



WATER-MODERATED REACTOR FUEL CLADDING RELIABILITY STUDY

page 4–8

Considering the fuel element, averaged by fuel assembly (FA) of water-moderated reactor with the power of 1000 MW (VVER-1000), the number of fuel elements with the greatest cladding failure probability after 4 operation years at Khmelnytsky NPP-2 (KNPP-2) is found. This will allow to calculate the fuel cladding failure probability and determine the most likely cladding damages, which will enable to improve the performance and economic indexes of VVER.

The novelty of the paper lies in calculating the fuel cladding failure probability after 4 years of operation at KNPP-2 using a method, based on the energy version of the theory of creep (EVTP method). Up to date, this calculation for VVER of KNPP-2 was not performed.

The reliability study of VVER-1000 fuel cladding failure was performed. As a result, the most probable number of failed fuel elements in the fuel assembly depressurize provided its location for 4 years in a fixed cell of the active core is found. Using these values it is possible to forecast fuel cladding failure probability. This will allow to get an idea about the reliability of nuclear reactor fuel elements under the given operating conditions.

Keywords: VVER, fuel cladding, cladding reliability study, Khmelnytsky NPP-2 (KNPP-2).

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DEVELOPMENT DATA FOR CONTROL OF FLOW DISTRIBUTION IN REAL TIME

page 8–12

In this article we propose to use the information about the actual rate of discharge on the plumbing network areas for the flow distribution control in real time. The main purpose of research is to develop the algorithm for determining the actual rate of discharge based on pressures measured in separate control nodes. Using of telecommunication modern facilities allows the dispatcher of a communal enterprise to collect and analyze information about the pressures on the network, which comes from the sensors installed in its separate nodes.

The article presents a mathematical model that describes the distribution of the flows on the network in real time, the algorithm of software module created on its basis, the results of using of this module for leaks determining on a simplified scheme of the network of one of the residential estates of Zaporizhzhya.

The developed algorithm allows to determine the rate of discharge and water leaks locations in real time of pressure measurements in separate nodes.

The research results can be used by the controller's services of communal enterprises.

We suggest to use information about the actual rate of discharge for the operative redistribution of the flows, finding out the leaks locations and determining of the control nodes locations.

Keywords: mathematical model, load flow, actual costs, measurement of pressure, control nodes, outflow.

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ON THE ISSUE OF SYSTEM METHODOLOGY CRISIS AND WAYS TO OVERCOME IT

page 12–17

An analysis of general systems theory problems is conducted in the paper. It is shown that the introduction of an additional category

of «management» does not solve the problems of an unambiguous definition of the category of «system». The necessity to introduce the category of «activity» is demonstrated. The possibility to determine the meaning of the category of «activity», different from the meaning of the category of «process» is substantiated. For the category of «process», the feature of its meaning is the result of the process realization. It always has a certain meaning. Provisions of the theory of functional systems, developed by academician P. Anokhin have served as the basis for determining the category of «activity». Based on this theory, four organizational tasks, solution of which constitutes the «unit» of the integrated activity of the organization are introduced. The distinctive feature of implementing the «unit» of the integrated activity is the constancy of the activity result. This result is expressed in the equality to zero between the features of the project of future result and its actual results. Subject of wildlife is organization if and only if it is able to implement the «unit» of the integrated activity in the form of four organizational tasks. These tasks are realized in its two parts. These parts may be represented as systems. In this case, wholeness is not required of the system, it is enough to obtain a concrete final result of implementing the processes, included in it. System can be defined as a set of interacting elements, ensuring solving organizational tasks. Thus, it is possible to determine unambiguous meaning for the categories of the «whole» and «system» and their relationship — the «whole» and the «part».

Keywords: system, systemness, whole, wholeness, activity, category, management, relation, theory, structure.

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DEVELOPMENT OF APPROXIMATE ANALYTICAL METHOD FOR MODELING TRANSIENT THERMAL PROCESSES USING S-FUNCTIONS

page 18–23

A new methodology for mathematical modeling of transient thermal processes in structural components is proposed. It is based on the joint application of the structural method, the Bubnov-Galerkin method and S-functions to solving heat conduction problems with unsteady boundary conditions of the third kind. The analytic structures for solving these problems, accurately satisfying unsteady boundary conditions at any given time dependence of the heat transfer coefficient and ambient temperature are constructed. These qualitative features of the analytic structures for solving heat conduction problems have allowed first proposed solution methods to obtain approximate analytical solutions of these problems.

Using the Bubnov-Galerkin method has allowed to reduce solving heat conduction problems with unsteady boundary conditions to solving the system of ordinary differential equations with respect to the unknown time-dependent coefficients of problem solution structures. Herewith, in the given system of ordinary differential equations, known time-dependent coefficients contain the heat transfer coefficients and the ambient temperature in analytical representation at their any given time dependence. This first allows one-dimensional unsteady heat conduction problems (infinite plates, cylinder, hollow sphere) to obtain an approximate analytical solution of unsteady heat conduction problems for those options of time dependence of the heat transfer coefficient and the ambient temperature, for which the operating method is not applicable.

