ABSTRACT AND REFERENCES

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SIMULATION OF NANOMODIFIED POLYMERS TESTING BY THE ELECTRIC CAPACITIVE METHOD (p. 4-9)

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At present, the issue of the electric capacitive method application for non-destructive testing of nanomodified polymer composite materials (NMPCM) is relevant. The paper gives a mathematical model based on Maxwell-Ampere, Faraday and Gauss's equations and satisfying the Dirichlet boundary condition. This paper proposes a computer simulation of the nanomodified polymers testing by the electric capacitive method. The simulation was carried out in a two-dimensional planar formulation and a minimum required density of the calculated grid was determined (37,300 elements) to obtain a qualitative result of the calculation. A number of numerical studies were conducted with different contents of CNT in NMPCM in the range of 0 wt % up to 10 wt %, different defect depths in the material and distances from the sensor to the surface. The homogeneity of the dispersion is estimated using the Cochran statistical criterion. The value of the Cochren criterion did not exceed the critical one for all conducted experiments. Approximation relations of the maximum defect depth and distance from the sensor to the surface were obtained depending on the content of CNT in NMPCM. The results of the studies allowed determining the limits of the method application in the testing of NMPCM. The maximum defect depth was 5H (H is the relative value of the defect) at the CNT concentration of 1 wt % and with increasing the CNT concentration, the maximum defect depth decreases to 2H. The maximum distance between the sensor and the surface was 0.33H at the CNT concentration of more than 5 wt %. The obtained data can be used in the design of technological equipment for the polymeric nanocomposites production.

Keywords: electric capacitive method, capacitive nondestructive testing, nanomodified polymers, carbon nanotubes.

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IMPROVEMENT OF THE MODEL OF TEMPERATURE DISTRIBUTION AND REGISTRATION OF NATIVE RADIATION OF BIOLOGICAL OBJECTS (p. 10-16)

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Temperature is a reliable indicator of most physiological pathologies, since they are accompanied by disturbance of temperature balance. Non-invasive control of deep temperatures makes it possible to increase the efficiency of diagnosis. One of the promising methods of non-invasive measurement of deep temperatures is the method of radiothermometry, based on measuring the power of native radiation of the electromagnetic field on the surface of the human body. The model of the temperature distribution in the biological tissue has been improved in the case of a region of lower temperature taking into account the physiological processes of formation of thermal fields. During the analysis of the model, it has been established that at a depth of the temperature anomaly up to 2–3 cm, the temperature spots on the surface of the skin are distinguishable by the methods of infrared thermography. With this in mind, and also taking into account the penetrating power of electromagnetic waves, it is reasonable to choose the operating frequencies of the radiometer to 1.8 GHz. An improved model of temperature distribution makes it possible to estimate the integral temperature of a layer of biological tissue by electromagnetic radiation.

It has been shown that it is possible to determine the characteristics of the temperature anomaly region by numerical modeling of the formation of own electromagnetic radiation. The determination of two or more parameters of the temperature anomaly region is possible using a system of two or more equations, which is achieved by measuring the radiation power at different frequencies. A principle possibility of simultaneous determination of several parameters of the temperature anomaly, using a system of equations, has been considered very important. A working mathematical model has been created that makes it possible to solve the inverse problem of finding two parameters of the temperature anomaly with respect to the noise temperature measured at two frequencies. The next step is to study the multilayer model of biological tissue.

Keywords: temperature anomaly, thermal radiation, electromagnetic field, radiothermometry, multifrequency thermography.

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DESIGN AND RESEARCH OF FISHING TOOLS WITH RATIONAL PARAMETERS OF MAGNETIC SYSTEMS (p. 17-22)

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One of the effective methods of cleaning wells from ferromagnetic objects is the use of magnetic fishing tools. However, the known designs have a number of drawbacks. Therefore, new designs of high-efficiency fishing tools were proposed in the work. For development of these tools, magnetic systems consisting of cylindrical magnetic cores with segmented radially magnetized permanent magnets made of rare-earth materials between them were used. According to the results of theoretical research performed using the finite element method, rational parameters of the elements of the magnetic systems, namely, the length of the permanent magnets and the height of the magnetic system were established. This has made it possible to develop systems that are characterized by a maximum utilization of the power of permanent magnets. The paper presents results of experimental research into the hoisting capacity which confirm advantage of the developed fishing tools over the known counterparts. The use of new magnetic tools will increase efficiency of cleaning wells from ferromagnetic objects of varied shapes and weight during cutting "windows" in the casing and in the process of drilling branch holes.

