ABSTRACT AND REFERENCES
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DEVELOPMENT OF FERRITIZATION PROCESSING OF GALVANIC WASTE INVOLVING THE ENERGYSAVING ELECTROMAGNETIC PULSE ACTIVATION OF THE PROCESS (p. 6-14)

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This paper considers the prospect of improving the level of environmental safety of industrial enterprises resulting from the implementation of a resource-saving technology for processing the wastes of galvanic production by a ferritization method using the electromagnetic pulse activation of the process. The influence of different activation techniques of the ferritization process has been experimentally determined: thermal and electromagnetic pulse at stable technological parameters (C =10.41 g/dm^3; Z=4/1; pH=10.5; τ=25 min; υ=0.15 m^3/h) on the degree of extraction of heavy metal ions from galvanic wastes. It has been shown that the best processing indicators were achieved at the following mode characteristics for generating electromagnetic pulse discharges: the amplitude of magnetic induction 0.298 Tl, the frequency of pulses from 0.5 to 10 Hz. Such an activation technique ensures the proper degree of heavy metal ions extraction – 99.97 % enabling the use of purified solutions at an enterprise water circulation system. A structural study has been performed into the phase composition and physical properties of ferritization sediments. The environmentally safe ferritization sediments that were obtained under the thermal and electromagnetic pulse activation techniques are characterized by a high degree of compaction, exceeding 90 %, and the crystalline structure with the maximum content of ferrite phases with magnetic properties. In addition, as shown by experiments on heavy metal leaching, these sediments are characterized by a high degree of their immobilization, which reaches 99.96 %, in contrast to galvanic sludge from the neutralization of wastewater, <97.83 %. The method of electromagnetic pulse activation also has the undeniable energy advantages compared to the high-temperature one: energy costs are reduced by more than 42 %. The proposed process for galvanic waste processing by the improved method of ferritization prevents pollution of the environment, ensures efficient and rational use of water, raw materials, and energy in the system of galvanic production.

Keywords: ferritization, galvanic waste, heavy metals, electromagnetic pulse discharges, leaching.

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ANALYSIS OF ENVIRONMENTAL SAFETY OF RECREATIONAL TERRITORIES OF MOUNTAIN ECOSYSTEMS AND DEVELOPMENT OF TECHNICAL MEASURES FOR ITS STABILIZATION (p. 15-24)

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We studied ways of ensuring of the environmental safety of recreational territories of a mountain ecosystem on the example of "Vizhnytsky" National Nature Park (NNP) in the Pokutsko-Bukovynian Carpathians. Existing approaches to ensuring of the environmental security of nature reserve objects have been analyzed. The characteristic of the study region has been given. We proposed the concept for ensuring of the environmental safety of recreational areas. Its base is analysis of components and identification of components, improvement of which would ensure the appropriate level of environmental safety of NPP. An algorithm has been constructed for theoretical and experimental studies for assessment of the sanitary-microbiological state of the atmosphere, hydrosphere and soils in the study area and their influence on the environmental safety of NPP.

We monitored sanitary-microbiological and sanitary-environmental indicators of the hydrosphere, atmosphere and soil and identified environmental threats to analyze the state of recreational territories of the mountain ecosystem. It is proposed to plan measures for intensification of biological natural processes of self-purification of surface water in the area of recreation territories to ensure preservation of the limited values of sanitary-microbiological and sanitary-environmental indicators of the hydrosphere. The results of atmospheric air monitoring in the area of the recreation territories indicated that the air ion

content was 2.4 times higher, and the total microbial number was 1.5 times lower than in the territory of traditional farming. Therefore, the atmosphere of the recreation area does not require any technical measures to improve it. A system of engineering measures has been proposed for stabilization of environmental safety in the area of recreational territories (using the "Viya" fibrous carrier) for intensification of purification of surface water and disposal of wood waste by biofuel production.

Implementation of the proposed measures would help achieve stabilization of the environmental safety of the recreational territories of the mountain ecosystem.

Keywords: environmental safety, recreational territories, sanitary-microbiological indicators, sanitary-environmental indicators, monitoring, hydrosphere.

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IDENTIFYING THE PROPERTIES OF EPOXY COMPOSITES FILLED WITH THE SOLID PHASE OF WASTES FROM METAL ENTERPRISES (p. 25-31)

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The article addresses the issue related to the disposal of dust from steel industry as a reinforcing filler for epoxy composites. The polymer composition of "cold welding" that has been developed and studied includes epoxy dian oligomer, amine hardener and the filler – finely dispersed waste of metals. Polyethylene polyamine was used as a hardener in order to improve heat resistance and strength characteristics. Manganese triacetate was used in order to decrease the temperature and reduce the time of curing.

