ABSTRACTS

to the article P. Baran, V. Kidyba, Y. Pryshlyak, M. Dembitskiy,V. Shmahala

FEATURES OF CHECK DIRECTIONAL POWER RELAY SERIES RBM THROUGH THE USE OF DIGITAL TESTING SYSTEMS

During the set up and plan check of separate complex relays, such as relay of the direction of power of the RBM series, difficulties with test performance of electromechanical relays using traditional analog technical means of verification occur.

Special test systems implemented on a digital basis are used. For configuration and check of relay protection and automation (RPA) performed both analog and digital principle. These devices allow us to quickly and efficiently perform set-up and verification of complex sets of relay devices and certain complex relays. In Ukraine, the most widely used devices are "Rele-tester" and "RPA-tester" of domestic production.

Principles of formation of the directional power relay of RBM type verification module are developed, its digital implementation as a separate subsystem of specific software of digital system testing is made. Application of the power direction relay Module check allows to check and obtain its main electrical characteristics:

- Self-act by the current;
- Self-act by voltage;
- Coverage;
- Response characteristic;
- The response time;
- The return time;
- Reset of reverse power;
- The dependence of power on voltage angle changes at permanent current;
- The dependence of the power of changing the angle of current at constant voltage;
- Voltage dependence of current change at the maximum angle response level.

The developed module allows to check the power direction relay BSR series of according to nomenclature of such relays check.

During the experiments of the relay characteristics verification the test protocol, which is recorded in the archives of the protocols is automatically generated.

The possibility of forming a RBM series relay check objects library, which allows to use them for the same and similar relays check on the other objects of power systems.

K. Vasyliv

THE ANALYSIS OF AUTONOMOUS ELECTRIC POWER SUPPLY SYSTEM, BASED ON ASYNCRONISED GENERATOR WITH THREE-PHASE MODULATOR WITH ONE STAR SCHEME DURING COMPLEX LOADING

Autonomous electric power suply systems, based on asynchronised generator with contactless cascade modulated exciter, belong to promising one, as they perfect provide frequency strain stability on terms of changing frequency of generator rotor propeller. Theoretical concept of such electric rower supply systems provides 16 scheme decision kinds, which provide crucial impact on electromagnetic and

electromechanic processes course, and on work of electric power supply in general, as well. Besides, such systems are aslo influenced by type and conditions of generator loading work and functioning of automatic strain amplitude stabilization.

The author has developed mathematical models of high adequacy level. By means of them and on basis of proper program complex instant value calculation of all basic coordinates were received and electromechanic and elecromagnetic analysis, that happen in autonomous power supply system on basis of asynchronised generator with contactless cascade modulated exciter with one star scheme generator rotor and combined potential and common connection of rotor machine modulator phased branches, during generator's work at asynchronised motor joint and active-inductive loading were analysed.

Results of electromagnetic and electromechanic investigation processes, which were received for chain of consumers' work conditions: asynchronised motors and active-inductive loading are provided.

On the ground of the research, it was determined, that in contradiction to scheme with common connection of phased branches, modulator shceme with combined connection guarantees higher level of power supply system resistance, and, in particular, commutator resistance. The value and character of asynchronised motors loading, active-inductive loading parameters, including power factor, value of insert by strain commutator, and consumers work scedule have crucial influence of work resistance.

V. Gapanovych, V. Gapanovych, O. Mavrin

LIMITATION OF MAGNETIZATION CURRENT INRUSHES IN ELECTRICAL POWER SUPPLY SYSTEM OF ELECTRIC ARC STEEL-SMELTING FURNACE WITH PHASE-CONTROLLED FURNACE SWITCH

The process of steel smelting in electric arc steel-smelting furnaces (ESSF) requires frequent switching of idle furnace units, accompanied by high-multiplicity magnetization currents inrushes (MCI). Electrodynamic rushes, caused by MCI to windings of network transformers, affect loosenings with subsequent failures of transformers.

The analysis of main factors that influence the value of MCI allowed to offer a way to limit them using phase-controlled furnace switch.

