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INFLUENCE OF FLOODED FOAM JETS' MOTION PARAMETERS ON SUBSURFACE EXTINGUISHING OF FIRES IN TANKS WITH PETROLEUM PRODUCTS (p. 6–17)

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One of the safest ways to extinguish fires in tanks with petroleum and petroleum products is subsurface extinguishing. For this mode, a foam concentrate with fluorinated stabilisers is used, the aqueous solution of which is able to spread and cover the surface of petroleum and petroleum products with a thin film. The article presents a mathematical model of the movement of a flooded non-free foam jet in a motor fuel medium, which adequately describes the real physical processes that occur during subsurface fire extinguishing in vertical steel tanks. The motion parameters of flooded low-foam foam jets in a tank with motor fuel were determined as those that would be optimal for transporting foam through the thickness of the fuel to its surface. It was specified that the movement of the flooded foam jet is characterised by a significant attenuation (from 36 to 1.5 m/s) of the initial velocity with its subsequent increase due to Archimedes' principle. High values of the initial velocity of the jet lead to destruction of the foam and, accordingly, worsen fire extinguishing. A decrease in the initial velocity of the foam jet at a given flow rate should be carried out by increasing the corresponding number of foam jets with an initial velocity in the range from 2 to 3 m/s. Foam jets should be placed around a circle of a radius at which their mutual influence would be preserved, and the velocity of the combined foam jet should not exceed the maximum values recommended for a particular foam concentrate (3–5 m/s). It helps to improve the stability of the movement of the combined jet, to decrease the destruction of the foam during its movement, and to prevent the movement of the fuel to the combustion surface. The decisions made upon the implementation of the mathematical model are fully consistent with the results obtained during the experimental tests on extinguishing a class B model fire in a designed unit as a reduced version of the RVS-5000 tank.

Keywords: petroleum products, tank fires, subsurface extinguishing, foam concentrate.

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THERMAL STATE OF STEEL STRUCTURES WITH A COMBINED FIRE PROTECTION SYSTEM UNDER CONDITIONS OF FIRE EXPOSURE (p. 17–25)

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Given the need to minimize the weight-dimensional indicators of steel structures, the issue of the effective use of a combined fire protection system is relevant. The article deals with the thermal state of steel structures with such a system of fire protection under conditions of fire exposure in the standard temperature mode according to DSTU B V. 1.1-4-98*. The experimental samples used square steel plates with a side of 500 mm and a thickness of 5 mm and 10 mm. The conducted research revealed the peculiarities of dependences of the temperatures of steel structures with passive and reactive fire-retardant materials of two brands on the duration of fire exposure.

It was established that these dependences for steel structures with combined, passive, and reactive fire protection systems have a monotonously growing character. The maximum values of the duration of fire exposure are typical of the experimental samples that have the steel plate of the thickness of 10 mm, for a critical temperature of steel of 600 °C. They are 111 min, 101 min, 55 minutes, respectively, for the combined, passive, and reactive fire protection systems.

It was established that a combined fire protection system is characterized by an increase in the duration of reaching the critical temperature of steel in comparison with passive and reactive fire protection systems. This is due to the effective combination of physical and chemical properties of passive and reactive fire-retardant materials.

For the duration of fire exposure up to 79 min, the value of the duration of reaching the critical temperature of steel for a combined fire protection system exceeds the sum of durations of its achievement, which are typical for passive and reactive fire protection systems. This indicates the effectiveness of a combined system in this range of fire exposure duration.

At an increase in the duration of fire exposure, the effectiveness of a combined fire protection system decreases.

Keywords: fire protection material, critical temperature of steel, steel structure, fire protection system, fire exposure.

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PROTECTION OF TELECOMMUNICATION NETWORK FROM NATURAL HAZARDS OF GLOBAL WARMING (p. 26–37)

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Recently, the number of natural disasters caused by climate change on Earth has been growing in the world. To develop measures to protect hardware resources from the effects of natural disasters, the project method was used. The method developed in accordance with its provisions includes the phased collection of information on the impact of natural disasters on resources, their analysis and the development of appropriate countermeasures.

The actions and manifestations of the damaging factors that were not included in the families of the corresponding damaging factors of the list “The nature of the actions and manifestations of the damaging factors of natural emergencies”, but whose ac-

tion is caused by certain sources of potential emergencies and affects the performance of the hardware, are revealed. A matrix of the nature of the effects and manifestations of the damaging factors of natural emergencies has been developed.