Keywords: fishing tool, magnetic system, permanent magnet, hoisting capacity, tractive characteristic, magnetic flux density.

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A METHOD OF V-FUNCTION: ULTIMATE SOLUTION TO THE DIRECT AND INVERSE PROBLEMS OF DYNAMICS FOR A HYDROGEN-LIKE ATOM (p. 23-32)

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Based on the method of V-function, a continuation of the optical-mechanical analogy is attained. In contrast to classic quantum mechanics, a trajectory-wave motion of the particle is explored. We highlight the presence of energy quantization of the particle and the availability of solution without a particle in the case of rectilinear uniform motion at constant speed. A solution to the direct and inverse problems of dynamics is searched for in a new statement for a hydrogen-like atom. When solving a direct problem, we find a stationary wave function of the electron in a hydrogen-like atom, with its properties investigated. When searching for a final solution to the stationary wave equation, we take into account a solution to the inverse problem of dynamics for the electron. A linear dependence between two particular solutions is shown. The second linearly independent solution is found, decaying exponentially to zero. We present charts of the stationary solution for a wave of the particle (electron) for three lower stationary states. Energy levels of a hydrogen-like atom are determined as a solution to the inverse problem of dynamics, which fully coincide with the classical results by Schrödinger and Bohr. A wave function is regarded as a physical reality, which makes it possible to open up new possibilities in order to study the structure of the microcosm.

Keywords: variational principle, direct problem of dynamics, inverse problem of dynamics, optical-mechanical analogy, wave motion, trajectory motion, wave function, wave equation.

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HYDROCAVITATIONAL ACTIVATION IN THE TECHNOLOGIES OF PRODUCTION AND COMBUSTION OF COMPOSITE FUELS (p. 33-42)

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Special methods and means for production and use of new types of liquid composite fuels with addition of industrial wastes of various origins were developed and scientifically substantiated.

The studies enabled production of composite fuels with improved physical and chemical qualities. For this purpose, a rotary cavitation device for tryout of hydrocavitational activation of fuel components was worked out. The possibility of introduction of various industrial wastes including ecologically hazardous wastes of various origins into production of composite fuels was proved.

Comprehensive studies of producing and burning composite fuels with application of methods for activation of physical and chemical processes were carried out. Liquid composite fuels obtained on the basis of "classical" hydrocarbons with addition of various types of waste meet present-day energy, environmental and consumer requirements.

The developed technology of burning composite fuels is helpful for solving the environmental problem of recycling industrial waste and the problem of generation of a cheaper thermal energy. The proposed technological approach is universal and applicable for utilization and neutralization of organic and mineral wastes of various origins using hydrocavitational activation methods at the stages of production and combustion of composite fuels.

Theoretical studies of hydrodynamics of flow of a viscous incompressible fluid in channels of a complex shape have enabled design of new types of atomizers and hydrocavitational activators.

Keywords: hydrocavitation technology, composite fuels, nozzles, rotary cavitation device, industrial wastes.

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A STUDY OF PHASE TRANSITION PROCESSES FEATURES IN LIQUID-GAS SYSTEMS (p. 43-50)

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The results of designing the mathematical model of non-stationary thermal conductivity of the bubble's oscillating wall, with account of the changes in the aggregate state and the thermal and physical characteristics of the substance, are presented. It is shown that when applying the finite elements method, it is a system of nonlinear differential equations of the 1st order. Consideration of these features in the mathematical model allows obtaining the temperature values of liquid and solid phases at any time when changing the bubble's size and the heat flow direction at its boundary.

Based on the suggested mathematical model, a series of assessment calculations was performed. Applying mathematical modeling, the temperature fields' distribution in the liquid under the conditions of the phase transition processes and changes in the bubble size is obtained. The performed studies show that for an immobile bubble under the boundary condition of the 2nd kind, the icing and ice melting velocities are almost equal, but the temperature on the interphase gas-water surface is approximately four times exceeding the temperature on the gas-ice surface, which corresponds to the water and ice thermal conductivity ratio.

The temperature in the phase liquid-ice transition zone is practically constant. With the expansion of the bubble, liquid freezing and ice melting are going more than 1.6 times faster than in the immobile bubble. When compressing the bubble, the thickness of the ice formed or melted is approximately 1.7 times smaller than that of the immobile wall bubble. The analysis of the results obtained has shown that they are predictable and fully correspond to the physicists' ideas of the heat transfer and phase transition processes flow in the liquid.

