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Analysis of Existing Technological Processes for Preparation of Drinking Water From Surface Sources Water Supply

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Abstract

The article analyzes the existing technological processes for the preparation of drinking water from surface water supply sources in the conditions of Uzbekistan. In connection with significant volumes of water consumption in the interests of ensuring economic activity, the issue of disinfection of drinking water is acute. Along with traditional methods of disinfection, considerable attention of modern researchers is focused on the development of innovative technologies for this process. The features of the formation and qualitative composition of Buzsuva water are studied with an analysis of the reliability of the existing technology for the preparation of drinking water.

Keywords: organic pollutants, carcinogenicity, changes in water quality, ozonation, drinking water purification technology.

Introduction

Introduction. In recent years, our government has adopted a number of resolutions aimed primarily at improving the sanitary conditions of water bodies. These decisions are intended for the production and implementation of a number of activities. Very high demands are placed on the degree of preparation of drinking water and purification of wastewater discharged into water bodies. For this purpose, the following activities are aimed at improving the sanitary treatment of water bodies: construction of sewerage facilities, purification of drinking water; deep purification of drinking water; transition to the method of reusing purified water at industrial enterprises or multiple use for the technological process at industrial enterprises; not completely draining wastewater into water bodies by transferring water management at industrial enterprises to a completely related method; use of purified fresh water for irrigation taking into account sanitary conditions; transfer of technological processes at industrial enterprises to processes that do not use water[1-3].

The peoples of Central Asia, including city residents, have always received water from open water supply sources or special khauzahs designed to collect and process water. By extracting water from natural sources, purifying it, and building a complex of engineering structures and installations that provide industrial enterprises, the population can be provided with water in the required quantities and under pressure. Due to the significant volumes of water consumption in the interests of ensuring economic activity, the issue of disinfection of drinking water is acute. Along with traditional methods of disinfection, significant attention of modern researchers is focused on the development of innovative technologies for this process. The features of the formation and qualitative composition of Buzsuva water are studied with an analysis of the reliability of the existing technology for the preparation of drinking water[4-6].

Main part. In the recently published data on the study of the quality of natural and drinking water, as well as the efficiency of water purification at water treatment facilities, much attention is paid to the ever-increasing pollution of water supply sources with industrial and domestic wastewater and the insufficient efficiency of water treatment facilities with respect to organic pollutants. Moreover, the introduction of chemical reagents in the process of preparing drinking water can lead to the formation of more toxic substances in it. In the literature [7] it is believed that in unpolluted natural waters the total content of organic compounds is about 1.0 mg / dm3, in polluted - 10-20 mg / dm3, in heavily polluted - 100 mg / dm3 and more. Of these, a significant part is made up of organic compounds of natural origin - humic and fulvic acids, proteins, amino acids, carbohydrates and polysaccharides. However, organic compounds of anthropogenic origin pose a much greater potential danger.

According to the latest data, of the 2,221 organic impurities found in raw water, 765 are present in drinking water. Of these, 20 are recognized as carcinogenic and 23 are suspected of being carcinogenic, 18 are carcinogenic pathogens, 56 cause mutagenic changes [8-9].

To obtain drinking water, natural waters are most often subjected to chlorination. Along with the positive effects of such treatment, negative ones are also found. Thus, it has been established that as a result of chlorination of drinking water, trihalomethanes (chloroform, dichlorobromethane, bromodichloromethane, bromoform) are formed, the concentration of which in water is much higher than the concentration of other organic compounds. This problem has been devoted to many works by both domestic and foreign scientists [10].

In a review of the study of carcinogens and organic compounds in drinking water in the USA, it is indicated that chloroform is present in all drinking water treated with chlorine. It is noted that chloroform in an aqueous environment is formed mainly by the interaction of free chlorine with humic substances, and in the presence of bromide ions in water, bromoform is formed [11].

Experimental data on chlorination of water in the Rhine River show [12] that at a chlorine dose of 2 mg/l, the chloroform concentration increases from 2.3 to 7.3 μg/l, chlorobromo derivatives appear in the amount of 16 μg/l, and the total amount of TGM increases to 42 μg/l. The issues of seasonal changes in water quality were studied, and the process of TGM formation in waters that underwent chlorination was monitored [13]. In the summer months, the maximum content of total trihalomethanes in water is observed. It is also noted that the peaks of total TGM observed in the seasonal graphs correspond to periods of increasing total organic carbon content in river water. The increase in the content of TGM in water, and in particular chloroform, in the summer period is explained by many factors, the main ones being the chlorine dose, chlorine capacity and total organic carbon content. A potential source of TGM during water chlorination, in addition to humic substances, is algae [14]. However, the type of algae does not have a noticeable effect on TGM production. It has been shown that the source of chloroform is not some specific substance, but many organic components of the cell. Therefore, it is advisable to remove algae from water before chlorinating it, which is especially important during the period of water bloom.

