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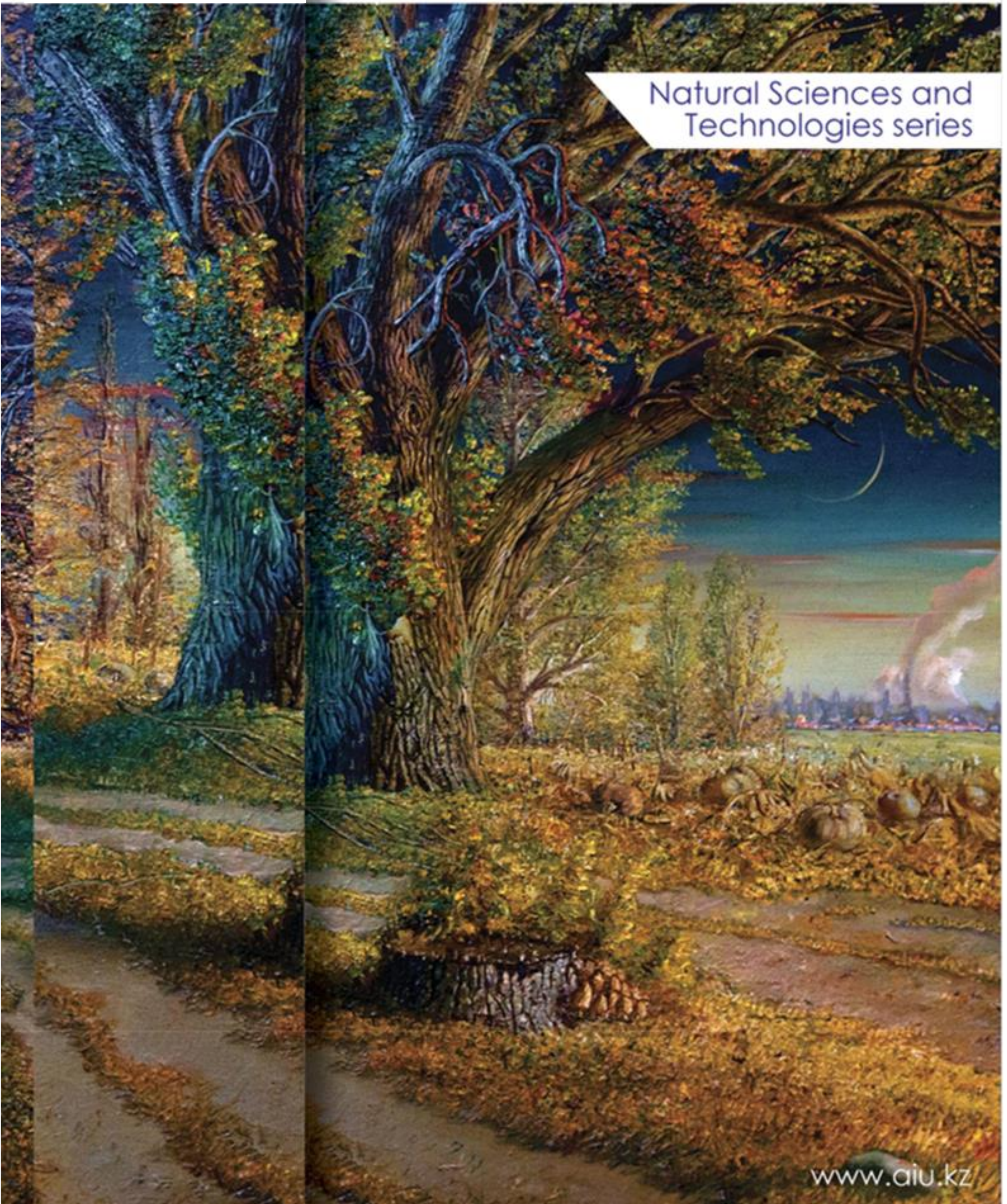

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CONTENT

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ABOUT THE CHOICE OF DRINKING WATER PURIFICATION METHODS

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Abstract: This article highlights the problem of providing the population of Kazakhstan with drinking water of standard quality, which is one of the main and determining factors for the successful implementation of economic reforms and strengthening their social orientation. To solve this problem, various methods of drinking water purification have been developed and implemented, methods of drinking water purification are considered in the article, and their analysis is made. Mechanical, biological, physico-chemical methods of purification are considered. The article presents the advantages and disadvantages of the methods

Keywords: water, water purification method, mechanical purification, biological purification, chemical methods, zeolite

There have been many methods of water treatment and purification developed. There are numerous reasons for contaminating drinking water [1]. However, all of them are somehow related to water sources. Each type of water source has its own characteristic reasons for water pollution. The solution to problems related to water pollution is its purification. Currently, there are a number of water treatment methods and purification methods that allow high-quality drinking water to be obtained from almost any source.

