ABSTRACT AND REFERENCES

ECOLOGY

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AUTOMATIZATION OF INDIVIDUAL ANTI-THERMAL PROTECTION OF RESCUERS IN THE INITIAL PERIOD OF FIRE SUPPRESSION (p. 4-11)

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The problem of protection of rescuers from thermal injuries at the initial stage of fire suppression was explored.

The authors substantiated structural components of the autonomous device for individual protection of rescuers from thermal injuries at the initial stage of emergency elimination, mainly during the site reconnaissance, when means of fire suppression and thermal protection of rescuers are not deployed yet. The automatic autonomous thermoprotective device, the structural system of which contains hydraulic and automatic parts, was proposed. The hydraulic part includes: the tank, pipelines for feeding a cooling agent, the atomizer, and the shutter of the electromagnetic valve. The tank is filled with the cooling agent under pressure. The shutter of the valve is located on the neck of the tank and in the initial state overlaps the pipeline. The atomizer is fixed on a rescuer's helmet. The automatic part of the device consists of the control unit with the autonomous battery, located in the under-clothing space, the temperature sensor and the driving part of the electromagnetic valve.

The model and the model sample of the autonomous thermoprotective device were tested under laboratory conditions. Testing results demonstrated workability of the proposed technical solution and possibility of operation in automatic mode. Effectiveness of cooling the rescuer's body by periodic sprinkling of the surface of special protective clothing was proved. The device timely reacted to the temperature change in the under-clothing space and automatically cooled down the surface of special firefighter clothing within five seconds. Pulse mode of device operation provides economical consumption of a cooling agent and an increase in the duration of rescuer's protection from thermal injuries.

External sprinkling for the purpose of cooling helps counteract thermal destruction of fabric of the special clothes for firefighters and increase their operation term.

Keywords: automated autonomous thermoprotective device, protective clothing of firefighter, cooling of firefighter's body.

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APPLICATION OF OXIDE-METALLIC CATALYSTS ON VALVE METALS FOR ECOLOGICAL CATALYSIS (p. 12-18)

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It is shown that a promising technique for obtaining oxide-metallic catalysts is the plasma-electrolytic oxidation (PEO) of valve metals, particularly aluminum and titanium alloys. Such a mode of synthesis makes it possible to form catalytically active materials with a developed surface, high content of dopants, and a broad scope of application over a single-stage technological process. The d-metals, in particular, manganese and cobalt are most promising as the dopants for oxide-metallic catalysts.

Employing results of the experimental studies, we demonstrated pathways to control the composition and degree of surface development of the mangan- and cobalt-containing oxide-metallic systems by using complex electrolytes. It is established that the obtained oxide coatings are characterized by high catalytic activity in the model conversion reactions of carbon (II) oxide. In terms of such critical process parameters as the degree of conversion and ignition temperature, they are not inferior to, and in some cases, outperform industrial platinum catalysts. The use of manganese-containing oxide-metallic coating of the piston in an internal combustion engine leads to lower fuel consumption and a reduction in the toxicity of gas emissions.

Keywords: ecological catalysis, oxide-metallic catalyst, plasma-electrolytic oxidation, catalytic activity.

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A SIMULATION STUDY OF SURFACE WATER PURIFYING THROUGH A POLYSTYRENE FOAM FILTER (p. 19-26)

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The study has improved the mathematical model of water purification in view of the physicochemical properties of surface water, the type of filter loading, and the filtration characteristics of filtering structures. The advanced mathematical model takes into account the inverse influence of the process characteristics on the filtration parameters, changes in the diameters of the loaded grains throughout the height, the direction of filtering, and the turbidity of water at the inlet.

The authors performed a comparative analysis of the work of filters with homogeneous and non-uniform loading for water filtration in different directions and carried out statistical processing of the results of the study with the establishment of the adequacy and the possibility of its use for a mathematical description of water treatment processes.

Physicochemical properties of surface water entering filtration structures are taken into account in the model in the form of kinetic coefficients. The kinetic coefficients, which characterize the intensity of contaminants' separation from and adhesion to the loaded grains, were obtained using the dimension theory method and were deduced for floating densities.

