THE STUDY OF ACTIVATION IMPACT DURING FORMATION AND TESTING OF Ni(OH)$_2$ ELECTROCHROMIC FILMS IN THE PRESENCE OF Al^{3+} AND WO$_4^{2-}$ IONS (p. 6-13)

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The present study is devoted to an attempt to improve the characteristics of nickel hydroxide electrochromic films. The study of optical and electrochemical characteristics of the films, prepared through the codeposition of nickel and aluminum and additional modification during the cycling of the prepared samples was conducted. The modification was realized through the cycling of films in the solution of potassium hydroxide with small amounts of potassium tungstate.

Over the course of the study, a series of films were obtained, which demonstrated different electrochemical and optical behavior. Thus, it was found that both the deposition method and the cycling regime have a significant effect on the characteristics of electrochromic films.

It is shown that for the potentiodynamic regime, the best characteristics were demonstrated by the film without modifications or additives. On the other hand, all modified films, codeposited with aluminum, demonstrated better characteristics in galvanostatic regimes over the reference film. It would appear that this is due to the physicochemical features of the films deposited in the presence of additives.

In turn, the use of high-rate cycling regime leads to a decrease of electrochromic characteristics, namely higher degree of irreversibility. Despite the difference of currents in different galvanostatic regimes by 4 times, the coloration degree did not differ much.

It was also found that the presence of 0.3 mM potassium tungstate in the cycling electrolyte resulted in a significant decrease in the electrochromic properties of the samples.

Keywords: electrochromism, nickel hydroxide, layered double hydroxide, aluminum, tungstate, polyvinyl alcohol, electrodeposition, cycling.

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IMPROVEMENT OF THE CURRENT CONTROL LOOP OF THE SINGLE-PHASE MULTIFUNCTIONAL GRID-TIED INVERTER OF PHOTOVOLTAIC SYSTEM (p. 14-22)

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Improvement of the current control loop of the multifunctional grid-tied inverter of the local object electrical power system is considered. The purpose is ensuring compliance with the quality standards of the grid current in the whole range of its values when connecting the load to the AC distribution grid and the converter unit of the photovoltaic system. The use of relay current controller with combining of unipolar and bipolar modulation in combination with a modified algorithm of switching the inverter switches is proposed. It is shown that at a non-linear load, the jump-like change of the derivative of the inverter reference current leads to a sharp change in the switching frequency of the switches. This leads to the appearance of "splashes" in the grid current, which worsens its harmonic composition at small current values.

In the nonlinear reactor with an increase in the inverter current, the "splash" is also caused by changes in the switching frequency of the switches. This takes place in the areas of current growth (fall) due to a change in the reactor inductance. The dependence of the given deviation for the relay controller is established. In the case of a linear reactor, this provides a practically constant switching frequency for the inverter switches. It is proposed to take into account the derivative of the inverter current in the deviation reference of the relay controller. This eliminates an abrupt change in switches

switching frequency. The necessity of taking into account the non-sinusoidal grid voltage during the determination of the voltage value at the inverter input is shown. It is proposed to reduce the capacitance of the filter capacitor at the point of common coupling and use of capacitor current coupling. This will improve the quality of the grid current at the non-sinusoidal voltage of the grid. The structure of the current control loop with a relay current controller with the combined modulation and regulation of the reference value of the controller deviation is proposed. Regulation is carried out in accordance with the reference value of the amplitude and the derivative of the inverter current. A mathematical model of the system "grid – grid inverter – load" with a block of determination of power losses in the switches and a nonlinear reactor is developed.

Keywords: relay current controller, unipolar and bipolar modulation, power losses, THD, simulation.

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IMPROVEMENT OF THE TOOLSET FOR DIAGNOSING UNDERGROUND PIPELINES OF OIL AND GAS ENTERPRISES CONSIDERING CHANGES IN INTERNAL WORKING PRESSURE (p. 23-29)

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A new criterion of strength and a set of informative parameters have been devised for modelling the stressed-strained state (SSS) of the underground metal pipeline (UMP) taking into consideration the system of defects of the cavity type, atop of which there is a crack.