Methods of purification, despite their diversity, are divided into three groups: mechanical, physico-chemical, and biological [2].

Mechanical purification is used to separate solid and suspended substances. Water purification from solid coarse-dispersed substances depending on their properties, concentration, and fractional composition is carried out by methods of sieving, settling, and filtering [3]. Settlement and filtration are the most widely used methods for water treatment.

The settling process is based on the fact that at low water flow rates, suspended particles in the water settle to the bottom under the influence of gravity. Water sources are characterized by different contents of suspended particles in the water, and therefore the duration of settling will vary [2,4]. The disadvantage of this method is that solid suspended substances settle to the sediment, while dissolved chemical substances remain in the water.

Filtration is carried out through porous or unbound materials. Filters purify water from fine-dispersed impurities [2-4,7]. Water purification through filtration is used for various purposes. For purifying water supplied from public water supply networks, fine filtration is used with the use of: backwash filters (this type of filters are mesh filters, where purification occurs by depositing mechanical impurities on the filter mesh and during backwashing, they are washed away with drain water) or cartridge filters (this type of filters are a vessel with a replaceable filtering element - cartridge, which is replaced with a new filtering element after its service life ends). Meshes and cartridges with a filtration degree ranging from 5 microns to 1 mm are used as purification elements, depending on the level of contamination. Rapid pressure filters are most widely used in water preparation techniques from individual underground or surface water sources. Depending on the filtration purposes, quartz sand, anthracite, dolomite are used as filtering materials.

Water filtration through sand frees it from suspended impurities and partially reduces its bacterial contamination. Mechanical methods are used as preliminary stages and are intended for preparing water for biological or physico-chemical purification methods.

Biological purification is a technological process based on the ability of biological organisms (reducers) to decompose pollutants. Disinfection of purified water is carried out to completely destroy remaining pathogenic bacteria. Water disinfection is carried out using various methods: chlorination, ozonation, with hydrogen peroxide, ultraviolet radiation, ultrasound, pulsed electric discharge, silvering, boiling, and others. Chlorine and chlorine-containing substances are most commonly used in water treatment practice. Mechanical methods of water disinfection include boiling water and filtering it through porous materials: unglazed porcelain (Pasteur, Chamberlain filters), infusorial earth (Berkefeld), diatomaceous earth filter, asbestos-cellulose plates and membranes [6,7,8,11].

Physical methods of water disinfection include the use of ultraviolet radiation, ultrasound, ultrashort waves, and ionizing radiation. These methods have not yet found wide application in the practice of communal water supply due to a number of drawbacks (low efficiency, uneconomical, low productivity, etc.).

Chemical methods of water disinfection include the use of heavy metal salts, silver ions, iodine, bromine, as well as hydrogen peroxide [11].

The most common water disinfection process is chlorination. However, the modern level of pollution of natural waters, especially with organic impurities, limits the use of chlorine for disinfecting drinking water due to the formation of chloroorganic compounds. A significant disadvantage is that chlorine does not remove pollutants from water, but only converts them into other compounds.

The most common methods of purification are physico-chemical purification methods. These methods are used to purify water from dissolved impurities, and in some cases from suspended solids.

Currently, with the use of recycling water supply systems, the use of physico-chemical methods of purification of drinking water is significantly increasing, the main ones being: flotation, coagulation, flocculation, hyperfiltration (reverse osmosis), ion exchange purification, sorption.

Clarification and decolorization of water by flotation is used when treating water with turbidity up to 150-200 mg/l and color up to 200 degrees, containing plankton. The separation of suspended matter occurs using gas bubbles obtained from a supersaturated water-air solution. The principle of the method is that part of the water, in which air is dissolved under pressure, is distributed in the rest of the treated water. When entering the zone of lower pressure, the smallest bubbles of air are released from the water saturated with air, necessary for the flotation of light suspended matter. The pressure-induced flotation method allows for easy adjustment of the amount of dissolved air and the size of bubbles introduced into the treated water, depending on the composition of the mixture in the original water. Flotation units used in water treatment technology are quite complex devices and serve to separate two- and three-phase systems, that is, they are labor-intensive and require high energy costs [7-9].

In order to accelerate the sedimentation process, reduce color, increase filtration rate, and separate fine dispersed suspended particles and colloids in drinking water, they are treated with coagulants [10].