The possibility was established to dispose of finely dispersed metal-containing waste from metallurgical production to be used a filler for epoxy composites of cold curing. It was revealed that the optimal content of dusts from foundries in the composite is at the level of 45–60 %. At this content, there is the highest impact resistance at the level of 40–50 MPa and a softening temperature in the range of 170–190 °C. It was established that at an increase in the amount of a filler from 40 % to 70 %, the cross-linking degree increases by 88 % to 98 %, respectively. However, at the content of the filler less than 45 % or exceeding 60 %, the impact resistance of the resulting composites decreases. At the content of a filler in the composite less than 45 %, the cause of low values of impact resistance and softening temperature could be the low cross-linking degree, less than 90 %. A decrease in these properties of composites at the content of the filler exceeding 60 % could be associated with the formation of a heterogeneous structure of filler. In the compositions with the highest perfor-

mance characteristics, there is an optimized content of the filler and catalyst. Using a hardener and a curing catalyst in quantities of 3–3.5 and 1.5–2 %, respectively, makes it possible to shorten curing time by up to 2 hours. In general, the resulting epoxy composites are superior in their performance to known cold-curing analogs.

The dependences of impact resistance, softening temperature, and cross-linking degree on the content of waste in the composite were derived, which make it possible to calculate the optimal formulation for composites depending on the required properties.

Keywords: cold curing epoxy composite, metallurgical dust, impact resistance, cross-linking degree.

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DEVELOPING A TECHNOLOGY FOR PROCESSING CUPRUM CONTAINING WASTES FROM GALVANIC PRODUCTION AIMED AT THEIR FURTHER USE (p. 32-41)

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The study reports results of experimental studies into processing highly concentrated metal-containing wastes (HCMW) from galvanic production with obtaining precipitates of the

predefined chemical composition, specified physical-and-chemical properties and with copper ions content. We defined the following precipitate properties in the study of copper-iron containing sludges obtained by coprecipitation of copper and iron-containing spent technological solutions (STS): humidity – 89.7 %, density – 1.17 kg/dm^3, specific precipitate resistance – 15–16·10^{11} m^2/kg. It is easy to filter such precipitate. Therefore, it reduces consumption of reagents, increases purification efficiency, and makes it possible to obtain the precipitate, which is ready for transportation. Therefore, it is advisable to obtain copper-containing precipitates (sludges) with iron content for easier separation and avoiding of the conditioning operation. A technological scheme was developed for processing and subsequent disposal of copper-containing HCMW. It included transformation of copper- and iron-containing precipitate into a solution by addition of sulfuric acid; precipitation of iron ions with 25 % ammonia solution; separation of the obtained precipitate of iron hydroxide (III) by filtration for disposal; sending the obtained copper-containing filtrate for electrochemical removal of copper in the form of a metal precipitate or for disposal by the reagent method. We established in the processing of copper-containing HCMW in a diaphragm electrolyzer to extract copper in the form of a metal precipitate that the current consumption decreases with an increase in the initial metal concentration. Therefore, it is possible to ensure the degree of transformation of a=0.9 with current efficiency >80 % at the concentration of copper ions >0.1 mol/dm^3. For reagent copper precipitation, it is optimal to use KOH and K_2CO_3 mixtures pH=9.5–10 as reagents to obtain a hydroxocarbonate precipitate. Precipitates obtained in this way are suitable for further disposal by processing or they can be raw materials for production of ready-to-use products, which may be a final stage of galvanic production.

Keywords: highly concentrated metal-containing waste (HCMW), spent technological solutions (STS), galvanic production, metal coating, copper and its compounds.

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CONSTRUCTION OF THE ALGORITHM FOR ASSESSING THE ENVIRONMENTAL SAFETY OF GALVANIC SLUDGES (p. 42-48)

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Based on the developed algorithm, the sanitary and toxicological properties have been assessed in the system "Galvanic sludge – natural object" using model copper-zinc sludge.

The following minerals containing heavy metal ions have been identified in galvanic sludge: $ZnSO_4 \cdot H_2O$, $ZnSO_4 \cdot 7H_2O$, $Cu_3(OH)_4(SO_4)$, $(Zn_{3.2}Cu_{0.8})(SO_4)(OH)_6 \cdot 4H_2O$, which could, at a long-term interaction with the environment, form easily soluble toxic compounds. It has been established that the process of neutralizing sulfate copper-zinc solutions with lime milk proceeds in two stages: the formation of semi-aquatic and two-water gypsum; heavy metal compounds. The water-migration activity of the Cu^{2+} and Zn^{2+} ions has been investigated, which are included in the galvanic sludge composition. It has been proven that of the two metals examined, the Zn^{2+} cations contribute more to the negative impact on environmental objects than the Cu^{2+} cations. Patterns in the distribution and migration of heavy metal ions in soils after contamination by galvanic sludge have been investigated. It has been established that the intensity of transformation of Cu^{2+} and Zn^{2+} ions from galvanic sludge to soil is defined by the soil type and the physical and chemical properties of the metals themselves. The correlation between the mobility of heavy metal ions and soil acidity has been investigated. For Zn^{2+}, maximum mobility is observed in soils whose pH is ≈7. For Cu^{2+}, mobility in neutral or alkaline soils is lower than that in acidic soils. The basic quantitative indicators of the potential phytotoxicity of galvanic sludge have been determined: germination, energy, friendliness and duration of germination of test plant seeds. It has been shown that the joint effect of Cu^{2+} and Zn^{2+} manifests itself both in the inhibition and stimulation of the growth processes of test plants and is determined, first of all, by the biological specificity of the test culture itself, as well as the properties of soil and the degree of its pollution.

