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RESEARCH OF OPERATION OF LIQUID-GAS EJECTORS WITH COMPACT AND DISPERSED JETS OF LIQUID

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The analysis of equipment for the sulfitation of sugar solutions is carried out. The shortcomings of the operation of a jet sulfitator are identified, for the elimination of which it is necessary to investigate the hydrodynamics of a two-phase flow in an ejector mixing chamber. An experimental setup is made. Ejectors with a compact and dispersed liquid jet are studied in a wide range of geometric characteristics (1.3...11.25). The range of the optimum geometric characteristic of the ejector (4...7) is established, at which the maximum ejection coefficient is reached. The numerical value of this coefficient depends on the supply pressure to the nozzle of the active jet and increases with its increase. At a liquid pressure on the nozzles P= $=1.25\cdot 10^5$ Pa, the ejection coefficient reaches a numerical value of 2.0. And the K_{ej} for the ejector with a compact jet of liquid is 15...20 % lower than K_{ej} for the ejector with a dispersed jet. The ejector locking mode is detected at low liquid feed pressures, which occurs when the resistances of the underwater gas path are equal and the movement of the water-air emulsion in the mixing chamber of the ejectors is equal. Explain the work of the ejector can be given the early crisis of drop resistance at small (Re≈40...130) values of the Reynolds criterion. For the investigated ejectors, the closing mode of the next one after the liquid supply pressure is 0.14...0.17 MPa.

Keywords: liquid-gas ejector, ejection coefficient, locking mode, dispersion flow of the liquid.

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INFLUENCE OF CHANGE OF HYDRAULIC MACHINE CONTROL PARAMETER DURING BRAKING OF THE TRACTOR WITH THE CONTINUOUSLY VARIABLE TRANSMISSION

page 11-18

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The influence of the hydraulic machine control parameter in the braking process of a wheeled tractor with a GMT is established. The relationship between the form of the change in the control parameter of the HMG hydrostatic machine and the kinematic, power and energy indicators of the wheeled tractor during braking is determined. The expediency of using the curved shape of the hydraulic control parameter change during braking due to the more effective intensity of the change is proved, which leads to a decrease in the braking and braking distances. The main disadvantage of this research is the need to confirm by experimental tests, obtained theoretically the results.

The article presents a dynamic model of a wheeled tractor with a mathematical description of engine operation, GMT, interaction of wheels with a supporting surface, makes theoretical calculations more approximate to the experimental one.

Making the characteristic evaluation results obtained when implementing a curved, linear and convex shapes of the hydraulic control parameter changes in the HMG should be noted that when compared linear with convex and linear with curved, there are:

– reduction (for linear with curved) of braking time by 11.4 % and an increase (linear with convex) 3.8 %;

– decrease (for linear with curved) of braking distance by 23.3 % and an increase (linear with convex) by 21.7 %.

Comparing the qualitative results (calculation of the area) during the tractor braking, using the linear form of the change with a convex-curved shape of the change in the hydraulic machine control parameter, let's observe:

– curved with linear: a reduction in the HMG efficiency by 9.3 %, a decrease in the GMT efficiency by 8.7 %, a decrease in the power consumption by 43 %;

– convex with linear: an increase in the HMG efficiency by 11.1 %, an increase in GMT efficiency by 7.4 %, an increase in the power consumption by 50.6 %.

These observations indicate that using the curved shape of the hydraulic control parameter for the tractor KhTZ-21021 during braking, the power losses in the HMG hydraulic link are increasing that is directly related to the efficiency of the braking of the tractor.

Keywords: wheeled tractor, continuously variable transmission, dynamic model, shape of change, hydraulic machine control parameter during braking.

