ABSTRACT AND REFERENCES

ECOLOGY

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DEVELOPMENT OF MODERNIZED PAPER FILTERING MATERIALS FOR WATER PURIFICATION, ASSESSMENT OF THEIR PROPERTIES (p. 6-13)

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Filtering paper materials (FPM), which are easy to recycle, are widely applied to water purification. The main disadvantage of the absolute majority of filtering materials, including paper, is their tendency to biofouling. This drawback considerably limits or even sometimes makes it impossible to use filtering materials and/or sorbents in a certain medium. In connection with the above, the object of our study was the process of water purification using the FPM with disinfecting properties based on modified cellulose fibers and natural sorbent palygorskite, which can adsorb mechanical impurities, heavy metal ions, entero-viruses, and bacteria.

It was found that the samples of modified filtering paper materials with the highest density and lowest thickness and the samples with the lowest density and the highest thickness have higher filtration and sorption capacity compared to samples with the mean values of these technological characteristics.

Swelling of cellulose fibers reduces the impact of the compositional structure of the studied FPM samples on their filtering capability and increases the impact of the compositional structure on the sorption ability of these FPM.

It was established that the samples with the introduction of about 40 % phosphoric ester of cellulose into their composition have the best technological characteristics.

The character of dependence of the rate of filtration process on consumption of purified water, thickness, density and composition of FPM was established. The obtained mathematical models are presented by second-order polynomial and make it possible to take into consideration not only technical specifications, but also the impact of the FPM composition on the rate of filtration process of purified water. Among the studied parameters, the content of sulfate viscose or sulfate bleached viscose in paper-forming mass of the studied samples and consumption of the purified water have the highest impact on the rate of the filtration process at constant pressure and contamination concentration. The proposed mathematical models also allow to determine the necessary compositional structure for obtaining FPM with determined properties.

Keywords: modified cellulose fibers, cleaning efficiency, water, modernized filtering paper materials, sorption and filter properties, mathematical models, technological regulations of operation.

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DEVELOPING A MODEL OF TANK COOLING BY WATER JETS FROM HYDRAULIC MONITORS UNDER CONDITIONS OF FIRE (p. 14-20)

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The main danger of a fire at an oil storage tank farm lies in its cascade spreading to neighboring tanks. This happens due to heating metal structures to the temperature of self-ignition of vapors of petroleum products. That is why cooling tanks is a priority in the localization of such fires. One of the most reliable methods of cooling is water feeding onto the tank walls using hydraulic monitors that are stationed outside the banking. In this case, the problem is to calculate the cooling action of water and to determine such parameters of its supply that would ensure cooling tank structures to a safe temperature.

The model of the water jet motion after exiting the nozzle of a firefighting barrel was constructed. The algorithm of water supply by using a hydraulic monitor, which provides consistent alternation of the water jet motion on the tank wall in the horizontal and vertical direction was proposed.

The model of cooling action of the water film formed after water jet hitting the wall of the tank was constructed. The model is based on heat balance equations for a tank wall and a water film and takes into consideration the periodic water jet motion on a tank wall. When constructing heat balance equations, we took into consideration convective and radiant heat exchange with a fire and the environment. It was shown that the temperature distribution on the tank wall and the water film is described by the system of two nonlinear differential equations of the first order.

The findings obtained in the study make it possible to determine the parameters of water supply, which provide tank cooling to a safe temperature.

Keywords: fire in banking, temperature distribution, convective heat exchange, radiant heat exchange, water jet, water film.

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DEVELOPMENT OF A PROCEDURE FOR DETERMINING THE BASIC PARAMETER OF AQUATIC ECOSYSTEMS FUNCTIONING – ENVIRONMENTAL CAPACITY (p. 21-28)

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Environmental capacity as the main parameter of functioning of aquatic ecosystems was studied. This parameter is an effective indicator of violation of structural and functional processes in the technogenically altered water body. The adapted conceptual model of the system of indicators Actions - State - Consequences was applied.

In accordance with the developed classification of the system of indicators, balance of environmental capacity of the aquatic ecosystem serves as a part of the integral indicator of state of the aquatic ecosystem, as a consequence of effect of exogenous factors of anthropogenic origin. Due to the use of integrated indicator systems, it was possible to provide not only qualitative but also quantitative characteristics of the environmental capacity.

Estuary of a medium peneplain river which is the most representative part of the river and reflects consequences of anthropogenic effects occurring in the river basin was selected as a study object. Taking into account the hierarchical pattern of levels of water systems development, the study of the state of medium rivers at a local level will enable development of water conservation measures that will contribute to improvement of water quality in large rivers. The developed procedure can be successfully adapted to other technogenically altered peneplain rivers.

