ABSTRACT AND REFERENCES

ECOLOGY

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DEVELOPMENT OF METHODS FOR ESTIMATING THE ENVIRONMENTAL RISK OF DEGRADATION OF THE SURFACE WATER STATE (p. 4-17)

Olga Rybalova
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-8798-4780

Sergey Artemiev
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-9086-2856

Maryna Sarapina
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-9011-8691

Bohdan Tsymbal
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-2317-3428

Anna Bakhareva
National Technical University
«Kharkiv Polytechnic Institute», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-0765-9943

Oleksii Shestopalov
National Technical University
«Kharkiv Polytechnic Institute», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-6268-8638

Olesya Filenko
National Technical University
«Kharkiv Polytechnic Institute», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-0277-6633

We presented three new methods for assessment of the environmental risk of deterioration of a surface water state. We defined the ecological risk of deterioration of surface water at the state level as an addition of the integrated parameter of the state of surface waters and the integral index of anthropogenic loading. We used the official information of the National Report on the state of the environment of Ukraine to calculate the mentioned indicators. We developed classifications of anthropogenic loading on aquatic ecosystems and ecological risk of deterioration of water ecosystems. The assessment of the ecological risk of deterioration of surface water state in Ukraine showed that there are watercourses of the Siversky Donets river basin in the most dangerous state. A base of the methodology for assessment of the risk of water ecosystem well-being disruption is the determination of all parameters of the state of quality of surface waters that exceed the ecological standards using the probit-regression model. The process of determining ecological risk for watercourses of the Siversky Donets river basin in Kharkiv region showed a high level of danger to the well-being of the water ecosystem of the Udi river. We obtained the forecast of climatic changes by parameters of temperature and volumes of precipitation in Kharkiv region. We investigated the dynamics of wastewater discharge to the Udi river for the period from 1992 to 2016. The study on an influence of natural and anthropogenic factors on the ecological state of the Udi river revealed that the impact of wastewater discharge with a correlation coefficient of 0.747 is a significant factor. The application of a new methodology for assessment of the risk of degradation processes made it possible to determine a list of small rivers in Kharkiv region, which require implementation of measures based on the analysis of water use efficiency, taking into consideration landscape and ecological features of a catchment area. We proposed an algorithm for the improvement of water protection strategy based on determining the ecological risk of deterioration of the condition of surface water at the state, regional and local levels. The improvement of water preservation strategy aims at introduction of an integrated interactive surface water quality management.

Keywords: water protection strategy, ecological risk, climate change, rational use of water, river basin.

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DEVELOPMENT OF NEW TECHNOLOGICAL SOLUTIONS FOR RECOVERY OF HEAVY NONFERROUS METALS FROM TECHNOGENIC WASTE OF ELECTROPLATING PLANTS AND SLUDGE OF WATER TREATMENT SYSTEMS (p. 17-24)

Mikhail Barkan
Saint-Petersburg Mining University, Saint-Petersburg, Russia
ORCID: http://orcid.org/0000-0001-7480-1220

Anton Kornev
Saint-Petersburg Mining University, Saint-Petersburg, Russia
ORCID: http://orcid.org/0000-0001-6371-9969

In galvanic cakes and municipal wastewater sludge, there are significant amounts of heavy non-ferrous metals, which are classified as hazard class I ecotoxicants and are currently being disposed. The existing methods of toxic waste processing do not provide for the selection and efficient recovery of valuable components. However, the cost of non-ferrous and precious metals and their industrial content in these types of technogenic waste allow justifying the payback and profitability of their industrial processing.

Based on the laboratory and large-scale laboratory experiments, flow diagrams of processing of galvanic cakes and wastewater sludge are proposed. The calculated kinetic and thermodynamic characteristics (activation energy, time of complete dissolution, Gibbs free energy value), the recovery parameters of heavy non-ferrous metals (ε_{Cu}=99.5 %, ε_{Ni}=99.5 %, ε_{Zn}=99.9 %) indicate the possibility of industrial implementation of the given flow diagrams. Dependencies of copper recovery on temperature and leaching time are presented. The obtained results allow speaking about the kinetic limitation of the process of galvanic cake leaching (E_{Cu}=15.7 kJ/mol) and demonstrate the possibility of conducting the process at low temperatures (t=40 °C), which leads to lower energy consumption.