The paragraph herein describes time-controlling algorithm for switching phase poles of furnace switch. Turning on the furnace unit is carried out in two stages. Firstly, two phases of the unit are turned on at rated voltage of the power supply network, and one of the phases is switched to previously demagnetized magnetic core leg. Then, in 1,5-2 seconds the third phase is turned on. Limitation of MCI at, the on first stage of switching process is achieved by total magnetic flux reducing in magnetic core of furnace unit and by decreasing phase voltage at the moment of switching. Though, maximum value of voltage, applied to each phase of furnace unit, is less than half of rated line voltage value. At the second stage limitation of MCI is a result of the fact that the third phase is switched to magnetic core, which is already demagnetized by influence of the remaining two phases. Preliminary demagnetization of one of magnetic core legs is performed at each unswitching of furnace unit of power supply in similar step-by-step way. Firstly the phase, magnetic core of which is subject to demagnetization, is disconnected. It is achieved by influence of remaining energized phases of electric furnace unit. Then, in 1,5-2 seconds these phases are disconnected from power supply.

The research hereinafter has been performed grounding on mathematical modelling. Named research has shown that application of phase-controlled furnace switch allows reducing the most probable maximum amplitude of magnetization current inrush in the windings of network transformer from 2,29 to 1,39 relative units. This limitation of MCI amplitude increases the reliability of network transformer by significant decreasing of electrodynamic effects in its windings.

L.I. Demkiv

INFLUENCES OF STANDARD LINEAR FORMS ON CHARACTERISTICS OF DYNAMIC SYSTEM WITH FUZZY MODAL CONTROLLER

To date, at the study of electromechanical systems the synthesis of the controller which ensures stability of the system as well as the desired transients is an important issue. One of the most common methods is the method of feedback. That is nonlinear system is replaced with the linear model and control synthesized for it is use to control a nonlinear model.

As it is shown in several scientific papers, most electromechanical systems can be described as two-mass model. At synthesis of full state feedback control for such systems a question of choosing the form of the distribution of the roots of the characteristic polynomial arises.

Studies show that system performance can be increased by applying predictive control approaches. Namely, by applying control actions, which are synthesized using a variety of standard characteristic polynomial depending on the size of the error of system's output coordinate.

The goal of this study is to compare the characteristics of a dynamic system with fuzzy controller, at combination of control actions that are configured for a variety of standard linear forms.

Based on the obtained results it can be argued that the use of intelligent control significantly improves the dynamic performance of the system.

The results obtained testify that it is preferable to use a system which consists of of three subsystems: subsystem with controller that is configured for standard linear form , which ensures maximum performance (at large deviations) , the controller subsystem that is configured for standard linear form of the Bessel (at small deviations) and the controller subsystem that is configured in a standard form that provides the minimum of the integral square error. In this case, the payoff can be achieved to 1.82 times in comparison with the standard binomial form to 1.15 times in comparison with the standard form Butterworth , 1.23 times in comparison with the standard form of Bessel 1.15 times in comparison with the standard form of Chebyshev 1.14 times in comparison with the standard shape, which ensures the highest performance and to 1.72 times in comparison with the standard form that provides a minimum error control.

B.L. Kopchak

APPROXIMATION ACCURACY ANALYSIS OF HIGH ORDER ELECTROMECHANICAL SYSTEMS OBJECTS WITH FRACTIONAL TRANSFER FUNCTIONS OF DIFFERENT TYPES

When optimizing circuits of automatic control system (ACS) of electromechanical systems in which objects are described by transfer functions (TF) of high order, there is tendency to resort to lowering the order of the numerator and denominator, ignoring the elements of operators in a high degree, resulting in significant adequacy deterioration of this model in relation to a real object. An effective way which ensures order lowering is to present control object with fractional parts of low order. This article is the continuation of the research conducted in this area in order to form a more complete theory of the creation of fractional order models for high-order TF approximation developed on the identification of real electromechanical objects with typical fractional models of first and second order and a comparative analysis of this approximation accuracy both in frequency and time domain. The results of this analysis enable to make recommendations on the usage of certain fractional order parts characterized by certain frequency and transition parameters.

