THE DYNAMIC MODEL OF THE FORECASTING THE POLLUTANTS ACCUMULATION IN SOILS

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The principles of the mathematical simulation based on the experimental data for forecasting the accumulation of the pollutants in soils are described. Such data is necessary for the evaluation of the ecosystem load.

Keywords: ecosystems, pollution, computerized simulation, accumulation, differential equations.

The critical load is defined as "a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge". Now it is one of the most important ecological problems. It can be proved by the fact that UNESCO founded special organization called Coordination Centre for Effects (CCE) to explore this problem. Despite of importance of a critical load problem, it is not explored in Belarus.

The mathematical dynamic model for contaminant deposition in a soil based on experimental data is represented in the article.

Contaminants are deposed in soil via two ways. One is an income of pollutants from external sources, another one is an uptake of contaminants via physical, chemical and biological processes. It is assumed that pollutants enter the soil with gravity precipitation, climate precipitation and background income. Background income includes processes that are difficult to consider separately. For example contaminant income with leaves and other biomaterial, that strongly depends on plant species, or chemical processes in soils and others. General equation for pollutant income is:

$$\frac{dC_{N,\ inc}}{dt} = \alpha_{pre} C_{N,pre} + \alpha_{grav} C_{N,atm} + C_{back,\ inc}, \tag{1}$$

where $C_{N,inc}$ – contaminant income in soil; α_{pre}– coefficient that determines income rates of contaminant via atmosphere precipitation ; $C_{N,pre}$ – contaminant concentration in atmosphere precipitation; α_{grav} – coefficient that determines income rates of contaminant via atmosphere precipitation; $C_{N,atm}$ – contaminant concentration in an atmosphere; $C_{back,inc}$ – background contaminant income in soil.

Uptake of contaminants is determined by next processes: leaching from soil, evaporation and backdrop pollutants uptake. These processes can be written by the next equation:

$$\frac{dC_{N,\ upt}}{dt} = -\left(\alpha_{le}(C_N - C_{N,pre}\right) + \alpha_{evap}\left(C_N - C_{N,atm}\right) + C_{back,\ upt}), \tag{2}$$

where $C_{N,upt}$ – contaminant output from soil; α_{le} – coefficient that determines leeching rates (for average annual precipitation and evaporation); C_N – contaminant concentration in soil; $\alpha_{исп}$ – evaporation coefficient (for average annual evaporation rates); $C_{back,output}$ – background contaminant output from soil.

Total contaminant change can be determined as difference between contaminant input and output:

$$\frac{dC_N}{dt} = \alpha_{pre} C_{N,pre} + \alpha_{grav} C_{N,atm} + C_{back,input} - \alpha_{le}(C_N - C_{N,pre}) + \alpha_{evap}\left(C_N - C_{N,atm}\right) + C_{back,\ output}, \tag{3}$$

This equation can be transformed to the next one by grouping respective concentrations:

$$\frac{dC_N}{dt} = \alpha_N C_N + \alpha_{ос} C_{N,ос} + \alpha_{возд} C_{N,возд} + C_{фон}, \tag{4}$$

where α_N, α_{pre}, α_{atm}, C_{back} – are generalized coefficient, that determines the rates of contaminant concentration change in soil and contaminant concentration change in atmosphere and background contaminant concentration change.

Given equation (4) is a linear differential equation of a first order, that has the next solution:

$$C_N(t) = C[1]e^{t\cdot\alpha_N} - \frac{\alpha_{ос} C_{N,ос} + \alpha_{возд} C_{N,возд} + C_{фон}}{\alpha_N} = C[1]e^{t\cdot\alpha_N} + \alpha^*_{ос} C_{N,ос} + \alpha^*_{воздз} C_{N,возд} + C^*_{фон}, \tag{5}$$

where C_N – contaminant concentration in soil at time t; C[1] – coefficient, determined by boundary conditions.