The advantage of the proposed options of processing of galvanic cakes and wastewater sludge is the presence of commercial equipment, the use of traditional hydrometallurgical processes, availability and low cost of reactants, short payback periods and anthropogenic load reduction.

Keywords: technogenic waste, heavy non-ferrous metals, wastewater treatment, electroplating waste.

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HYDROTHERMAL MODE OF THE FLOWTHROUGH RESERVOIRCOOLER WITH RESPECT TO ITS MORPHOMETRIC CHANGES (p. 24-29)

Nikolai Bosak
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0003-0306-9583

Oleksandr Hvozdetskyi
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0001-5590-4689

Roman Hnativ
Lviv Polytechnic National University, Lviv, Ukraine
ORCID: http://orcid.org/0000-0002-4931-7493

We carried out hydrothermal investigations of the flow-through reservoir-cooler with running water of the thermal power plant. The purpose of the study was to investigate a degree of silting of the flow-through reservoir-cooler of TPP for the operation period and an effect of morphometric changes of RC on its temperature and temperature of circulating water. The peculiarity of the circulating water supply of this thermal power plant is that two channels carry out the discharge of circulating water into the reservoir – to the tail part of it and to the head part, near the water discharge facility.

The volume of silting of the Dobrotvir reservoir during the operation period is 0.88 million m^3, the total volume decreased by 9.6 %. The depths up to 2 m increased by 28 %. The area of the reservoir decreased by 1.56 km^2 as a result of silting and overgrowth of coastal water area.

Circulating water in the near water area of its discharge into the reservoir cools by 3–4 °C, that is, by ≈50 % of the total value. Over the operation period, the near water area became shallow, but this did not affect temperature performance of the reservoir.

We recommended the formula for forecasting a temperature of water discharged from flow-through reservoir to a river, which is important for the summer period. The discharge of circulating water for cooling by two channels – to the upper and to the catchment water area of the flow-through reservoir-cooler increases its active area. It is possible to provide sanitary norms regarding the thermal pollution of the river below the reservoir-cooler by regulation of the discharge of deep layers of water by discharge facility in summer.

The results of research can be useful for operation of reversible systems of technical water supply with reservoirs-coolers. They are important for regulation of redistribution of circulating water of a thermal power plant to a water area of a reservoir-cooler, as well as for operation of their discharge facilities in flow-through reservoirs.

Keywords: flow-through reservoir-cooler, silting of a reservoir, water temperature in a catchment water area.

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PROCESSES OF BIOLOGICAL WASTEWATER TREATMENT FOR NITROGEN, PHOSPHORUS REMOVAL BY IMMOBILIZED MICROORGANISMS (p. 30-37)

Maria Blyashyna
National University of Water and Environmental Engineering, Rivne, Ukraine
ORCID: http://orcid.org/0000-0001-7275-7254

Veronika Zhukova
National Technical University of Ukraine "Igor Sikorsky Kyiv polytechnic institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-8296-7519

Larisa Sabliy
National Technical University of Ukraine "Igor Sikorsky Kyiv polytechnic institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-4217-3535

Parameters of the biotechnology of wastewater treatment for nitrogen and phosphorus removal using immobilized microorganisms are investigated. The acutest problem of municipal wastewater treatment is the low removal efficiency of biogenic compounds, namely nitrogen and phosphorus. Exceeding the discharge norms for nitrogen and phosphorus compounds leads to a dangerous ecological situation in water bodies of Ukraine. The intensity of transformation of nitrogen and phosphorus compounds is limited by the rather low growth rates of nitrifying bacteria (0.25–0.35 day^{-1}), sensitivity to pH fluctuations (the value of 6.5–8 should be maintained), competitive relations with heterotrophs. It is advisable to use immobilized microorganisms to increase the concentration of nitrifying bacteria and create favorable conditions for biomass development. The perpendicular air flow in relation to wastewater flow in the aerobic bioreactor zone, which provides the oxidation capacity by ammonium nitrogen of up to 120–130 g/(m^3·day), is investigated. It is established that the specific oxidation rate of organic matter in municipal wastewater treatment reaches 25 mg COD/(g/day), providing COD treatment efficiency of up to 90 %. The efficiency of wastewater treatment for ammonium nitrogen removal at an initial concentration of 30–50 mg/dm^3 is 97.3–99 %. The sequence of anaerobic-anoxic-anaerobic-aerobic processes, which provides the efficiency of wastewater treatment for removal of organic pollutants of 90–95 %, ammonium nitrogen 97–99 % and phosphates 93–95 %. with the treatment duration of up to 4 hours is studied.