We have inspected the surface of pipes made from structural carbon steel 20, which are exposed to the internal hydrostatic pressure. It has been proposed that the strength criterion of a pipe's metal, which is in contact with the soil electrolyte, should take into consideration the stages of elastic and plastic deformation.

The strength criterion has been supplemented with ratios for a corrosion current (the Kaesche type) and internal pressure, which acts on a cylindrical pipe, taking into consideration the inelastic energy characteristic of the surface layer.

For a pipeline, in a neutral soil environment, we have measured polarization potentials and corrosion currents using the PPM (polarization capacity meter) and CCM (contactless current meter) equipment. Results measure respective defects of the cavity type (pitting), formed at the outer surface of an underground pipeline.

For five variants of internal pressure p_i=5.5÷7.5 MPa, the CCM and PPM devices determined currents and voltages for characteristic surface defects and, based on them, we have estimated the effective time it takes for a crack to reach critical depth (a pipe resource), as well as the reliability parameter β (a safety characteristic).

By comparing results from experimental study and appropriate calculations it has been established that the relative changes in the rate of corrosion V_{cor} is 2.8 times, and, accordingly, the UMP resource parameter t_R is 3.1 times, larger, while the reliability parameter β is 6.9 times less, than the relative changes in internal pressure changes p_T.

Based on analysis of the parameter t_R, which characterizes the UMP resource, it has been found that this dependence t_R on internal pressure p_T is nonlinear and tends to saturation.

The specified information is important for improving the methods of control over UMP at oil and gas enterprises, specifically, procedures for correct estimation of anode current density in metal defects at the outer surface of an underground pipeline, taking into consideration changes in internal hydrostatic pressure.

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EXPERIMENTAL DETERMINATION OF INDICATORS OF THERMAL STATE OF REFRIGERATOR CARS UNDER OPERATING CONDITIONS (p. 30-38)

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For the experimental determination of the thermal state of refrigerator cars under operating conditions, a procedure for separate determination of heat and mass transfer parameters is proposed. Its peculiarity lies in the fact that conditions, methods and means of thermal tests used in the construction, operation and repair of refrigerator cars are used for the experimental determination of conductive heat transfer and tightness indicators. For separate determination of the true heat transfer coefficient $\bar{K}$ and effective opening F_{ek}, experimental conditions of the thermal process of heating air in the cargo space of the car body and measurement of the volume of air flow through leaks under constant standard overpressure of 49 Pa in the body were used.

Based on the values of the true heat transfer coefficient $\bar{K}$ and effective opening F_{ek}, taking into account the thermophysical properties of cargo and using MS Excel tools, graphical dependences of changes in cargo temperature in the refrigerator car on transportation conditions are constructed.

The results of the study are proposed to be used for separate determination of heat and mass transfer indicators and evaluation of thermal properties of the body sheathing of refrigerator cars under operating conditions. Based on the value of the true heat transfer coefficient and effective opening, it is possible to determine changes in cargo temperature in transportation conditions, taking into account the temperature difference of the atmosphe-ric air.

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IMPROVING EFFICIENCY IN DETERMINING THE INDUCTANCE FOR THE ACTIVE PART OF AN ELECTRIC MACHINE'S ARMATURE BY METHODS OF FIELD MODELING (p. 39-47)

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Theoretical studies of electromagnetic processes in the active part of an electric machine's armature have been carried out in a dynamic short-circuit mode using a three-dimensional magnetic field model represented as a combination of electrical circuits of phase windings and a geometric 3D region. An approach was proposed to determine self- and mutual inductances between phases of the electric machine armature winding based on decomposition of electromagnetic processes by means of various combinations of powering the armature phase windings. Laws of electromagnetic processes resulting from self- and mutual effects of the armature phase currents causing appearance of effects of self- and mutual induction with and without taking into account magnetic properties of materials were established. The phenomena of self induction in phases of the armature winding, formation of components of induced currents in the phase as a result of action of currents in neighboring phases and their magnetizing and demagnetizing properties were considered. Influence of these processes leads to an asymmetry of the systems of mutual inductance between the winding phases. However, symmetry of total inductance of the armature phase windings is not violated. To determine with high accuracy inductive parameters of the electric machine armature winding according to the classical method, corresponding correction coefficients were proposed. This will minimize current errors and ensure adequacy of known widely used three- and two-phase models of electric machines based on systems

