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METHODS OF DETERMINING POLYAROMATIC HYDROCARBONS IN THE ENVIRONMENT

МЕТОДИ ВИЗНАЧЕННЯ ПОЛІАРОМАТИЧНИХ ВУГЛЕВОДНІВ У НАВКОЛИШНЬОМУ СЕРЕДОВИЩІ

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Polyaromatic hydrocarbons (PAH) are a large class of organic compounds characterized by the presence in the chemical structure of two or more condensed benzene rings forming different configurations. Currently, hundreds of compounds of this class are known, which differ among themselves in the number and placement of benzene rings [1, p. 35].

The vast majority of PAHs show not only a general toxic effect, but are also carcinogens, mutagens and teratogens. They are mainly products of fossil fuel combustion of car exhausts, enter the environment as a result of oil spills, and are formed during cooking [2, p.1743]. The concentration of PAHs in the soil varies greatly depending on how actively the territories are exposed to anthropogenic influence and is higher in those regions where the population is larger and large industrial facilities are located [3, p. 161–178]. In the vicinity of industrial zones or along highways, pollution of vegetation with polyaromatic hydrocarbons can be tens times higher than in rural areas. Food processing (drying, smoking) and cooking at high temperatures (grilling, baking, frying) are the main sources that generate PAHs [2, p. 1743]. An increase in the concentration of PAH in the soil can negatively affect the growth and development of certain types of plants, thus reducing its fertility [4, p. 113492] Their toxic effect can cause various disturbances in the development of aquatic organisms in reservoirs polluted by them, where PAHs settle and accumulate at the bottom of reservoirs [5, p. 1363].

The US Environmental Protection Agency (EPA) has identified 16 PAH as priority pollutants from the point of view of their toxicity [6, p. 69514–69517]. This list became the basis for the development of analytical methods for the determination of PAH in food products and the environment. The most toxic compound on this list is benzo(a)pyrene. The maximum allowable concentration of benzo(a)pyrene for soil in Ukraine is 0.02 mg/kg [7, p. 2].

There are many different methods of sample preparation, depending on which samples to extract PAHs from, and different chromatography methods, each with its own advantages and disadvantages. Among them: liquid chromatography (HPLC-FLD; HPLC-DAD, HPLC-MS/MS), gas chromatography (GC-FID, GC-MS, GC-MS/MS). Electrochemical sensors and optical sensors based on SERS (Surface-enhanced Raman spectroscopy) are also used, designed to detect PAHs [8, p. 494–522].

In order to effectively isolate the mixture of PAHs from the studied sample, it is necessary to make it suitable for analysis using liquid or gas chromatography methods, to clean it from compounds in the sample that distort their detection and measurement of their concentrations (matrix effect) Extraction methods, such as the Soxhlet method, are suitable for this but require the use of large volumes of solvent and long extraction times. Standard purification methods, using GPC and silica gel, require large amounts of reagents, solvents, and materials. The QuEChERS method was developed to provide a fast, inexpensive and rapid method for the analysis of pesticide residues in fruits and vegetables [9, p. 412–431] and it is also suitable for the extraction of PAHs from soil and plants with a small lipid content. Acetonitrile was used as the extraction solvent in QuEChERS.

To determine PAHs in water, the standard method EN ISO 17993 [10, p. 1–20] is most often used. Although many other modern effective methods of PAHs extraction from water are used based on various methods of solid-phase extraction, its modifications and increased efficiency using nanotechnology [11, p. 2806–2812].

There are many methods for determining PAHs in aerosols in order to assess their contamination. Particle samples are collected with the help of quartz fiber filters, cellulose nitrate membranes, or with the help of special devices that work on the principle of a cyclone-type dust collector [12, p. 2].

To determine the content of PAHs in soil and water samples, the method of high-performance liquid chromatography with fluorescence detection (HPLC-FLD) or diode-matrix detector (HPLC-DAD) is most often used. Each of these two methods has its own advantages and disadvantages. HPLC-FLD allows the determination of PAH content below 1 μg/kg for individual PAHs and is more sensitive compared to the HPLC-DAD method, although of the 16 PAHs recommended for determination by the EPA, the sensitivity of the fluorescent detector to acetanaphthylene is low and is best determined by HPLC-DAD [13, p. 2].

Modern methods of assessing changes in ecosystems with the help of machine learning algorithms are becoming quite popular, which make it possible to estimate and predict with a certain probability the dynamics of the distribution of these substances in the studied ecosystems [14, p. 149509].

To determine polyaromatic hydrocarbons in the environment and to assess the pollution of ecosystems, there is a wide range of methods for their detection, each of which can be useful depending on how convenient it can be in specific laboratory conditions. The methods of extraction PAHs from samples of soil, water, living organisms, and other objects of ecosystems are constantly being improved in the direction of their simplification, cheapness, and increased efficiency, therefore, at present, there is a huge number of new methods and their modifications. With the development of data analysis methods using machine learning algorithms, opportunities for more effective modeling and prediction of changes in ecosystems appear.

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OPTIMIZATION OF DRINKING WATER QUALITY ASSESSMENT USING CORRELATION ANALYSIS

ОПТИМІЗАЦІЯ ОЦІНКИ ЯКОСТІ ПИТНОЇ ВОДИ ЗА ДОПОМОГОЮ КОРЕЛЯЦІЙНОГО АНАЛІЗУ

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Introduction

In today's world, the issue of water resources is becoming increasingly relevant, as growing water consumption in industry, agriculture, and households leads to a significant reduction in the amount of fresh water available for use. The pollution of water sources by chemicals, heavy metals, and other toxic elements poses a threat to public health and ecosystems as a whole. This problem is especially acute in countries with developed industries or intensive agriculture, such as Ukraine, where a significant portion of water resources do not meet sanitary and hygienic standards.

According to recent data, about 70 % of Ukraine's water resources show some deviations from the established water quality standards. The situation is particularly critical in the southern and eastern regions, such as Mykolaiv