ABSTRACT AND REFERENCES

ECOLOGY

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**ENSURING COMFORT MICROCLIMATE IN THE CLASSROOMS UNDER CONDITION OF THE REQUIRED AIR EXCHANGE (p. 6-14)**

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We performed comparative analysis of regulatory documents, which relate to ventilation of school premises and operate in European countries at present. We showed the essential difference of the recommended air exchange values. We assessed sanitary and hygienic conditions formed in classrooms at different efficiency of a ventilation system both by analytical calculations and by subjective monitoring of microclimate of experimental measurements conducted in school classrooms, when every pupil-participant performed an assessment of the internal environment in the form of a questionnaire. We measured carbonic acid gas contents emitted in a room and determined the required ventilation intensity in the evaluated school premises. We compared the multiplication factor of air exchange of the ventilation system determined in this way with the values obtained by analytical calculations carried out in accordance with current legislation and standards, which are active in Europe. We made calculations based on known analytical dependencies. We determined performance of the ventilation system of the classroom based on $CO_2$ concentrations in internal and inflow air at various values of the multiplication factor of air exchange. It made possible to state that we can achieve the optimal microclimate parameters at air exchange of 30 $m^3/h$ per person.

We presented the results of field studies and analytical calculations in the form of tables and visual graphic dependencies. The proposed research method makes it possible to increase accuracy and reliability of air quality control in classrooms by direct measurement of $CO_2$ concentration in a serviced area of a room. The study results provide an opportunity to improve ventilation systems of school buildings. This creates prerequisites for obtaining a social effect due to an increase in labor and learning efficiency.

**Keywords**: multiplication factor of ventilation, energy saving, carbon dioxide concentration, ventilation efficiency, monitoring of microclimate.

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**METHOD OF AGRICULTURAL SEWAGE WATER PURIFICATION AT TROUGHS AND A BIOSORPTION BIOREACTOR (p. 15-24)**

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We proposed a method for sewage water purification of nitrogen and phosphorus compounds on a disk bioreactor of full displacement. The developed method of sewage water purification on a bioreactor of full displacement is very promising and we can use it for purification of sewage water, which contains a large amount of organic substances. The efficiency of purification of mineral nitrogen reaches 98.9 %, phosphates up to 40–50 %. The total nitrogen content decreases by 4–6 times and the total phosphorus content – by 2–2.5 times. We proposed combined purification of surface runoff from agricultural land and household or industrial sewage water on troughs with filtering nozzles and on a bioreactor of full displacement.

The conducted microbiological studies showed that the process of purification removes nitrogen compounds complexly: as a result of nitrite-denitrification and of the process of anoxide oxidation. We observed transformation of nitrogen mineral compounds under nitrification on the surface of biodisks in presence of oxygen and inside structural elements of biodisks, which is characteristic of anoxide oxidation during ANAMMOX process. Efficiency of purification of sewage water from the territories for agricultural purposes makes up: for suspended substances – 98 %; for mineral nitrogen – 99 %; for CCO – 99 %; for phosphates – 50 %. We can use the scheme of purification on troughs and a bioreactor of full displacement for sewage water of dairy industry, livestock farms, communal services, and surface runoff. Application of the proposed methods of sewage water purification will contribute to improvement of aquatic ecosystems.

**Keywords**: surface runoff, agricultural lands, purification, troughs, disk bioreactor of full displacement.

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**ANALYSIS OF CORRELATION DIMENSIONALITY OF THE STATE OF A GAS MEDIUM AT EARLY IGNITION OF MATERIALS (p. 25-30)**

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We have considered the application of the method of nonlinear dynamic systems in order to analyze and detect the structural patterns in the dynamics of increments in the state of a gas medium generated by early ignitions of materials in a non-sealed chamber. The research method is based on analysis of the correlation dimensionality of increments in the state of a gas medium during ignition of materials. We have theoretically justified the method for evaluating the dynamics of correlation dimensionality of increments in the state of a gas medium at ignition. The considered method for CD evaluation is based on the computation of the Grassberger-Procaccia correlation integral, applied to the gas medium state increments using a sliding window with a fixed width. That allowed us to derive a current estimate of CD increments in the state of the gas medium during ignition of flammable materials in a chamber synchronized with the observation data acquisition rate. We have analyzed the dynamics of correlation dimensionality of increments in the state of a gas medium at early ignition of alcohol, paper, wood, and textiles in a simulation chamber. It was established that for the investigated state of the gas medium during ignition of various examined materials, the dynamics of correlation dimensionality is within 0.1 to 0.6. It is noted that this fact testifies to the fractal structure of the considered increments in the state of a gas medium in a chamber and its chaotic dynamics at the emergence of ignition sites of tested materials. In this case, the fractal structure is not the same, suggesting a "transitional chaos" in the examined state of the gas medium. It was established that current estimates of the correlation dimensionality of increments in the state at the time of materials ignition tend to a sharp increase. A given fact can be used to reliably detect early fires indoors. The results obtained are important for the in-depth studying and understanding of patterns in the structure of dynamics of increments in the state of a gas medium at early ignition. It has been shown the increments in the states of a gas medium at premises characterize it as a chaotic dynamic system with a small fractal dimensionality as opposed to the traditional approach assuming a gas medium being either deterministic or random system.