It has been determined that the optimum loading height is 1.0 m for the ascending and descending filtration directions, where the output water quality is of the normative values. The improved mathematical model can help select the optimal design (the loading height and area, the granulometric composition, etc.) and the technological parameters (velocity and direction of filtration, degree of vaporization of incoming water) of polystyrene foam filters; it allows producing simulation of filters' work in different conditions.

A simulation of the work of polystyrene foam filters with different parameters of operation was carried out, which made it possible to specify optimal structural and technological parameters of the polystyrene foam filters for purifying water of the Horyn River (Rivne Oblast, Ukraine), the composition of which is typical for most plain rivers in Ukraine.

Keywords: expanded polystyrene (EPS) loading/polystyrene foam loading, duration of filtering, pressure loss, concentration of pollution, granulometric composition.

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THERMAL TREATMENT OF CONCENTRATED LIQUID TOXIC WASTE AND AUTOMATIC CONTROL OF PROCESS EFFICIENCY (p. 26-31)

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One of the promising approaches to reducing the energy consumption in the thermal distillation of liquid toxic waste is the use of immersion combustion units with the efficiency of more than 100 % relative to the lower calorific value. The development of the method of LTW thermal distillation (evaporation) in volume by means of immersion combustion units will allow wide application of the technology in the industry.

The energy-efficient technological system based on deep thermal evaporation in the ICU is developed. It is shown that the developed EETS has improved characteristics in comparison with the existing thermal treatment systems. The proposed solutions allow simplifying the vat residue processing after the LTW treatment process.

The final product of thermal distillation of toxic waste is a dry residue that does not require repeated or additional processing.

As an efficiency indicator of the LTW distillation complex, it is proposed to use the density of evaporated effluents. The paper proposes to use the vibration method of density control with simultaneous measurement of density and viscosity of controlled LTW. The structure of the automatic density control scheme allows compensating for a decrease in the resonator quality factor due to the damping of its vibrations by a viscous medium.

Keywords: liquid toxic waste, thermal evaporation, immersion combustion unit, vibration control method, density, mechanical resonator.

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EXAMINING THE DYNAMICS AND MODELING OF OXYGEN REGIME OF CHERVONOOSKIL WATER RESERVOIR (p. 32-38)

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The problems of deterioration of the ecological state of surface sources of drinking water supply especially concern water reservoirs since they are created for accumulation of water reserves. Biochemical oxygen demand and dissolved oxygen are integral indicators that characterize ecological state of a water body on the whole.

Based on retrospective observational data for 2010–2014, the authors analyzed dynamics of indicators of BOD and of dissolved oxygen in the Chervonooskil reservoir (Ukraine). The tendencies towards improving oxygen regime of the reservoir were detected: an increase in concentration of dissolved oxygen and a decrease in BOD by average annual indicators. This is explained by a decrease in anthropogenic load on the basin of the water body due to economic decline, which is a consequence of unfavorable political situation in the country.

Authors determined coefficients of biochemical oxidation of organic substances of the Streeter-Phelps model for the water reservoir. Given the influence of temperature on oxygen solubility and on the rate of biochemical processes, calculation of parameters k_1 and k_2 was performed for each month of the year. Correlation coefficient between the modeled and empirical values of biochemical oxygen demand is 0.86, which can be considered acceptable for such research.

Keywords: oxygen regime, biochemical oxygen demand, dissolved oxygen, Streeter-Phelps model.

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IMPLEMENTATION OF THE METHOD OF ELECTROCHEMICAL DESTRUCTION DURING DISPOSAL OF PHARMACEUTICAL GLASS WASTE (p. 39-45)

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Active development of the pharmaceutical market shows a tendency to increase of pharmaceutical glass waste. The negative impact of waste on the environment shows itself in contamination of its elements by pharmaceutical substances contained in the waste, as well as the effects of medical glass and pathogens of infectious diseases.

