ABSTRACT AND REFERENCES

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RESEARCH INTO BIOTECHNOLOGICAL PROCESSES OF PLANT SNUTRITION STIMULATION BY THE PRODUCTS OF PHOSPHOGYPSUM DISPOSAL IN GAS CLEANING SYSTEMS (p. 6-14)

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The rational qualitative and quantitative composition of granules of phosphogypsum that is used as the load for the systems of biochemical cleaning of gas emissions was established. The study of the zones of biotransformation of phosphogypsum component with the use of raster microscopy was performed. The biofilm, formed by sulfur oxidizing bacteria on the surface of granules, and elementary sulfur that is metabolite, deposited during oxidation of hydrogen sulfide, were explored. Physical and chemical properties of biosulfur, produced as a result of biochemical gas cleaning of sulfur-containing gas flows in biofilters with the load from phosphogypsum, were determined. We analyzed the models of metabolic pathways of sulfoxydizing bacteria, providing oxidation of sulfur-containing compounds into the forms that are easily accessible for plants using electronic databases, such as KEGG database, MetaCyc and EzTaxon databases. The biochemical mechanisms of transformation of biosulfur when using it in the process of S-nutrition of plants were determined, which will make it possible to dispose of it in agroecosystems. The combined scheme of the ways of bacterial oxidation of sulfide to sulfate was substantiated. The species structure of ecological and trophic groups of microorganisms, involved in oxidation of sulfur, among which hemolithotrophic bacteria of the genus Thiobacillus are dominant, was assessed.

The general technological scheme of the phosphogypsum disposal with the production of biosulfur in the systems of biochemical gas cleaning was developed. Environmental effects from implementation of the proposed technological system were obtained: impurities (hydrogen sulfide, carbon dioxide) were removed from gas emissions; the waste of chemical industry – dump phosphogypsum was disposed of; biosulfur as a product, used to improve S-nutrition in agroecosystems, was produced.

Keywords: biosulfur, phosphogypsum disposal, biochemical gas cleaning, biotransformation of sulfur compounds, S-nutrition of plants.

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A STUDY OF WASTEWATER TREATMENT CONDITIONS FOR THE POULTRY MEAT PROCESSING ENTERPRISE (p. 15-20)

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For the local treatment of wastewater of food industry enterprises, physicochemical treatment methods are widely used, which, with properly selected reagents and their doses, allow achieving high treatment efficiency. At the same time, doses of reagents and conditions for their use can differ sharply between enterprises, therefore the regularities of the treatment process must be studied at a particular drain.

In the paper, the regularities of the process of wastewater coagulation by coagulants and flocculants of different chemical composition are examined on the example of the wastewater of the turkey meat processing enterprise. The regularities of the process of wastewater coagulation in a wide range of pH values of the medium are studied. It is experimentally determined that the optimum pH of the medium for the use of polyaluminum chloride is in the range 5.9÷6.4, iron chloride 6.2÷6.7, iron sulfate 5.1÷5.7. The regularities of the effect of the coagulant dose on the efficiency of suspended solids removal from wastewater and color reduction are established. Based on the data obtained, the most optimum doses of coagulants are determined. The rational dose of polyaluminum chloride was 140 mg/l, iron sulfate – 110 mg/l and iron chloride – 80 mg/l. The regularities of the process of wastewater flocculation with the use of flocculants of different charges and molecular weight are investigated. The most effective types of flocculants are determined, and optimum reagent doses are established. The rational conditions for physicochemical wastewater treatment using coagulants and flocculants are determined. The obtained data make it possible to optimize the operation of local treatment facilities of the poultry processing enterprise: to increase performance, as well as to reduce operating costs. The selected binary combinations of reagents allow achieving the efficiency of suspended solids removal of 99.4 % and color reduction – 82.4 %.

Keywords: wastewater, coagulant, flocculant, reagent dose, physicochemical treatment, suspended solids.

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EXPERIMENTAL STUDY OF TEMPERATURE MODE OF A FIRE IN A CABLE TUNNEL (p. 21-27)

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We established, based on the conducted research into a change in temperature in the cable tunnel during fire, that in the combustion zone the temperature grows faster in comparison with the standard temperature mode of a fire. This indicates the need for testing fire resistance of construction structures of cable tunnels using the temperature regime that differs from the standard one.

During the research, a scientifically-substantiated sequence of procedures was created, with a detailed selection of equipment and test samples, in order to provide reliable experimental data when studying the temperature regime of a fire in a cable tunnel.

Thus, based on the results of our experimental study, we determined the temperature modes of a fire in different zones of the cable tunnel using the proposed procedure. The highest temperature is observed directly in the combustion zone. In the fire zone next to cables, it is 700–900 °C; between a fire center zone and the opening for the discharge of combustion products, it is in the range of 250–500 °C. In the zone between a fire center and the place of air head, the temperature reaches 80–150 °C. The rate of flame propagation, in terms of direction, coincides with the direction of air flow twice as faster as in the opposite direction.