This analysis is carried out in MATLAB Simulink environment and provides the following:

– creation of low order fractional models of individual parts chosen as the basis of modeling that are not presented in the environment;

- high order part approximation, which is the transfer function of an induction generator with self excitation, with low order fractional models and estimation of approximation accuracy of the object with a fractional model by applying square error of mismatch of both frequency and transition functions of full and simplified models;
- evaluation of approximation accuracy of all part types is done in time and frequency domain with the same step, thus ensuring validity of the results.

Due to the comparative analysis to approximate the control object which is an induction generator with self excitation, it is necessary to use fractional order part with the transfer function $W(s) = \frac{k}{a_1 s^{\alpha_1} + 1}$ which provides high approximation accuracy and is simpler to be implemented in comparison with others.

I.V. Lischak, T.V. Binkevych

ASSESSING THE RELIABILITY OF OVERHEAD LINES LIGHTNING PROTECTION SCHEMES OF TRANSMISSION LINES

Mathematical modeling is the primary method for studying the reliability of lightning protection of transmission lines. Mathematical models are used mainly to quantify storm sustainability of EPS. In this case, the following parameters are defined: average annual number of short circuits in power switchgear and substations caused by direct lightning β; the average number of dangerous overvoltages that occur at substations throughout the year as a result of crowding waves from transmission lines β_1; annual average number of storm outages TL n_p. The above mentioned figures demonstrate the intensity of lightning failures of certain types.

The model is generalized as the reliability of lightning protection of TL at direct lightning strikes and the incoming waves is calculated using only algorithms defined by the expressions (1) and (7). All random variables that define lighting proofness of the object are take into account, and developed methods of calculation provide adequacy and match for natural processes.

Input data for calculation of reliability include geometrical dimensions of the elements of the object that is studied, characteristics of protective devices, operating and experimental characteristics of isolation and crown. In order to maximize the accuracy of the model and input data, it is necessary to exclude the variation of random variables that have the greatest impact on the accuracy of the result. This fact is also substantiated by claims of reducing the length of the digital design. This is one of the important features of the proposed model. The accuracy of the model of reliability of lightning protection can not be justified formally. The main criterion to be considered is correspondence the results of calculations and operating experience. This correspondence was observed in almost all instances of the created model for which data on operating experience were available.

V. Moroz, M. Solskyy

THE ANALYSIS OF THE EXISTING METHODS FOR ASSESSING THE SENSITIVITY OF THE TRANSFER FUNCTIONS ROOTS TO CHANGES IN THEIR COEFFICIENTS

It is very important to research all impacts that can cause incorrect work of digital control systems because of the thorough introduction of them in electromechanics. The existence of the problem of impact of the finite hardware precision in digital control systems which significantly influences their practical

realization was shown in previous works. The explanation of this phenomenon can be found in publications on applied mathematics. It is shown there that polynomials with multiple or close roots are very sensitive to the transfer function coefficients accuracy. Decreasing of sampling step leads to the displacement of all zeroes and poles of the discrete transfer function to a unity. So, all solutions of the polynomials in the numerator and denominator become very close. Consequently, polynomials become singular and, as a result, very sensitive to the coefficient resolution accuracy.

According to this, it is very important to make the analysis of the existing methods for assessing the sensitivity of the polynomials roots of the transfer functions to changes in their coefficients and to describe the basic mathematical equations for assessing the sensitivity of the polynomials roots of the transfer functions to changes in their coefficients.

The existing methods for assessing the sensitivity of the polynomials roots of the transfer functions to changes in their coefficients were analyzed in this article. Particular attention was paid to the case of the multiple polynomials roots of the transfer functions, leading to a drastic impact of the slightest error in polynomial coefficients on result of their roots finding. The basic mathematical equations for assessing the sensitivity of polynomials roots of the transfer functions to changes in their coefficients were described.

The conducted analysis has shown that there are a few methods for assessing the sensitivity of the polynomials roots of the transfer functions to changes in their coefficients and has confirmed the actuality of searching the ways of solving the problem of impact of the finite hardware precision on the practical realization of digital control system. The analysis of publications has shown that the problem of discrete transfer functions for the small sampling step is still unsolved.