**Keywords**: correlation dimensionality, increments in the state, gas medium, early ignition.

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**DEVELOPMENT OF TECHNIQUES TO PREDICT AND PREVENT BOTH THE EFFECT OF XENOBIOTICS AND THEIR MIGRATION INTO PIG-DERIVED PRODUCTS (p. 31-49)**

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This paper reports research into the influence of heavy metals, specifically cadmium and plumbum, on the body of young pigs, and the effectiveness of the preparation to prevent intoxication with heavy metals. Heavy metals were fed separately and jointly, in doses that exceed the maximum permissible concentrations in fodder by 10 and 20 times. Thus, we have simulated the process of intoxication of a biological object (pigs) with heavy metals, which could happen as a result of environmental pollution. The study was carried out to determine the direction

and degree of influence of heavy metals on the live weight, the weight of internal organs of animals, the degree of accumulation in pig production, as well as determining the effectiveness of an anti–toxic additive that acts as a heavy metals detoxicant. Statistical processing of the acquired data made it possible to construct mathematical model and to establish the correlation relationship between the studied factors.

It was established that heavy metals exert a significant negative impact on the intensity of growth of animals with an elevated effect in proportion to the dose. This is confirmed by the high correlation connection between these attributes, the correlation coefficient (r) is equal to 0.854. Thus, the live weight of pigs at the end of the experiment both in series I and II under the action of chemotoxicants reduced by 5.5–14.8 % in comparison control. The strength of the impact depended on the toxin itself. Thus, the greatest negative effect was observed under the action of cadmium alone, as well as cadmium and plumbum together. The animals that received, against the background of intoxication with plumbum and cadmium, the antitoxic fodder additive, maintained the intensity of growth at the level of control, while, based on the results of series I, outperformed its indicators. Heavy metals mostly accumulated in the liver and kidneys, with the lowest level in the lungs, heart, and muscles. The constructed regression equations demonstrated that the main influence on the increase in the content of cadmium and plumbum in organs and meat is exerted by a rising dose of the respective element in the fodder. The content of plumbum in fodder affected the content of cadmium in meat, an increase in its concentration led to a decrease in the content of cadmium in meat.

The research data obtained allow better understanding of the direction and the extent of effect of heavy metals on biological objects. Mathematical models could be employed to predict the content of toxins in pig products.

**Keywords**: ecocidal impact, migration of xenobiotics, antitoxic additive, safe pig production.

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## DEVELOPMENT AND STUDY OF HYDROMECHANICAL METHOD FOR CLEANING SEWAGE COLLECTORS FROM CONTAMINATION (p. 40-47)

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In connection with bad state of existing sewer headers, there is a great need for quick and high-quality cleaning for their further operation. To extend service life of distribution systems, new technologies for their repair and recovery are being developed which makes it possible to ensure their stable functioning and as a result, provision of continuous drinking water supply and sewer disposal to improve quality of life for population. From an economic point of view, extension of service life of distribution systems through development of alternative repair technologies is promising as it will ensure their sustainable operation in conditions of limited financing.

The proposed bucket design for cleaning the sewer headers has made it possible to identify the best option when using one design in different conditions.

A new design of the bucket was proposed which enables cleaning of the sewage headers either separately in a purely mechanical way or with additional use of the hydraulic method. Thanks to such combined method, it is possible to eliminate dirt which cannot be qualitatively done separately with each of the existing methods in various technical and economic conditions.

Purposefulness of application of the proposed method for cleaning sewage headers using the bucket of new design providing a combined method of operation was presented and justified. Examples of application of the new method for cleaning the headers using the bucket of new design were given. The obtained indicators confirm quality of the sewage header cleaning when working in various conditions, both technical (diameter, length and type of the header material, degree, and nature of foulness) and economic (work duration, energy, and water costs).

Thanks to the use of this method, 75...85 % dirt elimination in the sewage headers and pipelines have been achieved which confirms its effectiveness and possibility of reducing work duration as well as resource and energy saving in carrying out these works.

**Keywords**: sewage header, sewage pipeline, sewage network, cleaning method, sediment.

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**DEVELOPMENT OF COMBINED METHOD FOR PREDICTING THE PROCESS OF THE OCCURRENCE OF EMERGENCIES OF NATURAL CHARACTER (p. 48-55)**

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We developed a combined method for forecasting of the process of occurrence of emergency situations of a natural character. In contrast with other methods, it makes it possible to perform a complex forecasting of emergency situations, both in general and by types, taking into consideration trends of periodic changes in the process. We considered a number of emergencies for a certain period of time as a generalized parameter of the process. Taking into consideration an influence impact of all destabilizing factors, we should present the process in the form of an additive mixture of systematic, periodic, and random components. The systematic component is a polynomial of some degree. We performed detection and assessment of the periodic component based on the statistical criterion, which subordinates to the chi-square distribution. We used the method of group consideration of arguments to forecast the random component. We should carry out forecasting of emergency situations by type by the probabilistic-statistical method of forecasting.