Thus, we can argue that the research results obtained could be the basis for constructing mathematical models that describe fires in cable tunnels and might be used for the engineering estimation of fire resistance of building structures of cable tunnels.

Keywords: cable tunnel, temperature mode of a fire, procedure of experimental research, modeling a fire.

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SUBSTANTIATION OF CHOOSING THE DESIGN OF A REACTORDUST COLLECTOR WITH TWO COLLIDING FLOWS (p. 28-34)

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The objects of this study are the dust collectors for dry gas purification – devices in which hydrodynamic modes are implemented. Advantages of using such devices are: work with gases of high temperature, high degree of purification; regulation of a process of gas purification from dust due to regulation of secondary air consumption. There are no improvements for the theory of operation of apparatuses for the dry purification of a gas flow from dust. It does not provide an opportunity for a reasonable choice of the design of an apparatus and its main characteristics. We consider a design of a dust collector for dry purification of a gas flow, in which a degree of purification of a gas flow from dust reaches 97–98.5 %, regardless of the particle size of a dispersed phase. This fact is a necessary condition for modern industry. We proposed the design of a heterogeneous reactor for a gas-solid system with two colliding flows. We determined specific features of hydrodynamics of a reactor, distribution of stay time in a reactor, and proposed a model of a reactor based on discrete Markov processes. We established experimentally that a degree of purification of a gas-dispersed flow from dust in the proposed reactor can reach 98 %. This is possible because of formation of agglomerates due to intensive interaction between particles that are larger than the particle size at the reactor inlet 3–4 times. We proved that, compared to a suspended layer and hydrodynamic conditions in cyclones and vortex chambers, the proposed reactor has an advantage in terms of energy consumption for overcoming of resistance. This is due to the fact that in these devices spend a large proportion of energy for maintenance of particles in a suspended state, and also for pumping air through internal devices. During operation of the proposed gas-purifying dust collector, we achieved qualitative indicators, which confirm the expediency of the conducted studies and the expediency of choosing a device for dry purification of a gas flow.

Keywords: reactor model, purification efficiency, gas, dust flow, hydraulic resistance.

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CONTROLLING THE PROCESS OF EXPLOSIVE DESTRUCTION OF ROCKS IN ORDER TO MINIMIZE DUST FORMATION AND IMPROVE QUALITY OF ROCK MASS (p. 35-42)

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Based on the adapted model by G. N. Lyakhov, we established a pattern in the propagation of pressure waves during explosive destruction of rocks, which relates to acoustic rigidity of the gap filler between the charge and the wall of the well and its size. It was determined that an increase in the acoustic rigidity of the solution proposed to be uses as a gap filler between the charge and the well reduces the peak of pressure in the zone close to the charge. In addition, the amplitude width of the pressure wave increases. An increase in the magnitude of the gap through the use of charges with smaller diameters enhances the effect of reducing the volume of dust formation. We have established regularities in the propagation of pressure waves related to acoustic rigidity of the gap filler between the charge and the borehole wall, as well as its magnitude, for different types of rocks. Specifically, for basalt, diabase, gabbro, granite, and limestone. It was determined that solutions with larger acoustic rigidity would reduce the amount of dust formation and improve the homogeneity of fractional composition of rock mass. That is possible by reducing the amplitude of pressure waves at the media interface and by increasing the width of the amplitude in any rock. In particular, filling the gap with the aqueous solution of iron (III) sulfate could reduce the amplitude of pressure waves by 20 %. The research results are important as they make it possible to control the process of explosive destruction of rocks. Such a control can be executed by changing the acoustic rigidity of the gap filler between the charge and the well, and by changing its size. Adjusting these parameters would not worsen the explosion results, such as, for example, reducing the consumption of an explosive or decreasing a diameter of the charge. On the contrary, it will ensure a more uniform distribution of pressure waves in rock, thereby reducing not only the environmental load, but the cost of finished products as well.

Keywords: rocks, dust formation process, explosive destruction, re-shredding zone, fractional composition of rock mass.

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EXPERIMENTAL RESEARCH INTO THE PROCESS OF BIOLOGICAL TREATMENT OF WASTEWATER WITH THE USE OF THE MEMBRANE BIOREACTOR (p. 43-51)

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Effectiveness of operation of the membrane bioreactor (MBR) for wastewater treatment with the use of the biological method was considered. The pilot studies were carried out in the test membrane bioreactor, manufactured by company "Alfa Laval" (Denmark). The process of biological treatment of wastewater using the membrane bioreactor makes it possible to intensify the operation of biological treatment plants due to the lack of facilities for settling the sewers, an increase in the dose of active sludge up to 12–13 g/l; the process of deposition is replaced with filtration, washing of membrane modules can be carried out without emptying the tanks and without taking modules out of the tanks. In the process of testing of the membrane bioreactor, based on the module plant, manufactured by company "Alfa Laval" (Denmark) for treatment of domestic wastewater, the treatment mode that meets the requirements for discharge was achieved. Treatment effectiveness by basic indicators was: COD – 93 %, BOD_5 – 99 %, suspended substances – 98.5 %, ammonium nitrogen – 98.5 %. Operation efficiency of MBR as for nitrates amounted to 89 % after adjustment of reagent's dose (40–50 mg/l) and the oxygen dose in the nitrification zone (2–3 mg/l). Efficiency of 98.6 % for phosphates was achieved after the introduction of the reagent aluminum sulfate with the dosage of 40–50 mg/l.