V. Moroz, V. Stefanyuk, V. Tsyapa, G. Sivyakova

THE DYNAMIC ANALYSIS OF THE MINING SHOVEL TWO-MOTORS SWING DRIVE

Mining shovels are widely used in open cast workings of mining and usually use electric drive. Swing drive is the most difficult part because of the requirements for the electric drive and their implementation. Mechanical parts of the drive has long shafts that create elastic joints and significant backlash, which will eventually only grow because of wear parts and enhance grip in shock, reducing resource efficiency. The investigation of these phenomena due to the complexity of electromechanical processes with large fluctuations is quite problematic and without computer simulation is impossible.

The study of the dynamics of electric career excavators conducted at the Department of Electric Drive of the "Lviv Polytechnic" showed that the estimated unbranched mechanical systems due to main mass and stiffness with sufficient accuracy to analyze can mostly be reduced to three-mass or two-mass equivalent schemes. In the case of the mining shovel swing drive to improve the accuracy of the model somewhat different from the conventional structure of mechanical parts is used – namely, the equivalent three-mass two-motors system, the presence of natural damping and nonlinearity – backlash in gears and Coulomb friction.

The ducloped computer model using the automation of the modeling process, namely simulation modeling environment MATLAB-Simulink application with additional library SimPowerSystems, enabled to investigate the dynamics of the swing drive with regard to the presence of Coulomb friction and backlash in gearing, their initial values for each shaft including nonlinearities of the branch "thyristor exciter – DC generator". This model made it possible to explain the appearance of almost non damping vibrations of the mechanical parts of the two-motor drives.

This computer model was used for the research of the efficiency of damping mechanical vibrations into electric drive through different types of feedback.

V.M., Oksentyuk A.B. Krevnyuh, T.J. Dzyoba

COMPUTER MODELLING OF COLLECTOR AND AC ELECTRONIC EXECUTIVE MOTORS OF OPTICAL TELESCOPE

This paper describes the optical reflecting telescope (OT), celebrated a mirrors mass about 20 tons and a large inertia moment - about 160 000 kg•m2 for azimuth rotation axis. Trying to get the best observations showings leads to a complication of tasks, performed by OT aiming electric drives (ED).

That is why, direct drive based on ac electronic direct drive constant voltage torque motor is used for prospective telescope. Adjustment and choosing the best control system (SAC) version on the real OT object is associated with considerable difficulties.

Therefore, at first it is advisable to provide mathematical computer SAC modeling of positional telescope ED on a mathematical model and then start physical tests. The mathematical description of the ac electronic motors is quite difficult and cumbersome when using the synthesizing control systems in mathematical tools. Instead, classical mathematical model of a direct current motor with permanent magnet excitation is simple, widely adapted and allows to receive the necessary decisions of various SAC synthesis process mathematical problems without complications of mathematical description. Therefore, to prove the applicability of alternative simple and informative mathematical description control object – ac electronic direct current motor, an executive commutator and ac electronic motors of OT ED comparative analysis was held, their mathematical models in different modes were investigated, the features were founded and positional telescope ED SAC, build on the closed-loop principle speed, was synthesized. As a result, it was found that the static and dynamic characteristics are similar with a small percentage differences (5%). Therefore, for a further OT ED research, when the dependence between the executive motor moment and the angular speed of the input voltage, but not its design, is important, mathematical model of collector engine is chosen.

The theoretical investigations results physically implemented on an experimental stand (SCB of electromechanical systems "Lviv Polytechnic"), which is designed for electric torque motors and low-speed rate generator for direct drive ED testing. Experimental studies of developed SAC by OT ED speed have confirmed the correctness of the mode decisions.

L.F.Karplyuk , B.Ya.Panchenko

SUBORDINATE CONTROL SYSTEM WITH SELECTIVE SPEED CONTROL

A necessary condition for the operation of electric mechanisms that ensure accurate testing of specified trajectories, is a high speed and accuracy of controlled coordinates maintaining in dynamic and steady state. In addition to these requirements, the control system should provide a wide range of speed control, limit the output coordinates by accepted values and ensure the margin stability in the range of possible changes of the electric and machinery parameters. To provide these requirements modern systems are mainly subordinated to the principle of regulation circuits connection.

Performance compensated inertia motors provided input forcing circuits links to regulators regulatory choice fast converter to power the engine that defines uncompensated time constant of the system and the number of circuits, of regulation.