It was established that increasing of the ecologically safe handling of pharmaceutical glass waste and improvement of the disposal of glass can be provided by the method of electrochemical destruction of pharmaceutical substances. The optimal regimes and conditions to carry out the anodic oxidation process and the kinetic parameters of complete destruction of pharmaceutical substances (diclofenac, beta-estradiol, furosemide, atenolol, cefuroxime) were experimentally determined. The effectiveness of electrochemical destruction of five priority pharmaceutical substances, as well as their mixtures in a solution with sodium chloride using ORTA anode, was experimentally proved. It was established that complete destruction of pharmaceutical substances occurs during the process of electrochemical oxidation. It was noted that the introduction of this method makes it possible to destroy harmful pharmaceutical substances and to disinfect the solutions of pharmaceutical preparations infected with Escherichia coli bacteria in a single process. An additional positive effect of the introduction of the method is the improvement of the quality of pharmaceutical waste as a secondary material resource and promotion of the improvement in the technological processes of pharmaceutical waste disposal.

Keywords: pharmaceutical glass waste, pharmaceutical substances, electrochemical destruction, disposal.

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MODELING OF A PROCEDURE FOR UNMASKING THE FOXES DURING ACTIVITIES ON THE ELIMINATION OF BIOSAFETY THREATS RELATED TO RABIES (p. 46-54)

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The study presents results of mathematical modeling of protective coloration of foxes in order to discover on the ground the animals, which are potential reservoirs of rabies. For simulation, discrete dynamical model, dynamics of which is determined by relationships between components, was used. This type of models was

previously used for formalized description of the structure of relationships of components and dynamics of various biological systems.

The authors constructed the idealized trajectory of the system of plant community in habitat of foxes and idealized pseudo trajectory of the system, reflecting distribution of various combinations of colorometric parameters of protective coloration of these animals. The trajectories of these systems were constructed using rechronization technique. This technique implies that various sections of the image of a system change their colorometric parameters within one cycle, but are in different phases of this cycle.

As a result of comparison of obtained idealized trajectories, feature space that allow us to distinguish between the image of protective coloration of foxes and the image of plant communities, was determined. This is a two-dimensional feature space, coordinates of which are systemic colorometric parameters of the RGB model of the image.

Unmasking of the brood of young foxes against grassy background with the use of the proposed technique made it possible to determine location of the animals in the image, sharpness and contrast range of which were deliberately artificially degraded.

Improvement of methods of animal unmasking on terrain by digital photos allows us to enhance effectiveness of measures on elimination of biosafety hazards, caused by rabies of wild animals.

Keywords: dynamical systems, remote detection of animals, identification of models, colorometric parameters, rabies.

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INFLUENCE OF DRY MIXTURES IN A COATING ON THE EFFECTIVENESS OF WOOD PROTECTION FROM THE ACTION OF A MAGNESIUM FLAME (p. 55-60)

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We carried out an analysis of the occurrence of fires and explosions on objects of storage of explosive products and established that one of the greatest risks is a fire hazard. Since the storage of such products involves the use of wood, both in building structures and packaging products, it is important to establish effectiveness of fire protection at high temperatures and influence of components that are part of the composition, and their role in ensuring fire resistance and fire protection mechanisms. This makes it possible to develop effective methods and means for extinguishing fires in such classes and take into account their peculiarities. We proposed a composition to counteract a high temperature. The basis of its mixture consisted of fire retardants (ammonium polyphosphate), gas formers (melamine), carbohydrates (pentaerythritol), and high-temperature fillers based on mineral substances. Studies showed that charring depth under the action of magnesium flame for untreated wood samples was larger than 16÷20 mm. Instead, after the fire protection treatment of wood with dry mixtures coating, the charcoal depth did not exceed 5÷6 mm. This allows us to conclude that the fire protection of wooden structures and the use of dry mixtures for the localization of magnesium flame is appropriate.