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MECHANICS

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REDUCTION OF TECHNOLOGICAL RISKS OF FLIGHT OPERATION BY ARTIFICIAL FORMATION OF THE BUFFER ZONE TO PENETRATING ACOUSTIC RADIATION

page 19-24

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The possibility of reducing technological risks from the effect of penetrating acoustic radiation on flight equipment of flight elements is analyzed. The object of research is the process of elastic interaction of an ultrasonic beam with a metal bush in the form of two identical lengths and different shell radii connected at the ends by flat rings, the internal gap between them is filled with liquid. The disadvantage of the proposed technical solution is to recognize some complication in the design of the float gyro. Results of semi-detailed experimental studies of the float gyroscope in an acoustic medium are presented. As shown by experimental studies, the equipment of the float gyro from outside the thermal casing by a bush of two coaxial, identical lengths, circular shells makes it possible, with artificial irradiation with ultrasonic waves of the outer shell, to create conditions for formation of a caustic zone in the liquid between the shell spaces. This will lead to the creation of an increased energy state relative to the initial state, in the form of a surface coaxial with the internal cavity of the device body. The attainment of the incidence angle equal to the coincidence angle of the wave of the ultrasonic beam allows the outer shell to be converted into an acoustically transparent design. Thus, the entire energy of the ultrasonic radiator will go to the formation of the maximum energy state of the inter-shell liquid turbulent in structure and the available cavitation spaces. This will create a buffer zone for the propagation of external acoustic waves, in which intense dissipation of its energy takes place, and thus the level of the acoustic radiation passing through the device is reduced to zero. At the wave coincidence angle θ_c=10 degree, the offset of the output signal of the device is 1.24 mV. The measurement error is $\Delta\omega_{av}\approx 0.00282$ degree·s^{-1}.

Keywords: aberration, caustic zone, wave coincidence, buffer zone, polyaggregate construction.

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IMPROVEMENT OF SHIP BALLASTING SYSTEM

page 25-29

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The process of ballasting of ships used for transportation of non-standard cargoes, during their operation on waves, is studied. When auditing the ballasting process it is established that the presence of parasitic air volumes inside the tanks leads to an increase in the angle of the ship's list. To eliminate this drawback, a new technology for destroying parasitic air bubbles by means of jets under pressure is developed. During the operation of the developed technology on the ship a number of positive results are obtained. The angle of the ship's list is reduced from 2 to 1.5 degrees when the sea surface is 0.5 m high. The level of uncontrolled ship's list on waves with the operating system of destruction of the parasitic air volume and without it is different. At a wave height of 0.3 m to 0.12 degrees, with a wave height of 0.6 m to 0.65 degrees, and at 1 m to 1.2 degrees.

Keywords: excess air, ballast water, ship hull, impact jets, ship's list.

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METALLURGICAL TECHNOLOGY

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INVESTIGATION OF ELECTROCONTACT ANNEALING IN THE PRODUCTION PROCESS OF STEEL WELDING WIRE

page 30-34

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The possibility of replacing the technological operation of direct heating in the furnace used in the process of production of steel welding wire for performing electrocontact heating to improve the quality of performed operations and improve the characteristics of the wire is considered. An experimental unit with a special arrangement of the electrocontact rollers with respect to the wire with the possibility of cooling is developed. Using the experimental unit of electrocontact heating, the mechanical parameters of the copper-plate welding wire are obtained for the technological route for production of wire with a diameter of 1.6 mm:

– ultimate strength – 770÷850 N/mm^2;

– elongation – 5÷10 %.

For the production of wire diameters of 1.2 mm:

– ultimate strength – 700÷770 N/mm^2;

– elongation – 5÷10 %.

These values satisfy the conditions for further wire processing and correspond to the requirements for the finished product.

The effect of direct current heating on the formation of the structure and the change in the mechanical properties of the welding wire СВ08Г2С is shown, namely, it provides the necessary strength of the wire and prevents the formation of «work hardening». Work hardening causes the wire to break when the drawing mill is working. The use of automatic temperature control by adjusting the supply of current for heating the wire has made it possible to ensure homogeneity of the internal structure of the wire and to reduce the number of breaks by 80 %.

Keywords: steel welding wire, electrocontact annealing, mechanical properties of welding wire.