Based on the Classifier of Emergency Situations of Ukraine, a Register of natural threats to the telecommunication network hardware has been built. New sources of threats have been discovered (13 items). The global warming process has amplified the harmful effects of known dangers and identified a number of new ones that are proposed to be classified. The “catalyst” of dangers can be anthropogenic impact, which is distinguished by the promotion of climate change, the artificial modification of the environment.

The variability of the environment does not allow to present a complete list of detailed systematized threats, actions and manifestations of damaging factors and their compliance with certain threats. The list of known protective actions includes organizational measures and countermeasures. According to existing experience, the network hardware resources must comply with the principle of redundancy, in which the operational reconfiguration is performed. It is proposed to apply redundancy of communication lines by means of three-level multiplexing with mutually independent levels.

Keywords: telecommunication network hardware resource, damaging factor of danger, natural threat, natural disaster, three-level multiplexing of communication channels.

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DYNAMIC VARIABLE VOLUME SAMPLING METHOD FOR DETERMINING MASS EMISSIONS OF POLLUTING SUBSTANCES WITH EXHAUST GASES (p. 38–47)

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The results of the development and research of a promising full-flow dynamic method of variable volume sampling to determine in laboratory conditions the values of mass emissions of pollutants from the exhaust gases of automobile engines are presented. Emissions are determined by the test procedures for complete vehicles in driving cycles, or separately of their engines in motor test cycles.

Current mass emissions of pollutants are calculated from time-synchronized instantaneous concentrations and instantaneous flow rates of the mixture of exhaust gases and air. In the mixing chamber, which serves the exhaust gases and air, also serves calibration gas mixture with a flow rate that is changed in accordance with the periodic function. This is used to determine the transfer functions of the inverse calculation of the instantaneous flow rate of the mixture of exhaust gases and air, and the current values of the concentrations of pollutants at

the time of sampling. Mass emissions of gaseous pollutants are calculated as the difference between the total mass emissions of pollutants and the mass emissions of pollutants that are added with the flow of the calibration gas mixture.

The performance of the dynamic full-flow variable-volume sampling method is proved by comparing the calculated (carbon balance method) and directly measured fuel consumption by cars in driving cycles. The difference between the directly measured and calculated (for certain mass emissions of pollutants) fuel consumption does not exceed $\pm 3.5\%$. This is a satisfactory result, taking into account, in particular, the measurement uncertainty in the dynamics of rapidly changing concentrations of pollutants, diluted exhaust gas flow rate, fuel consumption, and the determination of carbon content in the fuel.

Fundamentally new possibilities have been obtained for measuring the mass specific emissions of pollutants by forced-ignition engines and modern diesel engines (Euro-6 environmental class) and promising low-emission vehicles.

Keywords: exhaust gases, mass emissions of pollutants, constant volume sampling, CVS, variable volume sampling, VVS.

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FEATURES OF THE PHASE AND STRUCTURAL TRANSFORMATIONS IN THE PROCESSING OF INDUSTRIAL WASTE FROM THE PRODUCTION OF HIGHALLOYED STEELS (p. 48–54)

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We have investigated the physical and chemical properties of the alloy obtained by reduction smelting using wastes from the production of highly-alloyed steels and alloys. This is necessary to determine the technological aspects that reduce the loss of doping components when obtaining and using a doping alloy. The study results indicate that at the charge's oxygen-to-carbon ratio of 2.25, the alloy consisted mainly of a solid solution of doping elements in γ -Fe. At the charge's oxygen-to-carbon ratio of 1.67, we also observed Fe_3C , followed by an increase in the intensity of carbide manifestation at the oxygen-to-carbon ratio of 1.19. Photographs of the microstructure clearly showed several phases with a different ratio of doping elements. The Ni content in the examined sections of various phases changed within 1.38–46.38 % by weight, Cr – 3.45–45.32 % by weight, W – 1.51–27.32 % by weight, Mo – 0.48–10.38 % by weight. Mo, W, Nb mostly concentrated in individual particles. The Nb content in some inclusions reached 47.62 % by weight. Analysis of the study results has shown that the most beneficial charge's oxygen-to-carbon ratio is 1.67. At the same time, the phase composition is dominated by a solid solution of doping elements in γ -Fe. The proportion of residual carbon, which was in the form of a carbide component, accepted values in the range of 0.52–2.32 % by weight while providing the necessary reducing capacity when using the alloy. Our research has identified new technological aspects in the processing of highly-alloyed anthropogenic waste when obtaining an alloy with a relatively low residual carbon content. The resulting parameters of the resource-saving doping material ensure the possibility to replace some of the standard

ferroalloys when smelting steels with certain carbon content restrictions.

Keywords: oxide anthropogenic waste, alloy steel scale, reduction smelting, X-ray phase studies.