of differential equations of the first order. Reliability and accuracy of the data obtained in 3D modeling of magnetic fields were confirmed by the results of physical tests. When taking into account magnetic properties of materials used in the active part of the electric machine armature, relative current errors did not exceed 2.68÷2.91 % and when magnetic properties were not taken in account, the errors measured 103.09÷106.32 %.

Keywords: electric machine, electromagnetic field, inductive parameters, three-dimensional field model.

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It has been determined that the most expedient and economically beneficial flaw detection method for plywood is the impact method. Samples of plywood with and without a defect were used for the research. Among the acoustic techniques, the most accurate is considered to be ultrasound; its implementation, however, requires that the surface of plywood should be treated with a special substance, which makes the method impractical for plywood raw materials. Nevertheless, given the accuracy of the method, we have performed a correlation analysis involving the impact method. The chosen initial parameters for the shock method were the number of pulsations, the oscillation frequency and the coefficient of harmonic distortions of a shock sensor's signal. The ultrasound study has been found to produce almost identical results with previous experiments, especially regarding a harmonic distortion coefficient (Kh=0.84). This allows us to argue that the selected parameters make it possible to reliably detect a defect in plywood. Solutions for automating the flaw detection process have been suggested. A device has been designed to control quality and to enable the automated selective sorting of plywood, as well as a multichannel automated quality control system for plywood to be installed at a production line. The proposed systems would make it possible to perform the automated flaw detection in plywood, both in the form of finished products and at the production stage. Information on the quality of plywood can be transferred both to workers at a warehouse and to a transportation robot, as well as to a production line in order to run an analysis and identify causes of defects and to correct the technological process parameters. Automating the flaw detection process would improve its speed and accuracy. We have proposed an easy-to-use relative criterion of plywood quality, which makes it possible to eliminate measurement errors caused by instability in the plywood oscillation amplitude at a sensor's impact. That makes it possible to significantly improve the accuracy of detecting internal defects in the non-destructive quality control.

Keywords: plywood, flaw detection, impact method, selective sorting, non-destructive testing, quality control.

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CALCULATION OF THE PENETRATION ZONE GEOMETRIC PARAMETERS AT SURFACING WITH A STRIP ELECTRODE (p. 57-62)

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This paper presents the techniques for mathematical modeling of the geometric characteristics of surfaced surfaces, which make it possible to predict the result of experimental studies. The accuracy of existing techniques for assessing the geometric parameters of a penetration zone has been determined.

It has been established that by using the distribution scheme of a heating source over a rectangular region it becomes possible to bring the estimation data closer to experimental in the surfacing rate range of 6–12 m/h. At a distribution parameter of the heating source over a width of 1.5 mm, the maximum discrepancy between the estimated and experimental values for a penetration depth does not exceed 15 % for strips with a width of 60 to 90 mm. This is due to that a given model is adequate only for cold–rolled solid strip electrodes. We have investigated an estimation scheme of temperature distribution in a semi-infinite body from a movable linear heat source with the distribution of temperature by width, making it possible to adequately assess the depth of penetration of the basic metal at surfacing with a strip electrode. The arc, which moves along the end of the strip, does not form a significant crater as is the case at surfacing with a wire electrode. The efficiency of heat transfer from arc to the main metal is determined by the convection of a liquid metal in the active part of the pool, which decreases at low surfacing speeds. The movement of a metal in this zone is linked to its movement throughout the entire volume of the weld pool. It has been established that a decrease in the temperature of a metal in the liquid layer of the weld pool within 300–500 ºC when using a strip electrode, compared to the wire one, relates to the phenomenon of arc displacement along the end of a strip electrode and to a change in the heat source's concentration ratio.

Keywords: strip electrode, temperature distribution, semi-infinite body, penetration depth, heating source.

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