The stiffness of the mechanical characteristics of the segment of speed stabilization selection provided by integrated speed controller with parameters calculated by "symmetrical optimum". Application of the regulator causes significant overshoot signal when mining tasks and the load . An implementation of variable structure speed regulator , which will use a variety of structural solution, with positive qualities of different regulators is offered.

Studies have shown that the system with selective choice of speed control ensures performance of electric drive which is higher than that corresponding to the default settings, with allowable overcontrol of controlled origin, speed in stability of the load . The system is easy to establish and requires no special calculation methods except traditional systems of subordinate control.

O.G. SeredA

PROTECTION OF BRANCHED POWER GRID NETWORK WITH DISTRIBUTED LOAD FROM NEUTRAL WIRE BREAKAGE

The possibility of extending the list of implemented protections in circuit breaker trip units based on the digital processing of signals from current sensors is justified. The possibility of protection against neutral wire breakage anywhere in a branched power grid network with distributed load in the presence of nonlinear distortions is proved. The need for protection against neutral failures in any part of a long electricity grid is conditioned by the fact that in the presence of phase currents asymmetry and neutral failures there is a possibility of dangerous overvoltage in single-phase consumers as a result phase voltages distortion.

The feasibility of identification of neutral failure fact by the harmonic analysis of the phase currents spectrum in the presence of nonlinear distortions is proved. The neutral failure fact is fixed by comparing the expected value with the actual value of the neutral wire current at its breakage.

With linear loads in the electrical circuit when phase currents vary by sine wave is not difficult to determine the expected current in the neutral wire. However, office equipment is nonlinear load which creates phase currents sine wave distortion. The time curve of current variation has the full odd harmonics range. Therefore, to form the expected image of the electrical circuit for networks with nonlinear loads, it is necessary to carry out harmonic analysis of the phase currents spectrum.

Only then it is possible to build protection correctly allowing for peculiarities of different harmonics currents variation. The phase currents harmonic analysis is carried of owing to the wide use of instantaneous current values squared integration mathematical operations in relaying devices.

The new technical solution enabling in sliding monitoring mode to create of circuit breakers operation criterion during the protection of single - phase electric power consumers from neutral failures is proposed. The algorithm for functioning of circuit breakers microprocessor trip at the neutral wire failures, in which the phase currents harmonic analysis is carried out through mathematical operations widely used in relay protection devicec, allows perfectly combining it with the mathematical apparatus for construction of other types of network protection.

M. Twerd, L. Kopchak, V. Tsjapa

APPLICATION OF FOURQUADRANT FREQUENCY CONVERTER TO UPGRADE PERFORMANCE OF MACHINE ELECTRICAL DRIVES

The automated control systems of electric drives of metal-cutting machines enhance their performance because the processing of metal occurs at the maximum allowable power modes and extends the operation of the cutting tool.

One of the trends of the automated electric drives of metal-cutting machines is the use of controlled AC electric drives for head movement gear using modern frequency converters (FC) with microprocessor control. In particular, TWERD company is developing the option for machine electric drive in the system of PLC (Programmable Logic Controller), which will lead to simplification of the problem-solving

related to automation of metal-cutting machines, namely: software for drive control, regulation of metal processing technological parameters. In addition, TWERD company is doing research aimed at reducing FC impact on power supply system.

High coefficient of current distortion as well as unidirectional energy flow, that is, inability to bring energy back into the network in brake modes, are the main disadvantages of modern FC associated with diode rectifiers which the inverters are powered by.

An alternative of power supply of FC metal-cutting machine electric drive is a three-phase rectifier with IGBT with modulated impulse width (MSI "converter") to the DC lines of which inverters for speed control of electric mechanisms of one machine, or, for example, the main motion electric drives of several machines in one process line are connected.

These test results make it possible to conclude that MSI VF – DTC converter is a valuable alternative for the frequency controllers with uncontrolled rectifier (DC link) in machine electric drives and has the following advantages: it provides energy recovery into the network in brake modes, which saves braking time and increases efficiency coefficient, has high degree of protection against errors in the control algorithms, provides good dynamic performance and a low total harmonic distortion (THD).