The results of the performed mathematical calculations were presented in a form of graphs of dependence of environmental capacity and techno-capacity on numerous parameters of the aquatic ecosystem functioning. Dynamics of changes in these parameters in 2009–2017 was demonstrated. The study results indicate that biota adapted to a certain level of technogenic pollution and environmental capacity was stable (27–37) in the period of 2012–2016 which shows optimal conditions for existence of the aquatic ecosystem. The generalized estimation of changes over the whole period of studies suggests that the loss of environmental capacity (decreased to 13.3) was caused by excessive technogenic impact on the river aquatic ecosystem which predetermines formation of techno-capacity. As a result, a reduction in the level of remaining ecological reserve necessary for restoration of a technogenically altered aquatic ecosystem of the river was observed.

Keywords: environmental capacity, ecological reserve, technogenically altered aquatic ecosystem, ecological indices.

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DEVELOPMENT OF THE METHOD FOR RAPID DETECTION OF HAZARDOUS ATMOSPHERIC POLLUTION OF CITIES WITH THE HELP OF RECURRENCE MEASURES (p. 29-35)

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The method for rapid detection of hazardous pollution of the atmosphere of cities, which is based on dynamic measures of recurrence (repeatability) of the states of the pollution concentration vector, was developed. The new scientific result is related to the use of the unconventional modification of the known measures of recurrence based on the dynamic window averaging the current recurrence of the states of atmospheric pollution concentration. One type of a window has the width that is increasing over actual time of measurements. The other type uses the window of a fixed width that is movable over the time of measurements. The modified measures take into consideration the integrated nature of explicit and hidden destabilizing factors that contribute to current pollution concentration at the point of control. In this case, it is emphasized that there is no need to take into consideration the traditional meteorological or other conditions when identifying hazardous pollution of the atmosphere. The developed method makes it possible to detect rapidly not only explicit, but also hidden dangerous pollutions of the air basin in cities and thus to improve the effectiveness and timeliness of the measures to reduce the harmful effects of pollution of the atmosphere on the population and the environment. Nitrogen dioxide was considered as a hazardous pollutant during the experimental verification of the method. It was established experimentally that the dynamics of the concentration of nitrogen dioxide in the atmosphere of a typical urban configuration has a fractal structure, which depends on the pollution control points. In this case, these structures are characterized by the existence of the elements of periodic and extreme topologies with sharp changes in dynamics. The modified measures were found to characterize the features of specific structures and to detect not only explicit, but also hidden hazards of atmosphere pollution. In this experiment, the dynamics of the modified measures varies from zero to 0.78 units. It was shown that the maximum value of the measures belongs to the interval of observation, which is determined by 12–36 counts. It was established that at the studied control points, current concentrations of nitrogen dioxide exceeded the limit concentrations by 2.75–4.5 times and admissible maximum single concentrations – by 1.3–2.1 times. It was determined that abrupt changes in the dynamics of the modified measures can serve as an indicator of not only explicit, but also hidden hazardous pollution of the atmosphere of cities.

Keywords: concentration of air pollution, state of city atmosphere, recurrence measure, recurrent plot.

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ESTABLISHMENT OF HEATEXCHANGE PROCESS REGULARITIES AT INFLAMMATION OF REED SAMPLES (p. 36-42)

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The conducted studies into the influence of induction period on reed inflammation have established the mechanisms of the process of heat transfer to material which makes it possible to influence this process. It was proved that these mechanisms consist in heating material to a critical temperature at which an intensive decomposition of the material occurs with release of a critical amount of combustible gases and their inflammation. This makes it possible to establish effect of fire protection and properties of roofing formulations on inhibition of the reed inflammation process. Experimental studies have confirmed that untreated reed inflames under thermal action in 58 seconds which is respectively equal to the induction period of material decomposition and flame spreads throughout the material surface which results in a complete combustion of material. Duration of the induction period extends to 587.45 s due to decomposition of flame retardants under thermal action with emission of non-combustible gases inhibiting material oxidation and significantly intensifying formation of a heat protective layer of coke on the reed surface. This leads to a growth of the coke layer thickness and inhibition of heat transfer from high temperature flame to the material. The study has made it possible to determine conditions of fire protection of reed by creating a barrier for thermal conductivity. In addition, when a flame-retardant protection coating is applied, the temperature effect manifests itself in reactions in the pre-flame region with formation of soot-like products on the surface of a natural combustible material. This gives grounds to assert that the mechanism of imparting fire protection properties to the reed by means of bloating formulations is feasible and that the proposed technological solutions have practical attractiveness. The latter, in particular, relate to determination of quantity of the polymeric component since the reed is characterized by hydrophobicity and the aqueous solution of the flame detergent flows off the surface. Thus, there are grounds to assert that the controlled fire protection of reed can be ensured through the use of a complex roofing formulation of a mixture of flame retardants and a natural polymer capable of forming a flame-retardant film on the material surface.