The last equation can be used to calculate contaminant concentration in soil depending on time and contaminant concentration in air, as well as to determine background change of pollutant in the ecosystem using experimental data.

There are five different coefficients in the equation (5). They can be calculated using experimental data from five different years. National environmental monitoring system gives necessary data to use the equation (5) to simulate the critical load.

ECOLOGICAL ASPECTS OF RATIONAL USE OF RAW MATERIALS OF THE FACTORY "STROYFARFOR" JSC "KERAMIN"

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The factory "Stroyfarfor" JSC "Keramin" is specialized in the production of sanitary ceramic products. A significant part of the raw materials used in production are imported from outside the Republic: The Ukraine, Russia, etc. Waste water generated in the production, represent a multi-component, resistant to segmentation of the slurry, the treatment efficiency does not exceed 60 %, which allows the reuse. The formed sediment containing a significant amount of valuable raw materials is shipped and transported to landfills. Separate discharge and treatment of qualitatively different wastewater will reduce the share of waste to reduce the environmental tax for the disposal of precipitation in landfills, and therefore reduce the cost of production.

Keywords: plant "Stroyfarfor", clay materials, zircon concentrate, kaolin, slip, glazes, waste water, precipitation JSC "Keramin" unites three divisions: manufacture of ceramic tiles; the factory "Stroyfarfor"; Minsk ceramic factory.

The factory "Stroyfarfor" was organized in 1985 on the basis of pilot production of sanitary ceramic and by the end of the year produced 73 thousand sanitary ceramic ware – toilets, sinks, flushing cisterns. Currently the plant produces over 1,8 million products per year.

The main raw materials used in production are: raw materials are clay, alumina, kaolin, emaciated materials (sand, feldspar, pegmatite, and gypsum), zircon, nepheline and datolite concentrates, dyes, other chemical products and ancillary materials. A significant part of the raw materials used in the manufacture of products and imported from outside the Republic of Belarus, does not contain refractory clays, feldspars and kaolins. In the total volume of purchased raw material resources, the share of the Ukraine accounted for over 60 %, Russia – more than 30 % and 5 % – Belarusian raw materials. Imports are purchased for a small share of high-quality dyes and auxiliary materials. Thus, the main supply of high-quality clay, kaolin, zircon concentrate (used in production of glazes and enamels, providing product desired thermal and chemical resistance, abrasion resistance and gloss) are made from oil fields in the Ukraine.

For the production of sanitary ceramics two kinds of technology are used: with the use of plaster molds and machines for pressure casting in polymer form. Mechanized stands casting in plaster molds is the traditional equipment for the production of sanitary ceramics. Automated test benches pressure casting in polymer form (Italian SACMI equipment) installed in 2009 are the latest achievement in the production of sanitary ware, which allows to reduce the production time significantly and to improve the quality of the product. In addition, the company has introduced automatic glazing installation robot spraying (manufactured by SACMI). This equipment allows to cover the entire surface with the glaze evenly and ensures the high whiteness of products.

JSC "Keramin" pays great attention not only to the introduction of new innovative technologies, but also to the protection of the environment. There is the reverse system of water supply and sewage water. With the exception of the wastewater of "Stroyfarfor", the cleaning efficiency does not exceed 60 %, which allows it to be reused. Wastewater represent a multi-component, resistant to segmentation of a suspension. It contains particles of quartz sand with a size of 50–100 microns, the particles of kaolin with a size of about 10 microns, and colloidal suspended matter, which represents the remains of a Frit with a particle size of less than 0,1 microns. The sediment containing a significant amount of valuable raw materials is shipped and transported to landfills.

The technological process of production of sanitary products can be divided into the following stages: preparation of the slip, glaze preparation, casting on the mechanized stands, injection moulding, enrobing products and their firing. It is possible to distinguish three types of wastewater of fundamentally different composition. The first is wastewater generated after washing of the mixer for the preparation of the slip and mechanized forms that contain relatively inexpensive components. The second wastewater is generated after washing of the mixer for preparation