V.I. Tkachuk, I.Y. Bilyakovskyy, V.I. Zhuk

AC ELECTRONIC MOTOR FOR THE ELECTRIC DRIVE OF THE TROLLEYBUS WHEELS

Today the opportunity to reduce load of the city motor transport and to improve an ecological state by expansion of trolleybus networks has promoted the revival of interest to the trolleybus.The most perspective among many types of engines in modern adjustable electric drives of average power are permanent magnet synchronous motor (PMSM).

To improve the use of PMSM they increase electromagnetic loadings and an active zone of alarm sector of the sensor rotor position (SRP). The half-wave switchboard with parallel connection of the accumulative condenser allows to improve power indicators and to reduce pulsations of current of the SRM with a passive rotor. U-similar stator structure with almost no electromagnetic ligaments between the sections, which increases the resistance of electronic components and energy performance due to a shorter length of magnetic field lines, and hence the losses in the steel is used in the PMSM.

The PMSM designing for the electric trolleybus wheels through the use of developed at the department of electrical machinery and apparatus (DEMA) for the electric motor trolley wheels put the theory of electromechanical energy conversion in the SRM of capacitive energy storage (CES), and comparative analysis of the moment and electromagnetic loads of SRM with capacitive energy storage with traction electric motors.

Mechanical and adjusting characteristics served as optimality criteria of selected engine variants.

The engine was investigated with use of automated study subsystem of switched reluctance motor with capacitive energy storage, developed at the department of electrical machinery and apparatus of Lviv Polytechnic.

Results of studies with use of automated system show that the electric drive designed on the of designed motor, provides the necessary speed of the trolleybus 90 km / h on the horizontal section. The power developed by the engine per unit weight (ton), is about 7 kW / t, and the angle at which the trolleybus can move up without acceleration at a speed of 25 km / h is 11.2°, which approximately corresponds to modern foreign and domestic trolleybuses.

Serhiy Shcherbovskykh

MATHEMATICAL RELIABILITY MODEL FOR FAILURE CAUSE ANALYSIS OF ELECTRICAL SYSTEM WITH COMPLEX WHOLE STANDBY REDUNDANCY

In this paper the mathematical reliability model of repairable electrical system with complex whole standby redundancy for minimal cut set probability characteristics calculation is proposed. Minimal cut set probability characteristics are used for failure cause analysis as well as for creating recommendations on how we can improve system reliability. The analyzed system is composed of four components: two generators G1, G2 and two converters VD1, VD2. The generator G1 and the converter VD2 make up the main subsystem, and G2, VD2 make up reserve subsystem. The reliability of such system is formalized by dynamic fault tree. System down state occurs if both main and reserve subsystems are in down state. Subsystem down state occurs if even one of its components is in down state. Time to failure for all components is distributed according to Weibull and repairing time is distributed exponentially. In the model such load-sharing phenomena are formalized. Firstly, load-sharing of reserve subsystem components are depending on the main subsystem state. Secondly, load-sharing of the main subsystem components are depending on the state of it's another component. Thirdly, load-sharing of the reserve subsystem components are depending on the state it's another component. The state and event model of the system is constructed using dynamic fault tree. Such system can be in seven states, three of which are operational. Eight events can occur in the system, four of which are failures. Using states and events model, the split homogeneous Markov model of the system is constructed. Such model has 112 differential equations. By the split homogeneous Markov model minimal cut set probability characteristics are defined. "TV1–G2" cut is recognized as the most weak with 33.75% percent ratio. The main advantage of the proposed mathematical reliability model for electrical system with complex whole standby redundancy consists in treating load-sharing impact on cut probability characteristics.

I. Z. Shchur, V. I. Klymko

PREDICTION OF ENERGY EFFICIENCY OF PHOTOVOLTAIC PANELS IN LVIV

Along with other devices generating electrical energy (EE) from renewable energy sources, photovoltaic (PV) panels have several advantages, including: simplicity in design, construction, low weight and size, long life. The main disadvantages of using solar cells are their low efficiency, instability of receiving of EE due to weather conditions and the dependence of output power from the angle of incidence of sunlight on a panel. The value of the output power of solar cells depends on the locations and orientation of the panel, the angle of inclination of the panel, weather conditions, environment, season, time of day and other factors.