Coagulants are predominantly used in the form of aluminum and iron salts. The hydrolysis of these salts leads to the formation of hydroxides. Since colloidal particles in water have a negative charge, while aluminum and iron hydroxide particles have a positive charge, when these particles interact with the coagulant, the charge on the surface of the particles decreases and they agglomerate to form flocs, i.e. they undergo coagulation. The efficiency of coagulation is increased by mixing the liquid (in mixers, flocculation chambers), as this increases the probability of collision and subsequent interaction between oppositely charged particles. At low temperatures, high color, and low turbidity of the water being treated, flocculation proceeds very slowly, resulting in small-sized flocs that do not settle in sedimentation tanks. In such cases, pre-chlorination is effective, as well as the addition of flocculants to the water, which promote the agglomeration and settling of suspended solids. High molecular weight organic and inorganic substances that are soluble in water are used as flocculants. The most commonly used are polyacrylamide and activated silicon, as well as alginates, starch, and some types of clays. Currently, the production of coagulants and flocculants in

Kazakhstan is almost non-existent, and the deficit is covered by the import of Russian products of rather low quality. Ion exchange water purification is used for desalination and removal of metal ions and other impurities from water. The essence of ion exchange lies in the ability of ion exchange materials to capture electrolyte ions from solutions in exchange for an equivalent amount of ions of the ionite. Water purification is carried out with ionites - synthetic ion exchange resins made in the form of granules ranging in size from 0.2 to 2 mm. Ionites are made from water-insoluble polymer substances with a mobile ion (cation or anion) on their surface, which, under certain conditions, reacts with ions of the same sign contained in the water. Strong and weak acid cationites (in H+ or Na+ form) and strong and weak base anionites (in OH- or salt form) are distinguished, as well as ionites with mixed action. The fundamental factor in the process kinetics is the rate of ion exchange between water ions and the resin particle being washed. Ion exchange resins have the ability to be regenerated. After the exhaustion of the working exchange capacity of the ionite, it loses the ability to exchange ions and must be regenerated. Regeneration is carried out with saturated solutions, the selection of which depends on the type of ion exchange resin. The regeneration processes usually take place automatically. Regeneration typically takes about 2 hours, with about 10-15 minutes for rinsing, 25-40 minutes for filtering the regenerating solution, and 30-60 minutes for washing. Ion exchange purification is implemented by sequentially filtering water through cationites and anionites.

The method described in the article requires concentrated acids, alkalis, and other reagents, as well as a complex of measures for filtrate purification. This method cannot be considered universal, as purification (replacement with H+ or OH-) is provided not for all ingredients, but only selective ones, while the composition of drinking water in different regions varies significantly.

Sorption is one of the most effective methods of deep water purification. The efficiency of sorption is primarily due to the fact that sorbents are capable of extracting many organic substances from water, including biologically persistent ones that cannot be removed by other methods. By using highly active sorbents, water can be purified from pollutants (sorbates) to practically zero residual concentrations. Finally, sorbents can extract substances from water at any concentrations, including very low ones, when other purification methods are ineffective. Historically, the use of sorbents is associated with microporous carbon materials - activated carbons. Currently, activated carbon is used for sorption of impurities from aqueous solutions in granular, powdered form, or in the form of carbon fibers [16,17].

However, non-carbonaceous sorbents of natural and artificial origin such as zeolites, clinoptilolites, and aluminosilicates are increasingly being used [18]. Zeolites have a fairly high sorption capacity, cation exchange properties, relatively low cost, and availability, especially in cases where deposits are close to industrial enterprises that can use these sorbents [19].

The characteristics of zeolites are presented in Table 1[20].

Table 1 - Characteristics of natural zeolites

Names of minerals	Channels in a hydrated structure			Density, g/cm^3	Hardness	Cation exchange capacity, mEq/l
	Directions	n - number of tetrahedra	Cross section, nm			
Clinoptilol-lit	(100) (001) (001)	8 10 8	0,40x0,55 0,44x0,72 0,41x0,42	2,16	3,5-4	56-63
Mordenite	(001) (010)	12 8	0,67x070 0,37x0,48	2,13	3-4	45
Phillipsite	(100) (010) (001)	8 8 8	0,42x0,44 0,28x0,48 0,33	2,12-2,24	4-4,5	24
Shabazite	(001)	8	0,36x0,37	2,05-	4,5	100
Erionite	(001)	8	0,36x0,52	2,02	-	92

Based on the data in Table 1, it can be concluded that zeolites have a high cation exchange capacity, allowing them to be used as sorbent materials.

Thus, the advantages of sorption purification methods include relative ease of use, relative low cost, and a wide range of xenobiotics removed. Additionally, zeolites can be subjected to additional treatment and modification.

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