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Research Article

Study of the Problem of Preparation of Drinking Water from the Reservoir

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Annotation

The article covers the methods of water ozonation at the initial stage of natural water purification. The quality of drinking water after chlorination and the advantages of preliminary ozonation at the initial stage of natural water purification have been studied, and the formation of volatile halogenated compounds in the process of preparing drinking water using chlorine is considered. Methods of water disinfection, preventing the formation of volatile halogenated compounds, have been studied. A water purification technology has been developed that allows obtaining drinking-quality water from the reservoir with the removal of hydrobionts, organic substances, prevents the formation of volatile halogenated compounds, significantly increases the sanitary-hygienic and consumer properties of drinking water.

Key words: *ozone, chlorine, carcinogenic substances, volatile halogen-containing compounds, trihalomethanes, volatile halogenated compounds, chloroform, adsorption, coagulation, preliminary ammonization, aeration, reservoir*

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Introduction

In recent years, many scientific research institutes working in the field of water purification, have developed new technological processes and methods for treating drinking water, ensuring the production of water with a high degree of sanitary reliability. One of the methods for improving the quality of water purification at waterworks is water ozonation.

After independence, studies were carried out in the Republic of Uzbekistan on the use of ozonation for medical purposes. In the field of drinking water purification, the use of ozone for water disinfection has not been studied.

In various reference sources \3-13\ ozonation of water is often considered only as one of the methods of disinfection that do not have the disadvantages inherent in other methods of water disinfection. In accordance with this point of view, the purpose of ozonation is limited only by its abiotic effect. Meanwhile, ozone, due to its oxidizing ability, guarantees not only fast and reliable sterilization, but also provides effective oxidation of organic substances, improving the organoleptic properties of water. As we know, ozone is one of the strongest oxidants \13\. By its oxidizing ability ozone is second only to fluorine \12\. From an economic point of view, the implementing of ozone as a reagent for water treatment is also cost-effective \4\. So, at ozone doses of 4-6 mg/l, ozonation is advisable not only from the point of obtaining a high effect of water treatment, but also from a technical and economic point of view.

An analysis of the available materials shows that at present, recommendations for the use of ozone in water purification processes have not yet been clearly developed. However, the enormous potential of ozone in water purification processes and its great impact on the aquatic environment are increasingly attracting specialists to conduct new research and searches for reliable methods of natural water treatment.

Mixing the ozone-air mixture with water plays an important role in the ozonation process. In the practice of ozonation, there is a wide variety of methods for mixing ozone with water. At large water supply and sewerage stations, the bubbling and emulsifier mixing method \11-13\ is widespread.

As a result of considering the existing methods for implementing ozone into the treated water, the designs of devices for mixing ozone with water, a direction was identified that turned out to be promising, especially for a station of low and medium productivity. This direction is the treatment of water with ozone in the technological pipelines \18\.

This article discusses a new technology for water purification using the accumulating ability of natural biocenosis, microfiltration and ozonation. The purpose of the work is to create a highly efficient technology for the preparation of drinking water from the reservoir. To achieve this goal, the following tasks were solved:

- the features of the formation and the qualitative composition of the water of the Tupolang reservoir in the Surkhandarya region have been studied with an analysis of the reliability of the existing technology for the preparation of drinking water;
- the effect of ozone on the physicochemical indicators of water taken from the reservoir has been studied;

-determined the mode of water treatment and the minimum dose of ozone and coagulant to achieve the standard level of drinking water parameters

-developed and tested in laboratory and semi-production conditions, various methods of preparation of drinking water from the reservoir

As a result of the study, the following results were obtained:

-developed a highly effective technology for the treatment of medium-turbid, medium-colored natural waters by natural biocenosis, microfiltration, ozonation and filtration, which ensures the production of drinking water with parameters corresponding to the O'zDST 950-2011 "Drinking water" /1/;

- on the basis of the regularities of the effectiveness of water purification at each stage established by the authors, the optimal technological load on the structures was determined with the provision of the minimum value of the reduced costs for its drinking water treatment system.

The practical value of the work

The developed water purification technology makes it possible to obtain drinking-quality water from the reservoir with the removal of hydrobionts, used substances, prevents the formation of volatile halogenated compounds, increases the sanitary-hygienic and consumer properties of drinking water. Анализируется существующая технология обработки воды на водопроводных сооружениях. The absence of a barrier role of treatment facilities for the retention of organic impurities, oil products, phenols and hydrobionts is shown.

In the recently published data on the study of the quality of natural and drinking water, as well as the efficiency of water treatment at water treatment plants, much attention is paid to the ever-increasing pollution of water supply sources by industrial and domestic wastewater and insufficient efficiency of water treatment plants in relation to organic pollutants \11-14\. Moreover, the implementing of chemical reagents during the preparation of drinking water can lead to the formation of more toxic substances in it. The reference \6\ consider that in unpolluted natural waters the total content of organic compounds is about 1.0 mg\dm^3; in contaminated ones - 10-20 mg/dm^3, in heavily contaminated - 100 mg/dm^3 and more. A significant part of them are organic compounds of natural origin - humic and fulvic acids, proteins, amino acids, carbohydrates and polysaccharides. But, a much greater potential danger is posed by organic compounds of anthropogenic origin.