Of all the potential replacements for active chlorine in the disinfection of drinking water available today (ozone, chlorine dioxide, chloramines), ozone is the most powerful biocide. It has long been used as a disinfectant in Europe [15]. The oxidation potential of ozone is significantly higher than that of chlorine, so it has higher disinfectant properties, especially with respect to viruses, and it is more effective in decolorization and deodorization.

Removal of organic matter from water before chlorination can be carried out on filters with activated carbon [16]. However, with a high initial content of total organic carbon, this method of purification is relatively expensive.

The possibility of removing THC "precursors" by adsorption on manganese dioxide was studied. Pure manganese dioxide weakly sorbs humic and fulvic acids at a pH of 7.0, which is typical for natural water. Most researchers have concluded that the best method of combating the formation of TGM is to replace preliminary chlorination with ozonation. Ozone oxidizes organic substances, converting them into polar or charged molecules. It destabilizes humic acid, which also promotes the coagulation of pollutants. The literature [17] shows that the COD values after ozonation and sand filtration decreased by 45%, after a carbon filter - by 70%. Preliminary ozonation with a dose of 4 mg / l increases the sorption of organic substances by carbon by 15-20%. The literature [18-20] suggests schemes for purifying natural water that reduce the content of organic substances and TGM in water. The water treatment scheme looked like this: water intake, reagent feed unit (aluminum polychloride, powdered activated carbon), flocculation chamber, settling tank, sand filter, ozonation stage, activated carbon filter, final bactericidal ozonation stage, purified water collector (sodium hypochlorite is dosed into the pipeline before it). As a result of using this scheme, the amount of flocculants used decreased by 1/3, the content of organic substances in purified water - by 22%, the content of TGM, ammonium nitrogen, total chlorine and salts also decreased. The authors believe that the main reasons for improving the quality of purified water are the destruction of bioresistant contaminants during ozonation, as well as the biological purification processes occurring in the storage tank and filters with activated carbon [21-23].

A technology for purifying drinking water is described, where water from the Rhine River basin is used as the initial water [24-25]. Most water treatment plants have 7 to 10 purification stages, such as: preliminary oxidation, microfiltration, filtration through a two-layer bed, neutralization, ozonation, adsorption on granular activated carbon, slow filtration through a quartz bed, and disinfection with chlorine dioxide before feeding into the water distribution system. The ozonation and adsorption stages achieve the highest effect of reducing organic matter. It is noted that despite the sharp reduction in organic matter, several types of chlorine derivatives are formed during the chlorination process. Organic and organochlorine substances are well removed at the ozonation stage, but aldehydes and ketones are formed. Practice has shown that with an ozone dose of 5 mg/l, better removal of organic and chlorine derivatives is achieved than with lower doses, but the amount of formed aldehydes and ketones increases. At the adsorption stage on granular activated carbon, the content of organic and chlorine derivatives decreases and aldehydes are completely removed [26-29].

The literature review materials provide an opportunity to see the sources of TGM formation, the main ones of which may be the following:

- natural humic substances;
- industrial wastewater discharge;

- organic components of algae cells;
- interaction of chlorine with organic carbon;
- high-molecular polymers - coagulants used in the process of water treatment;
- the results of the interaction of halogen-substituted phenols and anilines with chlorine;

The most acceptable method of water purification from organic contaminants and, in particular, TGM, as can be seen from the review, is ozonation. In this case, water should be treated with ozone at the initial stage of purification.

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

The main industrial method of obtaining ozone is its synthesis from oxygen or air under the influence of an electric discharge in ozonizers. An oxygen-ozone mixture with an ozone content of about 10% by weight is explosive [4]. In ozonation practice, one has to deal with very low ozone concentrations - from 0.15 to 0.93% by weight. Such mixtures are completely safe, even at a pressure of several atmospheres.

