ADSORPTION PURIFICATION OF NATURAL WATERS FROM HEAVY METAL IONS

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Water is an essential life component of all organisms. Human health by 70% depends on the quality and safety of water and is in direct relation with the composition of natural waters in the sources from which regular water supply is carried out. The ecological situation in Ukraine requires a scientific approach to the use of natural drinking water [1, 2].

In order to ensure the integrity of organism functioning, it is necessary to consume drinking water, which according to organoleptic properties, chemical and microbiological composition, radiological indices meets the state standards and sanitary legislation in accordance with DSanPiN 2.2.4-171-10 [3].

Water of natural sources is a complex disperse system containing a lot of various mineral elements, organic and inorganic substances, the composition and ratio of which are determined by the conditions of its formation. The quality and safety of water are defined by a complex of chemical, physical-chemical, biological components and physical properties that determine water suitability for certain uses [4].

Today, the population of Kyiv has become a popular use in the everyday life of water from the pump-rooms. Firstly, it is not decontaminated by chlorine like tap water. Secondly, pump-room water comes from an artesian well. The artesian water supply system in Kyiv exploits the wells of two aquifers: the Cenoman-Kelovian and the Middle Jurassic. Water from these aquifers is drawn by pumps from a depth of 180 to 360 m. At the same time, there is a centralized water supply system in Kyiv. Water distribution points from artesian wells directly to pump-rooms are constructed for each district.

Production control of the quality indicators of pump-rooms water is carried out by the bodies of the State Service of Ukraine for Food Safety and Consumer Protection in accordance with Article 44 of the Law of Ukraine “On Drinking Water, Drinking Water Supply and Drainage”.

The aim of the work is to determine the safety of water from 18 pump-rooms of the Desniansky district of Kyiv based on iron(III) ions, adsorption purification of pump-rooms water from excess of Fe^{3+} ions.

The experiments were carried out in the laboratories of the Department of Commodity Science, Safety and Quality Management, Kyiv National University of Trade and Economics at room temperature.

Iron is a heavy metal, one of the main elements of natural water, where it can be in the form of two- and trivalent ions, colloids of organic and inorganic origin, such as $Fe(OH)_3$, FeS, $Fe(OH)_2$, complex compounds of humates and fulvic acids, as well as in the form of a fine dispersion suspension. Iron(II) hydrocarbonate, which is stable only in large amounts of carbon dioxide and the absence of dissolved oxygen, is the preferred form of the existence of iron compounds in underground waters. With pH increasing and the appearance of oxygen or other oxidants in water, hydrolysis occurs and $Fe(HCO_3)_2$ passes into a low-soluble $Fe(OH)_2$. A number of intermediate

compounds are formed and non-dissociative molecules and ions are present in natural water as $Fe(HCO_3)_2$, $Fe(OH)_2$, Fe^{2+}, $Fe(OH)^+$. Then oxidation of iron(II) hydroxide to iron(III) hydroxide occurs. At the same time there are intermediate compounds such as $Fe(OH)_2^+$ and $Fe(OH)^{2+}$. This process flows in the natural environment with the participation of microorganisms.

According to DSanPiN 2.2.4-171-10 [3] norms of iron(III) ions should be no more than 0.2 mg/dm^3 in drinking water from pump-rooms. The high content concentration of Fe^{3+} ions in drinking water gives it a rusty color and a metallic flavor. Iron compounds are deposited in organs and tissues, which in turn, can lead to disfunction of the mucous coat of stomach.

Sorption methods of water purification of natural sources are topical today among other methods. It is known that sorbent has the ability to interact with sorbate through adsorption, absorption, ion exchange and complex formation. Adsorbents, absorbents, ion exchange materials and complex formers are means of purification of natural water. The most accessible sorbent for purification of drinking water is activated carbon. At the same time, water purification from iron ions by various methods has become widespread.

The spectrophotometric determination of iron(III) ions in samples of pump-rooms water and adsorption purification by means of activated carbon from surplus Fe^{3+} ions are carried out. The experiments have been made on spectrophotometer Specord 210 of Analytik Jena at wavelength of 510 nm.

The first series of experiments was performed on the model solutions of $NH_4Fe(SO_4)_2 \cdot 12H_2O$ with concentrations of 4.0; 8.0; 12.0; 16.0; 20.0 mg/dm^3 Fe^{3+}.

The obtained results were presented as adsorption isotherms of Langmuir and Freundlich. Isotherms adsorption constants were calculated. It was shown that with increasing concentration of iron(III) ions in model water solutions, the adsorption of Fe^{3+} on activated carbon increases.

At the maximum concentration of iron(III) ions – 20 mg/dm^3, the adsorption on activated carbon is 65.48 mg/g, which is 2.5 times higher than with the use of modified coal from waste processing of agricultural raw materials.

The optimal adsorption parameters have been established: the ratio of adsorbent and adsorbate, adsorption time, experimental temperature.

After application of adsorption purification method on the model solutions, adsorption was carried out on activated carbon of 18 samples of pump-rooms water and removal of surplus Fe^{3+}.

The results of the experiment show that only one third of water samples from the pump-rooms do not exceed the standard on iron(III) ions content. This situation is probably connected with outdated metal water pipes.

In all samples of pump-rooms water after adsorption, the content of iron(III) ions decreased and does not exceed the norm of 0.2 mg/dm^3. Adsorption of Fe^{3+} ions increases with increasing initial concentration in pump-rooms water. It was shown that after cleaning under the adsorption method on activated carbon all samples of pump-rooms water are safe on the Fe^{3+} ions content.

Thus, this method of adsorption purification on activated carbon for the removal of surplus iron(III) ions from pump-rooms water may guarantee its safety by this index. The results of the study indicate an alternative to the use of this technology for the purification other samples of drinking water.

References

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