Keywords: anaerobic, anoxic and aerobic bioreactors, immobilized microorganisms, biotechnology, nitrogen and phosphorus removal.

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IMPROVING THE INSTALLATION FOR FIRE EXTINGUISHING WITH FINELYDISPERSED WATER (p. 38-43)

Dmytro Dubinin
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-8948-5240

Kostyantyn Korytchenko
National Technical University «Kharkiv Polytechnic Institute», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-1100-5435

Andrei Lisnyak
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-5526-1513

Ihor Hrytsyna
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-2581-1614

Volodimir Trigub
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-5370-1340

Fires at residential buildings are extinguished by both compact and sprayed jets of water. The result of fire suppression at facilities using compact jets of water is the increased consumption of water, which leads to collapse of the structures at a building. The application of water firehoses without fire-rescue vehicles is also impossible. Water that is sprayed to the droplets of small size makes it possible to extinguish a flame mainly by the dilution of a gas combustible medium with water vapor, formed during evaporation of droplets. The effectiveness of fire extinguishing with finely-dispersed water is affected by a diameter of the droplets or dispersion.

It is proposed, to suppress developed fires at facilities, to apply the installation of fire extinguishing with finely-dispersed water of the pulse-periodic action. We have tested the designed installation for fire extinguishing. Based on the research results, we obtained parameters for the operation of the installation, such as the velocity of the shock wave, which amounted to 1,667–1,724 m/s. It was established that one detonation cycle uses about 30 mg/cycle of combustible mixture. Detonation cycle frequency is greater than 20 Hz. The estimated total power of the installation is 50 kW. According to results of the study, we found that the transition of combustion into detonation occurs at the expense of compression and heating of the combustible mixture. The established parameters for the operation of the installation make it possible to disperse water jets in the installation's barrel by a flow of detonation products.

The resulting dispersion of a finely-dispersed water jet by the method of trapping the droplets of water is within 60–100 μm. Based on the results of our study, it was established that an optimum water feed to the installation is 0.5–1 l/s, which depends on the area of a fire. This means that during operation water consumption to suppress a fire would equal 1,800 l, which would enable the removal of heat from a fire site at about 4 GJ/h; the area of a fire in this case would make up 125 m^2.

Keywords: technical means, finely-dispersed water, gas-water jet, fire extinguishing, fire load, area of fire extinguishing.

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DEVELOPMENT OF THE METHOD OF FREQUENCY-TEMPORAL REPRESENTATION OF FLUCTUATIONS OF GASEOUS MEDIUM PARAMETERS AT FIRE (p. 44-49)

Boris Pospelov
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-0957-3839

Vladimir Andronov
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0001-7486-482X

Evgeniy Rybka
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-5396-5151

Vadym Popov
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0003-4182-9248

Oleg Semkiv
National University of Civil Defence of Ukraine, Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-9347-0997

The method of operative frequency-temporal representation of fluctuations of gaseous media parameters at an early stage of fire at premises was developed. The basic assumptions about the peculiarities of dynamics of hazardous factors of gaseous medium at early ignition at premises were stated. The authors created theoretical framework for development of the method, based on the fact that violation of equilibrium state of gaseous medium is translated by the medium to the zone of sensors' localization and responds to emergence of an ignition in premises. The fire source in this case is considered a moving source of disturbances and parameters of the medium carry information about temporal and frequency shifts of disturbances. It was shown that these shifts of disturbances are characterized by the correspondent uncertainty function, which is an invariant with respect to the double Fourier transformation, determined by squared modulus of frequency-temporal energy density of the parameter. The proposed method is a further development of frequency-temporal representations of the Cohen class in case of fluctuations of gaseous medium parameters at early ignitions in premises. The main features of the method are its relative simplicity and the use of data in real time. The verification of the developed method was performed based on the experimental data of the main parameters of the gaseous medium at an early ignition of alcohol, paper, wood, and textiles in the simulation chamber.