Extinguishing of the magnesium flame with samples of dry mixtures coating with the addition of aluminosilicate microspheres, perlite, basalt scales, metallurgical sludge and ashes in the amount of 10 % showed the intensity of the supply of powder in the extinguishing of magnesium flame in the range of 0.034÷0.041 g/(cm^2·s), which is significantly lower than the sodium chloride supply rate. The results of determination of the efficiency of extinguishing magnesium flame with dry mixtures coating indicate the ambiguous effect of fillers on the change in supply rate during flame extinguishing. The greatest effect is demonstrated by the mixture with the addition of basaltic scales, its supply rate is the lowest when extinguishing the magnesium flame and is 0.034 g/(cm^2·s).

Keywords: metallic combustion, mass loss, charring, protective means for wood, extinguishing powders.

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TREATMENT OF RECIRCULATING WATER OF INDUSTRIAL FISH FARMS IN PHYTOREACTOR WITH LEMNOIDEAE (p. 61-66)

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The feasibility of using Lemnoideae as treatment agents from nitrogen compounds during treatment of circulating water win CWS is justified in the work. The intensity of transformation of nitrogen compounds in the application of nitridenitrification is limited by the relatively low rates of nitrobacteria metabolism, sensitivity to pH fluctuations, competitive relations with heterotrophic biota of biofilters-nitrifiers. Assimilation of ammonium nitrogen by plants occurs in the process of their growth, so the intensity of water treatment will be determined only by the rate of growth of plant biomass in phytoreactors. The artificial lighting system of the phytoreactor allows, regardless of the presence and level of natural insolation, to provide the necessary effect of removal of nitrogen compounds and other biogenic elements. The expediency of using various types of lamps for lighting of the phytoreactor with Lemnoideae is investigated. The dependence of the growth of plant biomass on the duration and intensity of lighting by different types of lamps is determined. The time of plant doubling during cultivation in contaminated circulation water in CWS is 4.5–6 days with the lighting duration within 4 hours to 2–2.5 days with the lighting duration within 14–16 hours per day. It is also confirmed that the lighting intensity is important for the growth rates of Lemnoideae. When fluorescent lamps are used, the rational limits for the lighting intensity of the phytoreactor surface are 6500–6650 lux. The treatment power by nitrogen of the phytoreactor with Lemnoideae in the specific biomass of plants in the range of 4–6 kg/m^2 is 9.6–14.4 gN/(m^2·day). Based on the obtained results, it is possible to calculate the required area of the phytoreactor and the power of the lighting system, depending on the load on the biological treatment facilities for ammonium nitrogen.

Keywords: biological treatment technology, phytoreactor with Lemnoideae, removal of nitrogen compounds.

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DEVELOPMENT OF A PROCEDURE FOR ASSESSING THE ENVIRONMENTAL RISK OF THE SURFACE WATER STATUS DETERIORATION (p. 67-76)

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A procedure for estimation of the risk of violation of the water body status was presented. The procedure is based on defining environmental standards of surface water quality taking into account landscape and geographical features of river basins. A database of the systems of monitoring surface water was used to assess the risk of deterioration of the aquatic ecosystem. This enables automated calculation of the environmental risk. At the first stage, it is necessary to determine environmental standards (ES) on the basis of analysis and statistical processing of long-term monitoring data on the qualitative state and hydrological regime taking into account forecasting models. At the second stage, probability of violation of ecological standards is estimated by the ratio of the number of observations of the ecological state of the water body with violation of the ES to the total number of observations. Exceeding environmental standards makes it possible to assess the risk of well-being violation in aquatic ecosystems. Assessment of the environmental risk of deterioration of Udy River and Oskil River in Kharkiv region, Ukraine, has made it possible to make the list of priority pollutants and outline the main problems for which a complex of environmental measures should be worked out. Establishment of the risk of well-being violation in the aquatic ecosystem will contribute to the implementation of a flexible system for regulating water quality taking into account ever-changing socio-economic and environmental conditions. The proposed procedure for assessing the environmental risk of deterioration of the status of aquatic ecosystems is based on the normative basis, approaches and methods of environmental assessment of surface waters adopted in Ukraine and the EU.

Keywords: environmental risk, water ecosystem, ecological standard, river basin, water protection strategy.

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