To get a clear picture of the work of PV panels and predict the amount of EE generation by it, it is necessary to have weather data for the region, where this panel is set, such as insolation and environment temperature at least for a period of one year. For this purpose, an electronic database of hourly meteorological data for 2013 year for the city of Lviv was formed, which includes hourly values of dispersed, direct and total insolation and hourly values of environmental temperature. Using this framework, it is possible to solve a number of useful tasks, such as: obtaining of the optimum parameters of solar cells location at which the largest value of EE will be generated during the year, finding the optimal value of tilt angle of PV panels at a given orientation (ie the azimuth of panel orientation are known in advance).

The algorithm of calculating of solar radiation arrival on arbitrary oriented in space plane was created based on the established database. It is shown how to estimate the annual amount of EE generated

by particular PV panel, set in some specific location in Lviv, considering the total annual inflow of solar radiation and having that PV panel nominal parameters.

Our calculation shows that the optimal placement of PV panels for the city of Lviv is their orientation to the south with a deviation to west which equals 3°, and the optimal value of tilt angle of the solar cells in relation to horizon is 49°.

I. Shchur, A. Kovalchuk

TECHNICAL AND ECONOMIC PARAMETERS OPTIMIZATION OF THE ROTATING HALF TRANSFORMER FOR WIND TURBINES OF VARIOUS POWERS

Autonomous contra-rotating wind turbine with vertical axis of rotation (VAWT), in which there is the rotating half transformer (RHT) conducting noncontact transmission and regulation of generated electricity, is of non-traditional design. Therefore, to determine the value of its main components shares cost, the methodology of expert evaluation was used. After analyzing the market value of an autonomous VAWT of different manufacturers and the results of expert evaluation, we determine the estimated market value of the three-phase RHT. Having reviewed the methodology of the developed design calculations it has been analyzed that problem of determining the optimal technical and economic parameters variation implementation can be operated by two parameters: the inner diameter of the core and the induction in the core. The analysis shows that there is no direct relationship between the dimensions and the cost of RHT. The induction in the core also has nonlinear effect on these parameters. With two objective functions (cost and efficiency) and two arguments (the inside diameter of the core and induction in the core), the two-parameter problem of determining the optimal technically and economically reasonable design of RHT was obtained. According to the results of the study the best option of RHT design was obtained.

The procedure of determining the value and efficiency for a number of wind turbine capacities – 1 kW, 2 kW, 5 kW and 10 kW was carried out. Moreover, in this study the only one variable – the inside diameter of the core was remained, and the induction is fixed in it at 0.5 T, which is defined in the previous task as optimal. For the implementation of the technical and economic parameters of RHT optimization, the generalized geometric criterion that combines efficiency and cost of RHT is introduced. The optimum design options of RHT and their technical and economic performances are determined. Analysis of expert evaluation and the calculated value of RHT showed that the real value of RHT for all power autonomous contra-rotating VAWT is lower than predicted value. This confirms that RHT does not increase the total price of wind turbines, and the use of RHT for contactless transmission and regulation of generated electricity parameters is more effective in wind turbines with higher capacity.

M. Yatsun, A. Yatsun

SELF AND MUTUAL STATEMENT AND TRANSITIONAL INDUCTANCES OF TRANSIT INTERNAL CIRCULAR EDDY CURRENT TRANSFORMER IN A LEADING PIPE

The question of the technical pipelines state monitoring for providing the reliability and safety of energy materials supply (natural gas) by main pipelines acquires all greater actuality because of the considerable degree of abrasion and aging of domestic oil-gas complex equipment.

The basic task of the technical diagnosticating of pipelines is establishment of actual thickness of pipe wall and exposure of defects like violation of integrity. For the carrying of the technical diagnosticating works on the whole length of pipeline with minimum pipeline outages the most effective way is realization of inwardly pipe diagnostics with the use of intellectual pistons which move under pressure of the transport product. However inwardly pipe diagnostics with the use of magnetic pistons, needs improvement, for providing higher control exactness and accuracy.