Ozone is an unstable gas even in the absence of oxidizing substances and spontaneously decomposes into atomic and molecular oxygen, so it is impossible to store it for any time.

Many works are devoted to the comparison of chlorine (the main reagent currently changed at water supply stations) and ozone, and all of them give preference to ozone.

Table 1. Chemical and bacteriological laboratory of the State Water Supply and Sanitation Service of Tashkent Shahar Suv Taminoti LLC for November 2021 on water quality control in accordance with OZDst 951 2011 "Sources of centralized domestic and drinking water supply"

№	Name of definitions	Unit measurement	Standards	Boz-su
1	Temperature	°C		11
2	Color	°C	no more 30	21
3	Aftertaste	score		2
4	Smell when $20^0/60^0$	score	no more 2	0/2
5	Turbidity	mg/dm^3	no more 20	7,5
6	Hydrogen indicator	pH	6,8-8,5	7,32
7	Rigidity	$mg\text{-}ekv/dm^3$	no more 7	2,44
8	Chlorides	mg/dm^3	no more 250-350	2,95
9	Oxidizability	mg/dm^3	no more 7,0	0,36
10	Nitrite	mg/dm^3		0
11	Ammonia	mg/dm^3		0
12	Nitrates	mg/dm^3		1,79
13	Sulfates	mg/dm^3		17,4
14	Fluorine	mg/dm^3	no more 0,7	0,181

15	Iron	mg/dm^3	no more 0,3	0,063
16	Copper	mg/dm^3		0,071
17	Lead	mg/dm^3		0
18	Zinc	mg/dm^3		0
19	Arsenic	mg/dm^3		0
20	Molybdenum	mg/dm^3		0
21	Manganese	mg/dm^3	no more 0,1	0
22	Polyphosphate	mg/dm^3		0
23	surfactants	mg/dm^3		0
24	Dry residue	mg/dm^3		149
25	Number of coliform bacteria	Number of BGKP 1dm^3 water	no more 1000	<500

Table 2. Standard concentrations of discharge of treated domestic wastewater into an open water body.

Indicators	Standards (MPC)	After cleaning the Sergeli sewage treatment plant (Tashkent)
1. The number of coliform bacteria (CGB) in 1 l	1000	1200
2. The number of pathogenic enterobacteria in 1 l	-	-
3. Suspended solids, mg/l	1,5	7,5
4. Hydrogen index (pH)	6-9	7,4
5. Dry residue, mg/l	1000	1560
6.Ammonium nitrogen (NH4+), mg/l	1,5	6,1
7. Nitrate nitrogen (NO3), mg/l	45	92
8.Nitrite nitrogen (NO2-), mg/l	3	5,5
9.Total hardness, mg-eq/l	7	9,3
10.Sulfates (SO4), mg/l	400	930
11. Chlorides (Cl), mg/l	250	395
12. BOD full. , mg O2/l	3,0	15,9
13.Manganese (Mn), mg/l	0,1	0,46
14. Copper (Cu), mg/l	1,0	2,2
15.Iron (Fe), mg/l	0,3	1,5
16. Zinc (Zn), mg/l	3,0	13,9
17.COD, mg O2/l	15,0	75,0
18. Phosphates, mg/l	1,1	4,7

19. Aluminum (Al), mg/l	0,2	0,9
20.Cadmium (Cd), mg/l	0,001	0,005
21. Nickel (Ni), mg/l	0,1	0,29
22. Mercury (Hg), mg/l	0,0005	0,0009
23. Lead (Pb), mg/l	0,03	0,15
24.Chromium (Cr), mg/l	0,05	0,25
25. Butachlor, mg/l	0,04	0,1
26. Organochlorine birikmalar, mg/l	0,5	1,1
27. Dioxin, mg/l	0,3	0,6
28. Organophosphorus birikmalar, mg/l	0,3	0,7
29. Phenol, mg/l	0,06	0,1
30. Pesticidlar, mg/l	2,8	4,1

Conclusions: From the above issues, it should be concluded that the problems of water purification and preparation of drinking water in Uzbekistan are among the most pressing issues. The problems of preventing negative situations arising during the design and operation of facilities used in the technology of preparation of drinking water have been studied. A retrospective analysis of research works on the issues of safety and reliability of drinking water supply facilities, safe operation of drinking water supply facilities has been carried out. The volume of water consumption and the process of saving it during the repair of pipes in drinking water supply networks have been improved.

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