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DETERMINING THE EFFECT OF ANTHROPOGENIC LOADING ON THE ENVIRONMENTAL STATE OF A SURFACE SOURCE OF WATER SUPPLY (p. 54–62)

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Based on an analysis of forecasting models of the state of surface objects, this paper has proven that it is advisable, when forming a system of operational prediction and evaluation of anthropogenic loads, to apply simpler models that make it possible to promptly conduct calculations. As an approach to the operative forecasting of anthropogenic loading, the application of an approximately necessary level of the reduction of harmful influence on the site of a surface water object in terms of pollutants received has been suggested.

Based on a retrospective analysis of data, the mathematical modeling of the indicators of the Dnipro river ecological condition has been performed. It has been determined that the

dependence of an increase in the pollutant concentrations on an increase in its mass, within the sections of a watercourse bounded by existing stationary sites, is described by a linear dependence.

An analysis of the derived dependences has made it possible to establish that regardless of the type of pollutant, they have IV characteristic points that allow the rapid prediction of an increase in the mass flow rate of the examined contaminating substance and a change in its concentration.

It has been established that at equal values of increasing concentrations for non-conservative substances, the increase in the mass flow rate would be less than that under the conditions of “clean dilution”. In other words, at an actual water object, increasing the Sp concentration amplifies the natural processes of self-purification.

The adequacy of the proposed approach has been tested at an actual surface water object, which has made it possible to establish the linear dependences for a change in the content of sulfates: $\Delta C_{\text{sulfate}} = 0.022 \cdot \Delta m_{\text{sulfate}} - 0.001$ and chlorides: $\Delta C_{\text{chloride}} = 0.0143 \cdot \Delta m_{\text{chloride}} - 0.033$. In its turn, the dependence of sulfate content on chloride content is as follows: $\Delta C_{\text{sulfate}} = 1.559 \cdot \Delta m_{\text{chloride}} + 2.286$.

It has been found that for a section of the watercourse in the Dnipro river the linear dependence for phosphates takes the following form: $\Delta C_{\text{phosphate}} = 0.019 \cdot \Delta m_{\text{phosphate}} - 0.020$; for sulfates: $\Delta C_{\text{sulfate}} = 0.022 \cdot \Delta m_{\text{sulfate}} - 0.001$; for chlorides: $\Delta C_{\text{chloride}} = 0.0143 \cdot \Delta m_{\text{chloride}} - 0.033$. The dependence of phosphate content on sulfate content takes the following form: $\Delta C_{\text{phosphate}} = 0.066 \cdot \Delta C_{\text{chloride}} + 0.422 \Delta C_{\text{sulfate}} - 0.017$. These equations make it possible in the first approximation to calculate an increase in the concentration of a single pollutant under the condition that the gain in the concentration of another one is known, which reduces data volumes and improves the efficiency of forecast calculations.

Keywords: surface water object, pollutant, ecosystem, harmful effect, operational control.

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WASTEWATER PURIFICATION TECHNOLOGY BY TWOSTAGE TREATMENT IN ELECTRICAL DEVICE OF A COMPACT LOCAL INSTALLATION (p. 63–70)

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Wastewater generated at industrial and communal facilities is treated within the limits of permissible values established by law. The drains of transport and tourism infrastructure in most cases are cleared with local treatment facilities. For wastewater purification, the biological method is most often used, which is implemented on complex and bulky wastewater purification plants located in large areas. It is proposed to carry out wastewater purification from small objects locally using physical and electrochemical technology with compact equipment. A design of a device for treating wastewater with cylindrical electrodes located coaxially with the device casing has been developed. It is shown that at the first stage of municipal wastewater purification in a laboratory setup with the appropriate parameters (plane tilt angle in a thin-layer sedimentation tank=45° and voltage on the 1st electric device with a soluble anode=12 V), the purification degree from weighted to 95 is ensured, 8%. The purification of municipal wastewater in the second stage of purification (the 2nd electric device with an inert anode at 10 V and filtering through the clinoptilolite zeolite layer) increases the purification degree from suspended to 96.1%. Wastewater purification of a car wash in the first electric device in front of a thin-layer sedimentation tank and in the 2nd electric device with an inert anode at a voltage of 10 V and filtering through a layer of clinoptilolite zeolite increases the degree of their purification from oil products to 95.6%. The technology with the participation of developed electrical appliances leads to an increase in the degree of wastewater purification in terms of COD to 97.0%. which allows to reduce the pollution discharge into the environment at the level of 50–70%.

Keywords: wastewater, physico-electrochemical wastewater purification, clinoptilolite zeolite, COD, suspended matter.

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