According to the latest data \11\ out of 2221 organic impurities found in raw water, 765 are present in drinking water. Of these, 20 are recognized as carcinogenic and 23 are suspected of carcinogenicity, 18 are carcinogenic pathogens, 56 cause mutagenic changes.

To obtain drinking water, natural waters are most often chlorinated. Along with the positive effects of such treatment, negative ones are also found. It has been established that as a result of the chlorination of drinking water, trihalomethanes (THM) (chloroform, dichlorobromethane, bromodichloromethane, bromoform) are formed, the concentration of which in water is much higher than the concentration of other organic compounds.

The issues of seasonal changes in water quality were studied, and the process of formation of trihalomethane in chlorinated waters \9\ was monitored. In the summer months, the maximum content of total trihalomethanes in water is observed. It is also noted that the observed seasonal graphs of the peaks of total trihalomethane correspond to periods of increase in the content of total organic carbon in river water.

The increasing in the content of trihalomethane in water, and, in particular, chloroform, in the summer period is explained by many factors, the main of which are the dose of chlorine, chlorine content and the content of total organic carbon.

It is noted that despite a sharp decrease in organic matter, several types of chlorine derivatives are formed in the chlorination process. At the ozonation stage, organic and organochlorine substances are well removed, but aldehydes and ketones are formed. Practice has shown that at a dose of 5 mg/l of ozone, a better removal of organic and chlorinated substances is achieved than at lower doses, but the number of formed aldehydes and ketones increases. At the stage of adsorption on granular activated carbon, the content of organic and chlorine derivatives is reduced and aldehydes are completely removed.

The materials of the studied references make it possible to see the sources of the formation of trihalomethane, the main of which may be the following:

-natural humic substances;

-discharge of industrial wastewater;

-organic components of algal cells;

-interaction of chlorine with organic carbon;

- high molecular weight polymers - coagulants used in the process of water treatment;

- the result of the interaction of halogenated phenols and anilines with chlorine;

The most acceptable method of water purification from organic contaminants and, in particular, trihalomethanes, as can be seen from the review, is ozonation. At the same time, water should be treated with ozone at the initial stage of purification.

The high efficiency of ozone, the impossibility in most cases of using chlorine as a primary oxidizing agent from a sanitary and hygienic point of view, confirm the versatility, environmental friendliness and the inevitability of its use.

Comparing chemical, bacteriological, hydrobiological and physical indicators of the water of the Tupolang reservoir with those indicated in Table - 1, it can be concluded that the Tupolang reservoir belongs to the class of moderately polluted water bodies. The accumulation of river runoff in the reservoir makes significant changes in its everyday regime: the flow rate decreases, solid runoff sedimentation occurs, the trophic conditions of the reservoir change, the photosynthesizing duration increases, water body biochemical and biological processes develop inside (flowering, overgrowth with aquatic vegetation, etc.), changes self-cleaning ability and others /11/.

In a reservoir, as in a lake-type reservoir, changes should be expected:

- sedimentation conditions and water quality that have a direct impact on the operation of water supply facilities;
- drift currents in the upper layers of the water mass, because the movement of the water mass begins to be largely determined by winds and compensatory currents in deeper layers, which carry the lower layers of water in the opposite direction. This moment is important in the establishment of the sanitary protection zone, since in this case, to a certain extent, the concepts of "up" and "down" are lost by the flow.

Changes in the distribution of current velocities, largely the level of fluctuations in the salt composition throughout the year and the predominant role of the spring flood runoff in the reservoir are determined. Long-term sedimentation has brought about significant changes in the suspended solids regime. The amount of suspended matter in the reservoir does not exceed two tens of milligrams per liter, in the pre-dam parts of the reservoir in the summer, suspended solids are about 3-5 mg/l, but it is necessary to take into account the possibility of the bottom roiling during strong winds. In winter, the amount of suspended solids decreases.

Thus, the reservoir removes a significant part of the work of treatment facilities, but it is necessary to reckon with the peculiarity of suspended matter.

Qualitative analysis of water in the Tupalang reservoir.

Table 1.

1. Microbiological indicators.			
Indicators	Unit of measurement	Regulatory data	Results
			Samples

			1	2	3	4
1.1. The total number of microbes	The number of microbes in 1 cm cube of water	No more than 100 units	24	22	26	29
1.2. Coli-Escherichia bacteria group	The number of microbes in 1 cm cube of water	10 000	2380	2380	2380	2380
1.3. Coli index (CI)	The number of microbes in 1 mg of water	No more than 3.	More than 2380	More than 2380	More than 2380	More than 2380
1.4. Escherichy	The number of Escherichia in 300 cm cube of water,	Don't have to attend	Not present	Not present	Not present	Not present
1.5. Koli-phages	The number of plaques formed in 200 cm cube of water	Don't have to attend	Not present	Not present	Not present	Not present
2. Parasitological indicators						
2.1. Pathogenic intestinal sticks: (Giardia, lamblia, dysentery, balantidia)	Amount of 25 dm^3 of water.	Don't have to attend	Not present	Not present	Not present	Not present