Contactless, absence of remaining magnetic effects and possibility to find out superficial cracks with the small opening and defects of stratification of pipeline metal advantages of eddy current method of control

A task of determination of statement and transitional parameters of internal transit eddy current transformers of self-reactance and transformer types at an impulsive feed in order to receive multi-parameter information about the object of control is actual.

While controlling the geometrical sizes, defects and physical and mechanical parameters of electrical conduction materials, details and products (pipes) by an impulsive eddy current method the informing parameters of primary transformer are its transitional self and mutual inductances of excitation and measurable winding and their response characteristic to the parameters of control object.

Expressions for self and mutual operator (converted by Laplace) and transitional basic and inserted inductances of excitation winding of the communicating screened circular primary transformer rectangular transversal to the cut into the controlled leading pipe with the current of free-form which is used as a primary transformer for diagnosticating of the technical state of internal surface of pipelines.

On the basis of operator inductances characteristic their approximate rotation of Laplace transforming for the receipt of the transitional inserted in inductances offered.

The obtained results are expedient to use for determination of informing sizes of primary characteristic to measurable circle with transit primary eddy current transformer and their response the parameters and defects of control object on purpose of compartmentation of multi-parameter information.

L.A. Bilyi, Y.V. Kovivchak

NEW DIRECTIONS IN TRANSFORMERS DESIGNING

The electric energy – is the main form of energy which is used by people. Transformer – is the main transfer link in the electricity network. Parameters and properties of transformers crucial way affect on their behavior in complex operational network. This depends on the reliability of electricity supply and on the efficiency of industrial production. To prevent an automatic shutdown of a large number of consumers in violation of the reliability of power, transformers use equipment which are capable of withstanding considerable asymmetry voltage three-phase network, which would preclude overloading the electrical system and a massive security operations. Transformers, which are used nowadays, in practice, do not have such properties.

Mathematical calculations and computer simulations results indicates on a significant improvement of the parameters and properties of transformers with increasing coverage of winding magnetic system.

The new principles of designing magnetic systems of transformers are proposed. Improving the flow of electromagnetic processes in transportation, is achieved by selecting the correlations of basic geometric dimensions of the magnetic system that provides maximum coverage windings in space and size-symmetric. As a result we achieved a significant improvement of specifications and we get a new features of transformers: an automatic regulation of balancing voltage of asymmetrical load.

Conversion of electrical energy without disfiguration, automatic or adjustable voltage balancing phases in the case of asymmetrical loading is possible by using transformers with three-dimensional magnetic system and symmetrical placement phase windings on it.

A new approach to the designing of transformers is based on making conditions for optimal flow of electromagnetic processes in the construction of magnetic systems. In practice, we can notice, that magnetic

system covers a maximum possible area of electrical windings of the transformers. This technique solution led to improved features of transformers (relative low value of current idling, reducing the eddy current loss in the magnetic wire, increasing the relation between unit voltage and the geometric sizes).

Proposed new constructions of transformers are more effective in industrial use on the transmission network and distribution of electricity.

Orest Kozevytch

PECULIARITIES OF APPLICATION OF MEASURING TRANSFORMERS IN ELECTRIC ENERGY METERING SYSTEMS

Problems, arising for electric energy industry, connected to increasing accuracy and validity of commercial metering of electric energy, is now today of very clear economy character. Increasing accuracy and validity of commercial metering of electric energy is not possible without estimating precision characteristics of the electric energy meters and primary scaling converters, i. e. measuring voltage and current transformers.

Due to this fact, measuring voltage and current transformers of various precision classes used for electric energy metering are subject to primary and periodic calibration. However, practically periodic calibration encompasses only electric energy meters and small-sized measuring current transformers that may be dismantled and calibrated in laboratory conditions. Calibration of other measuring means is hardly conducted due to absence of necessary equipment.

In the article problems concerned with estimation of metrological characteristics of measuring current transformers working in real operating conditions are discussed.

Two mutually exclusive approaches connected to estimating errors of primary scaling converters are investigated and analyzed.

Automatic measuring instrument providing estimation of metrological characteristics of measuring current transformers (MTC) of power lines from 6 kV to 750 kV during its exploitation in the line without disconnecting and deenergizing of primary windings is recommended.