Keywords: fire protection of reed, flame retardant coatings, heat conduction, surface treatment, thermophysical properties.

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RESEARCH ON THE EFFECT OF COMPOSITIONS OF ECOLOGICALLY SAFE SUBSTANCES ON THE HYGIENIC PROPERTIES OF TEXTILE PRODUCTS (p. 43-49)

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Textile products are an integral part of people's everyday life. In the process of exploitation of textile products, the human body directly contacts with textile materials throughout life, so the issue of their safety is especially important in the production of textiles and clothing.

Creation of innovative formulae of washing compositions allows combining the high efficiency of the washing process with the treatment of textiles with special types of finishing. Studies aimed at the development of effective compositions with polyfunctional action based on surfactants (surface-active biodegradable substances) with the use of antimicrobial preparations are urgent and promising. They also contribute to the development of the market of chemical products, reduce the material consumption of technology and the cost of production and increase the ecological safety of the process.

A complex evaluation of changes in the operational properties of textile materials after treatment with compositions of ecologically safe substances was carried out. The results of the study will contribute to reducing the ecological burden on the environment and human health. In addition, this ensures the preservation of the consumer properties of textile products during operation.

The complex study of the influence of compositions of ecologically safe substances on the hygienic properties of textile products is presented.

The analysis of the effectiveness of the compositions on the technological parameters (washing ability, anti-resorption capacity, composition concentration, treatment time) of the process of removal of contaminations from textile products made of cotton, polyester and their mixtures was carried out. The quantitative indices of capillarity of fabrics are determined, namely, the raising height of the composition of solutions (h, mm), which characterizes the quality of cleaning of pores of textile materials. Experimental data indicate that

the treatment of fabrics made of cotton and polyester and mixtures thereof contributes to their hydrophilicity, which is expressed in improving their wettability with aqueous solutions and increasing capillarity from 131 mm to 152 mm due to the presence of adsorbed surfactants on materials.

The influence of compositions of ecologically safe substances on the representative of the normal microflora of the human body P. freudenreichii was investigated. It was found that the culture was restored to 10^4–10^5 cells/ml after 48 hours of fabric sample exposure and in the P. freudenreichii sterility control environment.

It was found that treatment of textile products at the concentration of compositions of ecologically safe substances of 2.5 g/l is technologically and ecologically expedient. As the high quality of cleaning of products is achieved (from 80 % to 88 %), the capillarity of textile materials increases, and the healthy microflora of human skin is preserved. The obtained research data allows us to recommend the use of compositions of ecologically safe substances for the treatment of special-purpose textile products (for military, athletes, etc.), as well as home textiles.

Keywords: ecologically safe substances, binary compositions, textile products, hygienic properties, wet cleaning, antimicrobial treatment.

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REVEALING PATTERNS IN THE AGGREGATION AND DEPOSITION KINETICS OF THE SOLID PHASE IN DRILLING WASTEWATER (p. 50-58)

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We have investigated the influence of the concentration of the solid phase of drilling wastewater on a change in the sedimentation rate of the solid phase at aggregation when applying a physical-chemical method of water purification using flocculants and coagulants. This is important because a change in the concentration of the solid phase in wastewater is an uncontrolled process during reagent-based purification and it significantly affects the aggregation mechanism, as well as the kinetics of a solid phase sedimentation.

The study was performed using the model wastewater prepared by diluting the used drilling mud with tap water. It was found that the use of flocculants without coagulants is not effective and does not lead to aggregation. It was established that the optimum dose of the coagulant aluminum sulfate that is capable of disrupting the stability of the disperse system of drilling wastewater is 65 mg/g, while increasing the dosage of coagulant has no effect on the rate of flake deposition. Among the flocculants, the most active one is the anionic flocculant A-19. Sludge thickening results in the destruc-

tion of floccules; in 9 minutes, the floccule deposition rate is reduced two-fold. Increasing the concentration of a flocculant from 0.8 mg/g to 1.6 mg/g leads to an increase in the deposition rate of the solid phase by 2–2.5 times.

It is shown that the solid phase concentration affects the sedimentation rate of floccules; optimum conditions for aggregation are observed at a concentration of 4–6 g/l. Mechanical impacts on aggregates exert a destructive effect depending on the concentration of the solid phase. It has been established that changes in the dispersed system can be observed based on a change in pH, which varies depending on the concentration of the solid phase in drilling wastewater. Increasing the concentration of the solid phase from 1 to 10 g/l leads to the change in pH from 7.2 to 8.3; the introduction of coagulant reduces pH, while the subsequent destruction of aggregates leads to an increase in pH. The data obtained in the course of our research, as well as the proposed procedure, could be used in order to select the optimal dosages of reagents during drilling wastewater treatment.

Keywords: coagulation, flocculation, drilling wastewater treatment, aggregation, strength of aggregates, deposition rate.

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