The need to develop a combined forecasting method appears is due to that the existing methods for forecasting of emergency situations focus mainly on forecasting of certain types of emergency situations. Existing methods do not solve the problem of complex forecasting of emergency situations. We should also note that the presence of periodic components of an arbitrary form is characteristic for the process of occurrence of natural emergencies. Consideration of such components in the forecasting of emergency situations makes analysis of the processes of occurrence and development of emergency situations deeper.

In the process of experimental studies, we found that the use of the combined method makes it possible to perform forecasting of emergency situations at least a year ahead with a relative forecast error of no more than three percent.

The combined method combines the regression analysis method, the method of verification of statistical hypotheses and the method of group consideration of argument. This proves usefulness and expedience of the method. That makes it possible to compensate disadvantages of some methods using other methods, which would lead to the improvement of forecast accuracy.

**Keywords**: emergency, generalized parameter, method of group consideration of arguments, method of verification of statistical hypotheses, regression analysis.

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**DEVELOPMENT OF PROCEDURE FOR ASSESSING THE DEGREE OF ENVIROMENTAL HAZARD FROM THE SOURCES OF AQUATIC ENVIRONMENT POLLUTION (p. 56-65)**

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The new procedure for evaluation of the degree of environmental safety of water sites based on the comparison of the influence of separate point sources of sewage discharge was developed. The use of this procedure will make it possible to solve the problem of identifying ecologically dangerous sites and to determine priority directions of aquatic sites protection in the region. The essence of this procedure is to assess the environmental hazard of specific facilities of the national economy taking into account the safety level, the degree of influence on the water quality of an aquatic site, effectiveness of monitoring and the magnitude of anthropogenic load.

The logical-mathematical model of evaluating the impact of sources of water environment pollution, based on determining the coefficients of conditions of sewage discharge, sewage pollution and the load on an aquatic site, was proposed. The degree of environmental hazard of the sources of pollution of aquatic sites was determined by the value of coefficient of harmful influence of a pollution source on aquatic sites by the five-level scale from "safe" to "extremely hazardous". The designed scale corresponds to the environmental classification of the Water Framework Directive of the EU 2000/60/EU.

Testing of the developed procedure was performed on an example of the section of a river basin that is typical for territorial production complexes, where the facilities of nuclear power industry, industrial manufacturing and public utilities are located. Based on determining block and total coefficient of harmful influence of the sources of pollution of aquatic sites, we developed the map of ecological hazard of the sources of the river basin pollution. The sources of pollution of aquatic sites were classified by the designed scale. It was established that large enterprises of housing and communal services and the facilities of machine-building industry have the greatest degree of environmental hazard. These facilities belong to class II and are described as "hazardous'. Enterprises of atomic power and hydropower plants belong to class III of hazard – "moderately hazardous".

Results of the analysis can be used to develop water resources management strategies and measures to reduce the impact of pollution sources on aquatic sites.

**Keywords**: environmental safety, pollution source, harmful influence, load on aquatic site.

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## CURRENT DISTRIBUTION OF $^{137}$Cs IN SOD-PODZOLIC SOILS OF DIFFERENT TYPES OF FOREST CONDITIONS (p. 65-71)

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We have examined the current distribution of $^{137}$Cs in the turf-podzolic forest soils for different types of forest conditions. The analysis of the redistribution of $^{137}$Cs in soil in 30 years after the Chernobyl nuclear plant accident is necessary in order to assess the intake of the radionuclide by the various components of forest ecosystems and to substantiate the rehabilitation of forest areas. We have discovered a significant displacement of significant amount of $^{137}$Cs to mineral part of the soil in all types of forest conditions under consideration. The maximum magnitudes of the $^{137}$Cs specific activity in the forest litter were established, as well as a reduction in this indicator from its upper part (current litter) to the bottom (decomposed). In fresh forests, it reduced by 3.1 times; in fresh subors, by 1.2 times; in wet subors, by 1.5 times. Based on the magnitude of specific activity of $^{137}$Cs, the layers of the forest litter for the examined types of forest conditions can be placed in a descending order: decomposed layer > semi-decomposed layer > current litter. The humus-eluvial horizon of the soil with a capacity of 12 cm has concentrated: in fresh forests, 54.0 %; in fresh subors, 40.0 %; in wet subors, 52.8 %, of the total radionuclide activity in the soil, and, together with the content of $^{137}$Cs in the forest litter, 75.0 %; 65.8 %, and 71.5 % (according to the type of forest conditions). We have noted a gradual decrease in the$^{137}$Cs specific activity along the profile to the parent rock. Thus, 26.4 %, 35.7 %, and 28.5 %, respectively, of the total stock of the radionuclide in the soil, have migrated to the lower layers of the soil profile (12–88 cm). The obtained materials have been confirmed by a one-factor dispersion analysis at a 95-% confidence level. Based on the results obtained, one can predict the future levels of radioactive contamination in forestry products.

**Keywords**: $^{137}$Cs, radioactive contamination, specific activity, forest plantations, sod-podzolic soils.

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