The suggested calculation method can be used to determine the thermal characteristics of the liquid and steam in various technological processes associated with gases dissolution in the liquid, foam hardening and gas hydrates formation. The mathematical model designed can be applied as a component for calculation of more complicated physical processes. The study results can be applied to optimize various technological processes associated with materials swelling, gases adsorption, liquids boiling and gas hydrates formation.

Keywords: thermal and physical characteristics of gas-saturated liquid, gas-to-steam bubble, heat transfer in two-phase medium, phase transformations.

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SYNTHESIS OF THE SYSTEM FOR MINIMIZING LOSSES IN ASYNCHRONOUS MOTOR WITH A FUNCTION FOR CURRENT SYMMETRIZATION (p. 50-58)

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The operation modes of the TVC-AM electric drive in which the power losses can be reduced were mathematically described. It was defined more precisely that what was at issue is the continued operation of an asynchronous motor at artificial characteristics in the region of nominal slip with an energetics better than at the working section of the natural mechanical characteristic. The system of automatic minimization of power losses of asynchronous motors was developed. It was shown that under conditions of feeding the electric drive from a source with asymmetrical voltage, it is necessary to use phase-by-phase control which requires the use of three control channels and three feedback channels. The logic of the feedback action is that when the load on the AM shaft decreases, it reduces the output voltage of the TVC and the motor currents. As a consequence, it becomes possible to maintain equality of the load angles of all phases to the optimum value. This makes it possible to solve the problem of minimizing the AM losses in a case of equality of the load angles to the optimal value and symmetrization due to equality of load angles by the phases of the motor. The quantitative indices of power loss decrease as well as the symmetrization indices when the electric drive is powered from a source with an asymmetric voltage were shown. The features of the power loss minimization system and the ways of improvement of its efficiency were illustrated. It was shown that the use of the proposed control system led to an improvement in both the power and dynamic parameters of the asynchronous electric drive. A 5 to 45 % reduction of power losses in the range of operating moments of $0 \le M \le M_{bo}$ relative to losses during operation at the main mechanical characteristic was recorded. The symmetrization effect was characterized by a 1.5 to 6 times reduction of the current asymmetry coefficients.

The use of a thyristor voltage converter makes it possible to realize controlled transient start-up and braking modes. Symmetrization of the acting currents of the asynchronous motor results in an 80–150 % reduction of vibrational components of the electromagnetic moment in a steady-state regime.

Keywords: asynchronous motor, thyristor converter, electric drive, loss minimization, voltage asymmetry, symmetrization.

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EFFECT OF EXTERNAL PRESSURES IN DYNAMIC GAS MIXERS (p. 59-65)

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Analysis of the effect of pressures P_v of the sources of pure components, barometric pressure P_0 and output pressure P_w in the gas-dynamic synthesizer on the component concentrations in the obtained mixtures has been carried out. In this regard, the use of typical pressure stabilizers in the synthesizer does not provide high accuracy of concentration of the prepared mixture components.

It was shown that synthesizers designed on the basis of throttle flow summarizers are characterized by a significant effect of external pressures. Limit concentration deviation resulting from the changes in P_v, P_w and P_0 measure (in % abs/kPa) 1; 0.6 and 0.03, respectively.

It was established that equalizing of pressures at the ends of the dosing capillaries in the scheme of the flow summarizer leads, at least, to a partial compensation for the effect of external pressures. This is due to a unidirectional change in pressures and corresponding changes in the component flows metered by dosing capillaries.

Full compensation for the effect of external pressures can be provided by choosing dimensions of the capillaries applying the obtained system of equations.

Application of the dosing capillaries with dimensions differing from the calculated dimensions causes deviation of the component concentrations from the specified values at a level of 4 % rel. This deviation, if necessary, can be reduced by shortening capillary lengths during the measuring control of the synthesized mixture component concentrations using the gas analyzer.

The synthesizer of binary (CO_2+N_2) and ternary (O_2+CO_2+N_2) mixtures for calibration of analyzers of the blood gases was developed and studied. It was established that the limiting deviations of the component concentrations resulting from the effect of external pressures did not exceed $4{\cdot}10^{-3}$ %/kPa and, therefore they can be neglected.

Gas-dynamic synthesizers with a pressure equalizing scheme and the capillaries with dimensions determined by the compensation dependences are practically independent from the influence of external pressures and do not require high-precision means of their stabilization.

Keywords: pressure compensation, capillary throttle, flow mixer, gas mixture, component concentration.

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