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TECHNOLOGY AND SYSTEM OF POWER SUPPLY

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MATHEMATICAL MODELLING OF OPERATING MODES OF UNDERGROUND GAS STORAGE FACILITIES

page 35-42

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Underground gas storage facilities (UGS) are considered, which are technologically inseparable objects of a single gas transportation system (GTS) and provide reliable supply and gas transit. The system analysis of the problems arising in the process of UGS operation, as a separate technological facility, and as part of the gas transportation system, led to the search for ways to solve them. The existing methodological support, which has been transferred from gas production without changes, and metrological support does not provide high-quality information support for dispatching systems. Now most of the existing problems with the least resource costs can be solved by means of modeling and optimization. To this end, mathematical models of all the main technological objects involved in the process of injecting into reservoirs and withdrawing from gas layers are proposed. The models are adapted to real data – the values of the gas flow parameters in the area of their possible change. The process of constructing an integrated model and its analysis shows the instability of the work of the implemented methods at the junction of heterogeneous objects (instability of the process of «cross-linking» the parameters of gas-dynamic processes) to ensure, with a given accuracy, the equality of balance equations. In order to avoid this effect, new methods for solving systems with different mathematical representations of the equations are proposed, ensuring a stable obtaining of the result with guaranteed accuracy. In addition, a method for solving systems of equations is implemented, the matrix of the numerical model of the reservoir is sparse (contains a large number of zeros), which allowed to speed up the process of obtaining results by several orders of magnitude. To simulate compressor stations, an imitation (algorithmic) model is proposed. This approach makes it possible to take into account the actual state of each gas compressor unit and set optimization tasks according to the criteria for the stability of the compressor station and its optimality by the energy criterion.

Keywords: mathematical models of gas flows, underground gas storage, compressor station.

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FORECASTING OF THE PERFORMANCE OF THE SHIPBOARD ELECTRIC POWER SYSTEM ON THE BASIS OF THE ARTIFICIAL NEURAL NETWORK

page 43-49

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To date, the main limiting factor in development of forecasting systems based on mathematical methods of data processing, which in most cases is reduced to solving linear deterministic multiparameter problems, is the performance of a computer. Therefore, considerable attention is paid to development and research of neural network methods for solving such problems, which is explained by the inherent massively parallel processing of information that allows building high-performance computing systems.

In connection with this, the aim of this work is development of a system for predicting the SEPS performance on the basis of an artificial neural network implemented by the architecture of a multilayer perceptron. The problem of parameter normalization is solved, caused by the fact that the SEPS mode is characterized by parameters of different physical nature that have different dimensions. The task of training an artificial neural network is also solved. As a learning method, the back propagation algorithm is chosen. For the formation of a rational training sample used in the learning of an artificial neural network, mathematical methods of temporary extrapolation are used. The analysis of the obtained results shows that the value of the mean absolute error on the test set is 3.8 %. This allows to judge the possibility of using an artificial neural network to solve the problems of predicting the SEPS state.

Keywords: forecasting of the state of the shipboard electric power system, coefficient of the generalized parameter, artificial neural network.

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ELECTRICAL ENGINEERING AND INDUSTRIAL ELECTRONICS

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MATHEMATICAL MODEL OF HIGH-VOLTAGE INSTRUMENT AUTOTRANSFORMER INTENDED FOR USE IN SMART GRID NETWORKS

page 50-54

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The object of the research is a mathematical model of the active part of the high-voltage instrument autotransformer with several output windings. The most challenging task in this model is leakage inductance calculation of single winding turns or groups of autotransformer winding turns. Also, a significant problem when calculating the parameters of the autotransformer are those operating conditions, that are close to no-load conditions.

To create a mathematical model of the active part of a high-voltage autotransformer, taking into account the leakage inductance of each single winding turn (or groups of winding turns), and also the magnitude and type of the load, it is proposed to modify the known system of transformer equations detailed to the level of single turns (or groups of turns) and use the proposed method for determining the partial self- and mutual- leakage inductances by numerical methods.

With a help of the developed mathematical model of the active part of a high-voltage autotransformer, a prototype of a 10 kV autotransformer with high metrological characteristics was designed and manufactured. Positive results of metrological certification of the created high-voltage autotransformer confirmed the possibility of calculating the parameters of such primary high-voltage transformers that can be used in Smart Grid networks in conjunction with analog-to-digital converters, thus unifying the electromagnetic primary high-voltage transformers.

It is shown that the operating conditions of high-voltage autotransformers, close to no-load conditions, allow easily achieve high accuracy of high voltage transformation.

Keywords: autotransformer, voltage transformer, Smart Grid, mathematical model, leakage inductance.

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