The study conducted has made it possible to obtain the consistent operation mode of the MBR with ensuring effective process of wastewater treatment. Dependences of wastewater treatment efficiency on the MBR as for major contaminants (COD, BOD_5, nitrogen compounds and phosphorus) were shown. This enables meeting the strict requirements for wastewater discharge into water bodies and decreasing the cost value of the treatment through a decrease in power consumption. The mechanism of the MBR operation under conditions of treatment of actual wastewater, which allows determining the conditions of the use of the MBR in the technology of the biological wastewater treatment was studied.

Keywords: biological treatment, membrane bioreactor, microfiltration, nitrogen, phosphorus, nitrification, denitrification, reagent.

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RESEARCH INTO EFFECTIVENESS OF CAVITATION CLEANING OF WASTEWATER OF A FATANDOIL PLANT FROM ORGANIC AND BIOLOGICAL CONTAMINATION IN THE PRESENCE OF VARIOUS GASES (p. 51-58)

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The use of cavitation technologies for the processes of cleaning wastewater from a fat-and-oil plant is one of the promising methods for enhancing water quality indicators. The supply of gases of different nature, such as nitrogen, oxygen, air, the mixture of nitrogen and oxygen in the ratio of 1:1, to the cavitation zone was proposed.

The influence of the nature of bubbled gases both under the influence of the US and without it on the change in chemical oxygen demand and microbial number was studied. Effective constants of the rate of destruction of organic compounds and biological contaminants were calculated. It was found that the highest value of effective constant of the rate of water disinfection from MO ($5.13 \cdot 10^{-4}$ s^{-1}) was achieved at nitrogen bubbling. The highest value of water disinfection under cavitation conditions (99.9 %) was achieved in the atmosphere of nitrogen, and the highest value of degree of destruction of organic compounds of 64.3 % was achieved at the simultaneous influence of the air and the US.

It was determined that the process of destruction of organic contaminants and disinfection of wastewater of the fat-and-oil plant can be described by applying the kinetic equation of the first order. The relative series of influence of the nature of the studied gases on cavitation cleaning of water were established.

It was shown that cleaning wastewater of the fat-and-oil plant during simultaneous bubbling of gases in the cavitation field during destruction of organic compounds is by 5–35.7 % and during water disinfection from MO by 1–90.5 % more effective than the influence of the US alone.

The use of the proposed cavitation technology for cleaning wastewater of the fat-and-oil plant enables complete water disinfection from harmful MO and simultaneous destruction of organic substances. This makes it possible to eliminate the negative impact of harmful substances, contained in wastewater, for protection of the environment and the water basin of Ukraine.

Keywords: wastewater, cavitation, cleaning, nature of gases, organic compounds, microbiological contamination.

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STUDYING THE INFLUENCE OF DESIGN AND OPERATION MODE PARAMETERS ON EFFICIENCY OF THE SYSTEMS OF BIOCHEMICAL PURIFICATION OF EMISSIONS (p. 59-71)

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A procedure for evaluating efficiency of the systems of biological elimination of soluble and insoluble in water harmful gaseous substances as well as dissolved in water contaminants has been devised. The procedure is based on previously developed mathematical models of the corresponding non-stationary bio oxidation processes. Based on the analysis of 27 design versions, real capabilities of biological purification facilities were shown, the effect of design and operation mode parameters on efficiency of the systems of biological destruction of methane, hydrogen sulfide and formaldehyde were assessed. In quantitative terms, the results obtained in numerical experiments indicate the necessity of taking into account variation of the rate of pollutant inflow in the process of vessel filling. It was established that an increase in the facility efficiency in terms of the volume of the gas-air mixture, N, causes a decrease in methane concentration at the bioreactor entry and a reduction of the purification degree to 62 %. An increase in the rate of hydrogen sulfide inflow to the reactor leads to a reduction of the purification degree from 98 to 95 %. An increase in the initial concentration of biomass by a factor of 1.7 causes a decrease in concentration of hydrogen sulfide in water

from 2.5 to 1.1 g/m^3. A significant decrease in the average specific bio oxidative power with an increase in the working space in which the final stage of emission purification from formaldehyde takes place was also observed.

The revealed regularities represent a tool for improving quality of design solutions and increasing effectiveness of bio oxidation modes in operation of the systems of biological gas purification.

Keywords: biological purification of emissions, design and operation mode parameters, bioreactor, purification efficiency.

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