Keywords: mathematical modeling, S-functions, thermal processes, boundary conditions.

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RESEARCH OF THE QUANTITATIVE CONTENT OF LIQUEFIED GAS BY USING MODEL LIQUID SYSTEMS

page 23–26

This paper presents the experimental research method for the choice of a liquid system model, which has a similar to liquefied petroleum gas structure, and also the determination of its temperature dependence. That makes it possible to verify the proposed thermometric method adequacy for quantitative content determining of the liquefied petroleum gas. This method allows to determine the quantitative content of not only the main mixture components (propane and butane) with different temperatures, but the content of impurities such as ethylene, propylene, butylene, amylene, heksylen, heptylen etc., which can improve the quantitative content accuracy of condensed petroleum gas components. Among the studied substances, such as toluene, isoctane, hexane, authors have found a compound that can be the optimal liquid system model and can be used as a reference based on which the density of liquefied petroleum gas and its quantitative value will be determined.

Keywords: propane, butane, liquefied petroleum gas, quantitative content, model liquid systems.

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EMPIRICAL RESEARCH OF THE DISTRIBUTION FUNCTION OF SYNCHRONIZATION TIME OF NEURAL NETWORKS IN THE KEY EXCHANGE PROTOCOL

page 26–31

Neurocryptography is relatively new and little-studied area. Existing results show the prospects of this direction, but practical application requires a fairly complete analysis of existing protocols and systems. Analysis of the features of the key exchange protocol, which is built using the mutual learning of special-type neural networks – tree parity machines was conducted in the paper. Known existing protocol attack strategies were considered. A special part of the protocol is determining the synchronization moment of the neural networks of subscribers. The studies have revealed that the average number of the protocol iterations, required for synchronization significantly differs from the maximum value. To achieve the goal, the work of the protocol with a fairly large number of different neural networks was simulated. The synchronization time feature,

found in the work shows the vulnerability of the studied protocol since it allows an intruder to carry out one of the known protocol attack strategies.

Keywords: neural networks, mutual learning, key exchange protocol.

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EFFECT OF ALCOHOLS AS HARDENING-ACCELERATING ADMIXTURES ON THE CEMENT PROPERTIES

page 31–36

The effect of alcohols as hardening-accelerating admixtures on physicomechanical properties of cement, particularly strength indexes in early hardening period is investigated. Alcohols can be used as an effective hardening accelerators of cement. The effectiveness of the influence of alcohols on the cement properties depends on their spatial structure and the number of hydroxyl groups. It was found that the largest increase in the cement strength is promoted by individual admixtures of alcohols with 2–3 hydroxyl groups (ethylene glycol and glycerol). Comparative analysis has revealed that alcohols behave as hardening accelerators only in the early periods (up to 3 days, especially on the 1st day), and known and widely used accelerator – calcium chloride, on the contrary, has no influence on the strength development on the 1st day of hardening, but contributes to a significant increase in strength on the 3–28 day. It was found that alcohols can be used as components of complex additives. The influence of alcohol on the cement strength in the complex additive «superplasticizer + hardening accelerator» was studied. It was found that the effectiveness of alcohols as accelerators is strongly affected by the components of complex additives since the best results were in modifying superplasticizer by ethanol, which had no significant effect on the cement strength as an individual additive.

Alcohols are effective chemical additives that can be used as hardening accelerators, both individually, and as part of multi-component additives.

Keywords: hydration, accelerating admixture, complex additive, alcohol, superplasticizer, compressive strength, hardening time.

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ENSURING LINEARITY OF OPTICAL-RECEPTION SYSTEM OF INFRARED RADIATION THERMOMETER

page 39–43

The need to ensure the linearity of the conversion function of the optical-reception system of the reference radiation thermometer was substantiated in the paper.

The technique for ensuring the linearity of the conversion function of the optical-reception system of infrared radiation thermometer was proposed. It is based on the definition of deviations from linearity of conversion function of the optical-reception system of the radiation thermometer in several fixed temperature points, the formation of the temperature dependence of linearity corrections and their introduction into an output signal of the radiation thermometer.

The experimental studies, the results of which have allowed to obtain the function of corrections for linearization of the output signal of radiation thermometer for temperature range $0 \div 419,51$ K and spectral band $8 \div 14$ microns were carried out.

The proposed methodology is appropriate to apply in certification of reference radiation thermometers for implementing temperature scale transmission to working infrared radiation thermometers based on the Planck radiation law.

Keywords: radiation thermometer, infrared radiation, reference thermometer, linearity, optical-reception system.

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IMPROVEMENT OF THE PRODUCTS QUALITY LEVEL BY COMPETENT EXPERTS

page 36–38

Planning of improvement of the product quality level should be based primarily on the thorough study of the current and future demands for production, analyzing consumer reviews, competent expert opinion, qualified personnel etc.