The sequence of studies reported in this work makes it possible to predict the danger of galvanic sludge to the natural environment. It could also be used by environmental and design organizations in agricultural-ecological monitoring.

Keywords: algorithm, industrial waste, galvanic sludge, sanitary and toxicological properties, environmental safety.

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DETERMINING THE INFLUENCE OF THE MEDIUM REACTION AND THE TECHNIQUE OF MAGNETITE MODIFICATION ON THE EFFECTIVENESS OF HEAVY METALS SORPTION (p. 49-54)

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Development of reliable, environmentally safe and economically advantageous methods of water purification from heavy metals is the primary task for environmental protection. The effectiveness of sorption treatment and additional treatment of natural waters from ions of heavy metals with the use of modified magnetite was studied. The samples of magnetite obtained at the ratio of concentrations of iron (II) and iron (III) of 1:2; 1:1 and 2:1 and the samples modified by sodium sulfide were used as a sorbent. Experimental studies revealed that the sorption capacity of magnetite by ions of heavy metals increases at the increase in the ratio $[Fe^{2+}]/[Fe^{3+}]$ from 1:2 to 2:1. The influence of pH of the medium on the effectiveness of sorption of heavy metal ions on magnetite was studied. It was shown that the sorption capacity of magnetite for ions of copper, zinc, nickel and cadmium increases at the increase in pH of the medium from 6.0 to 8.6 due to partial hydrolysis of heavy metal ions. An increase in sorption capacity of magnetite occurs when it is modified by guanidine, thiosemicarbazide and sodium sulfide, which makes it possible to reduce residual concentrations of heavy metals to $\mu g/dm^3$. The use of magnetite modified by sodium sulfite, obtained at K=2, makes it possible to completely remove cadmium ions from water and reduce copper concentration to 1.2 $\mu g/dm^3$. This proves the appropriateness of using these sorbents for additional treatment or deep purification of water from ions of heavy metals. It was shown that it is appropriate to use magnetite for extraction of heavy metal ions from water in the presence of hardness ions, which do not affect the selectivity of this sorbent for ions of heavy metals. Thus, based on the obtained results of sorption purification of water from ions of heavy metals while using magnetite, we proposed a fundamental technological circuit for treatment of wastewater of nuclear power plants at discharge to water bodies.

Keywords: magnetite, heavy metals, sorption capacity, modification, guanidine, thiosemicarbazide, sodium sulfide.

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IMPROVEMENT OF THE METHOD OF CALCULATING A GROUP OF SOUNDINSULATING PANELS (p. 55-60)

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Original single-layer and multilayer structures of sound-insulating panels are considered, as well as their advantages compared to traditional analogs.

The shortcomings of the method of optimization calculation of a group of sound-insulating panels designed to reduce noise in several production rooms are analyzed. This method has limited functionality due to a relatively small number of objective functions and the corresponding conditions for their use. Given this, an improved method of optimization calculation of a group of sound-insulating panels is proposed.

The improvement of the method consists in increasing the number of objective functions intended for multipurpose optimization taking into account real production conditions. The refinement of the algorithm consists in the preliminary selection of a subgroup of panels with additional requirements for operating conditions (increased strength, fire safety, etc.). Under these conditions, the operator directionally distributes structures and materials among the selected panels.

The statement of the optimization problem of group calculation with an extended list of objective functions and restrictions is given. Recommendations on selecting an objective function in specific production conditions are given.

The regulatory requirements for noise reduction in production rooms and spectral characteristics of sound insulation of panels made of various materials are given. The spectral characteristics of noise in the room before and after application of the sound-insulating panel are also given.

The effectiveness of the method is confirmed by the steady reduction of the mathematical expectation and variance of the total noise load on people in production premises with an increase in the number of iterations. The calculation method demonstrated the reduction of excess noise load in comparison with standard methods.

Keywords: optimization of calculation of sound-insulating panels, excess noise load, random search, safety.

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