2.2. Helminth eggs	Amount of 25 dm^3 of water.	Don't have to attend	Not present	Not present	Not present	Not present
3. Organoleptic indicators						
Показатели	Unit of measurement	Regulatory data	Results			
			Samples			
			1	2	3	4
3.1. Flavor	Points	2	1	1	1	1
3.2. Odor	Points	2	1,2	1,0	1,0	1,4
3.3. Turbidity	mg/dm^3	1,5	20,0	6,0	6,0	4,0
3.4. Chromaticity	Degrees	20	18,0	20,0	19,0	16,0
3.5. Hydrogen exponent	pH	6-9	7,4	7,2	7,4	7,5

If we consider the effect of chloroform on the sanitary regime of water bodies, that is, on the organoleptic and sanitary-hygienic, toxicological properties of water, then, as follows from /1/, chloroform for aquatic organisms and warm-blooded animals is moderately toxic, characterized by high accumulation in organisms. An odor with an intensity of 2 points was detected at a chloroform content of 18 μg/l. Chloroform did not affect the color of water in the indicated amounts.

The maximum concentration that does not affect the sanitary regime of the reservoir is 50 μg/l. To determine the content of volatile halogenated compounds (VHCs), samples of source water and water from a clean water reservoir (CWR) were taken. The analysis of the samples was carried out on an LKhM-80 chromatograph (4th model).

The results show that drinking water contains a large amount of VHCs: chloroform - 93.7 μg/l, carbon tetrachloride - 0.8 μg/l, bromodichloromethane - 6.2 μg/l, tetrachlorethylene - 2.7 μg/l. The total amount of VHCs in drinking water is 103.4 μg/l, and in the original water there are traces of chloroform and 0.8 μg/l of carbon tetrachloride.

Thus, as a result of the applied classical technology at the stations, drinking water contains an unacceptably high amount of volatile halogenated compounds.

Consequently, water with such an amount of VHCs cannot be supplied to the water supply network and certain adjustments must be required to it.

Due to the fact that the removal of the formed VHCs is a difficult task /3-13/, it is advisable to consider the possibility of changing the technology of water treatment in order to prevent the formation of VHCs during chlorination.

Currently, several methods can be proposed to reduce the THM content to the established limit, the main of which are the following methods:

- do not use disinfectants that provide THM as secondary products;

- use pre-treatment of water before chlorination

to reduce the level of total organic carbon;

- to supplement the classical technology with adsorption purification to reduce THM.

Effective methods of preventing the formation of VHCs are measures aimed at reducing the concentration of organic substances before the implementing of chlorine /4/. Next, consider the methods for treating water that prevents the formation of VHCs:

1. Changing the point of chlorine injection (in front of the filters), reducing the VHCs to 32-40%, / 5 /. Disadvantages of this method: if there are LHS in the source water, the effect of lowering VHCs is less;

2. Coagulation, decrease in VHCs to 30-32%, /6/. Disadvantages of the method: residual aluminum in water; an effective dose of a coagulant to lower VHCs may not be effective in removing turbidity; coagulation with aluminum sulfate selectively eliminates chloroform precursors; in case of treating highly brominated waters (70-80% bromoform), coagulation with doses of 50-160 mg/l proved to be ineffective for the removal of THM.

3. Adsorption by activated carbon (AC) and synthetic resins, reduction of VHCs 40-50%, /6/. Disadvantages of the method: with an increase in the dose of AC, an increase in the dose of chlorine is required, due to the dechlorinating effect of AC; more than 100 mg / l AC is required to remove VHCs; AC contains lead, cadmium, zinc, mercury, etc.; there is no reliable way to regenerate AC; there are contaminants in the synthetic resin; high flow rate of rinsing water; low sorption capacity in synthetic resin; in case of preliminary chlorination, the AC additive is ineffective; ACs with small pore sizes are unsuitable for sorption of humic acids; AC has a low

sorption capacity in relation to low molecular weight organic substances; AC being a catalyst can lead to the formation of toxic substances, which are not formed in its absence; synthetic resins weakly remove brominated THMs; weakly basic resins are the source of THM formation.

4. Preliminary ammonization, reduction of VHCs to 20-25%, /7/. Disadvantages of the method: the content of active chlorine in water decreases; VHCs is formed at the stage of water disinfection; the amount of total organic carbon is preserved;

5. Implementation of chlorine dioxide, reduction of VHCs to 22-30%, / 8 /. Disadvantages of the method: chlorates (highly toxic substances) appear; difficulty in preparation at the place of use; high price.

6. Aeration, reduction of VHCs to 20-30%, / 7 /. Disadvantages of the method: simple aeration transfers harmful compounds from water to the environment; only volatile compounds are removed and, with subsequent chlorination, VHCs are reduced.

7.Preliminary ozonation, reduction of VHCs to 95-97%, /8/. Disadvantages of the method: an increase in ammonia from 0.7 to 1.5 mg/l; high cost of cooking; organization of preliminary water purification.

Of the methods considered, pre-ozonation is the most promising method that prevents the formation of VHCs and THM.

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