Keywords: fire source, gaseous medium, equilibrium state, frequency-temporal representation, fire sensors.

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MODELING A THERMAL CONDUCTIVITY PROCESS UNDER THE ACTION OF FLAME ON THE WALL OF FIRE-RETARDANT REED (p. 50-56)

Yuriy Tsapko
National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine
V. D. Glukhovsky Scientific Research Institute for Binders and Materials, Kyiv National University of Construction and Architecture, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-0625-0783

Aleksii Tsapko
National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine
ORCID: http://orcid.org/0000-0003-2298-068X

Creating environmentally friendly flame-retardant materials for natural inflammable roof structures will make it possible to control the processes of thermal stability and physical-chemical properties of a protective coating over its life cycle. There is therefore a need to study conditions for the formation of a thermal conductivity barrier and for the establishment of a mechanism that inhibits heat transfer to the material. It was experimentally determined that reed, non-treated with a flame-retardant agent, was ignited under the action of burner in 5 seconds, with the flame spreading throughout the entire surface, which resulted in its complete burning and the loss of mass. The study that we conducted into the influence of a coating on the transfer processes of a high-temperature flame to a material, established the fire protection process mechanisms, which imply the inhibition of such an action. It was proven that this process includes the decomposition of flame retardants under the action of temperature, with heat absorption and release of incombustible gases, the formation of ash-like products at the surface of a natural combustible material, as well as thermal insulation. That made it possible to determine conditions to protect reed from fire by forming a barrier to thermal conductivity. Experimental study has confirmed that a sample of fire-retardant reed withstood a thermal influence; the action of a heat flow lead to the swelling of the impregnation and the coating, which lasted for 120 seconds. We estimated the maximum possible penetration of temperature through the thickness of a coating and established that when reed, protected by the impregnating composition, was exposed to a flame of the burner, temperature at the inner surface was less than 147 °C with the mass loss not exceeding 2.9 %. Even greater efficiency was demonstrated by samples that were treated with the coating; the temperature did not exceed 140 °C, with a 2.5 % mass loss. We also established that the coefficient of thermal conductivity, when protected from fire, reaches 1.6 W/(m·°C) for the impregnating composition, and 1.2 W/(m·°C) for the coating, respectively.

Keywords: reed fire protection, swelling coatings, thermal conductivity, surface treatment, thermophysical properties.

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ESTABLISHING THE DEPENDENCE OF POLLUTANT CONCENTRATION ON OPERATIONAL CONDITIONS AT FACILITIES OF AN OILANDGAS COMPLEX (p. 56-63)

Teodoziia Yatsyshyn
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0001-7723-2086

Yulia Mykhailiuk
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0003-2448-3847

Mykhailo Liakh
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0001-9447-6605

Irina Mykhailiuk
Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine
ORCID: http://orcid.org/0000-0002-6489-3982

Vasyl Savyk
Poltava National Technical Yuri Kondratyuk University, Poltava, Ukraine
ORCID: http://orcid.org/0000-0002-0706-0589

Igor Dobrovolsky
PJSC «Ukrgazvydobutok», Kharkiv, Ukraine
ORCID: http://orcid.org/0000-0002-5606-9555

Environmental impact of gas burning parameters during operation of the gas pumping units of compressor stationswas studied. Simulation of the NO_2, NO and CO dispersion zone at the excess air coefficients of 1.0; 1.1; 1.3; 1.6 was made using the Eol-Plus, v. 5.23 software package. Adjusted dimensions of the sanitaryprotective zone were established for various values of the excess air coefficient and according to the local windrose. It was determined that the smallest distance of emission dispersionwas at the value of α=1.00 and the largest distance was at α=1.60. It has been established that withincreases in the coefficient α, the near-earth concentrations of nitrogen oxides grow and those of carbon monoxide fall. It was found that concentrations of nitrogen oxides are minimal during gas combustion in the GB chambers at α=1...1.1. Recommendations for raising the level of environmental safety of the gas transportation facilities and a method of purifying exhaust gases from CO in operation of compressor stations on main gas pipelines were proposed. The method consists in an additional supply of ionized air in exhaust gases.

Keywords: environmental safety, gas pumping unit, environmental pollution, atmosphere, oil-and-gas complex.

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