated the effectiveness of the practical implementation of the method of repair of car bodies.