The algorithm of the product quality improvement by the example of diesel fuel to ensure its competitiveness in the oil market has been suggested. The algorithm provides comparing of the current quality values taking into account the suggested quality boundaries and customer satisfaction level about the quality of products. The suggested quality boundaries make it possible to determine the level of consumer needs satisfaction and decide on the sufficiency of improving product quality.

The entire evaluation and quality improving procedure of products should take place under the supervision of competent experts in a certain field.

Keywords: products, level, quality, assessment, improvement, algorithm, quality boundaries, competence.

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STUDYING PECULIARITIES OF CATHODIC IRON REDUCTION FROM ELECTROLYTES BASED ON Fe (III)

page 44–48

The results of the voltammetric studies of the cathodic reduction of iron from electrolytes based on Fe^{3+} are analyzed in the paper. It is shown that the simultaneous discharge of Fe^{3+} , FeOH^{2+} and FeO^+ ions occurs under cathodic polarization. The concentration ratio of the electrode active particles in the solution, as well as the pH of the electrolyte, is determined by the initial concentration of Fe^{3+} ions and the degree of hydrolysis. Characteristic parameters of the electrochemical reaction, namely the Semerano criterion $X_S = 0,5$ and the concentration criterion $X_c = 1$ indicates irreversibility of the cathode process. Using the algorithm of analyzing the polarization dependency, the staging and mechanism of the process is set. It is shown that the electrochemical reaction of reducing iron (III) is limited by the charge transfer stage and is determined by the adsorption of FeOH^{2+} ions on the electrode surface and the stage of FeOH^+ ions dissociation. These results serve as a theoretical basis for the development of a stable electrolyte based on iron (III) to form electrolytic coatings with iron alloys.

Keywords: adsorption, hydrolysis, iron, kinetics, cathodic reduction, process mechanism, electrolyte.

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DEVELOPMENT OF THE MODELING METHODOLOGY OF SURFACE SHAPING AND THERMAL PROCESSES USING S-FUNCTIONS

page 48–53

Based on the solutions of inverse problems of differential geometry using S -functions, modeling methodology of shaping surfaces, described by weight functions that accurately describe the equations of complex boundaries was developed.

An algorithm of surface description in the complex area in the form of an inverted flat-bottom plate outside the boundary belt of the area was built. It has allowed to construct an approximate mathematical model of the thermal process using the proposed conservative solution structure of the heat conduction problem in such a way that it is fully consistent with the physical model of the thermal process, including the case, when the value of the heat transfer coefficient tends to infinity. The constructed analytical solution structure of the heat conduction problem exactly satisfies the Newton's boundary condition at any given values of the heat transfer coefficient and ambient temperature for complex areas. Conservativeness of the solution structure lies in the fact that it takes into account the influence of the boundary effects only in the boundary belt of the area of the problem solution.

Keywords: modeling of thermal processes, solution structure, S -function, surface shaping.

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CALCULATION OF STABLE OPERATION OF VORTEX SPRAY COUNTERCURRENT MASS EXCHANGE DEVICE (VSCMED) DEPENDING ON HYDRODYNAMIC CHARACTERISTICS OF GAS-DROP FLOW

page 53–56

The paper gives the method of selecting stable operation modes of the vortex spray countercurrent mass exchange device (VSCMED), which includes calculating the flow of drops taking into account flow uniformity and mutual influence. In order to make the calculation, a number of assumptions, which allow to calculate the device for specific conditions, was introduced. When developing techniques, the impact of forces on the motion of the drop was taken into account. As a result of theoretical and practical studies, the flow rate of gas and droplets, the ratio of centrifugal forces and the forces of aerodynamic drag were determined, thus having ensured the optimum mode of stable operation of VSCMED. The results obtained allow to design new models of VSCMED-type devices when developing new productions for the chemical and petrochemical industries.

Keywords: mass exchange, rate, instrument, vortex, drop, device, calculation.

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REASONABLE APPLICATION ANALYSIS OF CASNTER GRAPHITIZATION FURNACES ACCORDING TO THE DEMANDS OF MODERN MARKET

page 57–60

Analysis of the global market has shown that the production of graphite electrodes (GE) depends on the production of steel in electric arc steel furnaces. The growth of world production is the main driver of the market development of graphite electrodes.

Acheson-type graphitization of GE was extremely energy intensive and therefore costly, but was necessary to manage previously poor coke qualities with high sulfur and nitrogen content. Although invented earlier, the more economic Castner, or so called lengthwise graphitization, was not applicable until the development of electrical rectifiers for these high currents. As these became available and needle coke with low sulfur and nitrogen was invented, lengthwise

graphitization became the standard in the Western World for GE production.

Manufacturing requires high-quality large-diameter electrodes. They must be technically and economically advisable for the usage only in directly-fired furnaces by Castner method. But the given technology is not fully realized in Ukraine. First of all, it's so due to the absence of significant investment in electrode industry. Although, as the analysis of modern market of electrode industry has shown, the situation is changing and new requirements are emerging now.

Keywords: graphitization, electrode products, electric arc furnace, direct-fired furnace.

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