International Journal of Advance Scientific Research
(ISSN – 2750-1396)
VOLUME 02 ISSUE 12 Pages: 85-93
SJIF IMPACT FACTOR (2021: 5.478) (2022: 5.636)
METADATA IF – 7.356

ISSN-2750-1396

Journal Website: http://sciencebring.com/index.php/ijasr

Research Article

PROBLEMS OF ENVIRONMENTAL SAFETY OF WATER TREATMENT FACILITIES

Submission Date: December 09, 2022, **Accepted Date:** December 14, 2022,
Published Date: December 17, 2022
Crossref doi: https://doi.org/10.37547/ijasr-02-12-13

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ABSTRACT

The article justified the urgency of ensuring the environmental safety of water intake and treatment facilities in water supply systems by creating a complex of specialized protective equipment. The operation of water supply systems was analysed, as a result of which it was determined that the environmental safety of water intakes was insufficient. To solve this problem, the scientific justification of the ecologically sustainable operation of the natural-technical system of the specialized type "natural water environment - water management complex - agricultural water supply system" was carried out. The proposed systematic approach to solving the vital problems of ensuring the environmental safety of water intake facilities of water systems is to provide high-quality water to consumers in any operating conditions (mud, suspension) of agricultural water supply systems. At the same time, the complex of water and intake treatment facilities improves the river ecosystem.

Keywords

Environmental safety of water supply systems, engineering structures, the water supply of cities, natural and man-made emergencies, water purification and supply.

Introduction

In the practice of water supply construction in our country, the most widely used water treatment facilities are designed, but according to the technological scheme, which provides horizontal settling tanks and quick filters as the main treatment facilities.

In the process of water treatment at waterworks, various types of sediments are formed after sedimentation tanks, washing of drum screens (microfilters), quick filters, and regeneration of membrane devices (ultrafiltration, nanofiltration, reverse osmosis). The problem of treatment of sediments and wash waters is not completely solved at present.

Methods

Wash waters. For washing filters, contact clarifiers, as well as the discharge of the first filtrate after the regeneration up to 10% pure filtered water is used. The use of various reagents in the process of water treatment, and the quality of the source water have a significant influence on the composition of these waters.

Wash water in the last century after treatment facilities in most cases dumped nearby water sources without any treatment. This option is often used today, which contradicts modern hygiene standards.

The recommendations of the current regulatory documents [1-4] require to provide for the reuse of wash water in the process of water purification.

Environmental problems in the reagent treatment of water. Processes Water treatment in settling tanks and filters allows, along with water purification, to remove a significant part of bacteria and viruses from it. The rest is neutralized in the process of disinfection of water.

There are five main methods of disinfection [5-9]:

- thermal;
- exposure to strong oxidizing agents;
- ultrasonic influence;
- treatment with ultraviolet rays;
- oligodynamic (contact of water with ions of noble metals, such as silver).

Chlorination is used for oxidation and disinfection, with-prologue effect. The presence of pathogenic bacteria, parasites and viruses in the water makes it unsuitable for household and drinking needs, and the presence of certain types

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of microorganisms (filamentous, zoogley, sulfate-reducing bacteria, iron bacteria) in the water causes biological fouling, and sometimes the destruction of pipelines and equipment.

Chlorination of water is a reliable means of preventing the spread of epidemics. Although chlorine does not destroy spore-forming bacteria, this is one of the few disadvantages of disinfecting with active chlorine. When used correctly, active chlorine does not cause any noticeable odour or taste.

Chlorine is consumed for the oxidation of microorganisms, and organic and inorganic impurities. The consumption of chlorine, as well as the effectiveness of disinfection, are variables that depend on the dose of chlorine introduced, the time of its contact with water, the pH value and water temperature.

When gaseous chlorine is dissolved in water, hydrochloric and hypochlorous acids are formed: acids: $Cl_2 + H_2O = H^+ + Cl^- + HClO$. But it is the hypochlorite ion ClO that is the active agent. The chlorine present in water is hypochlorous acid (HClO) or hypochlorite anion(ClO), commonly referred to as free chlorine. Chlorine that exists in the form of chloramines (monochloramine - NH_2Cl and dichloramine - $NHCl_2$, as well as in the form of nitrogen trichloride NCl_3) is called combined chlorine. In drinking water, the content of active chlorine is set in terms of chlorine at the level of 0.3..0.5 mg/l in free form, and at the level of 0.8..1.2 mg/l in bound form.

Ozonation is necessary for the destruction of harmful substances and disinfection, for the destruction of colloids. Ozone (O_3), an active form of oxygen (O_2), is the strongest disinfectant and oxidizer in water treatment technology. All substances capable of oxidation, predominantly precipitate or aggregate.

Unlike active chlorine, ozone does not have an aftereffect, but in terms of its ability to oxidize, ozone is much stronger. For ozone to react with most pollutants, 4 minutes is enough, with complete mixing of ozone and water.

Coagulation (Fig. 1) is necessary for the enlargement and aggregation of colloids and suspensions. The processes of coagulation and flocculation (Fig. 2) are used to separate suspended particles from water if the rate of their natural settling is too low to provide effective clarification of the water. The colloidal particles found in raw water include clay, silica, iron, heavy metals, pigments and organic solids.

Figure 1. Scheme of coagulation.

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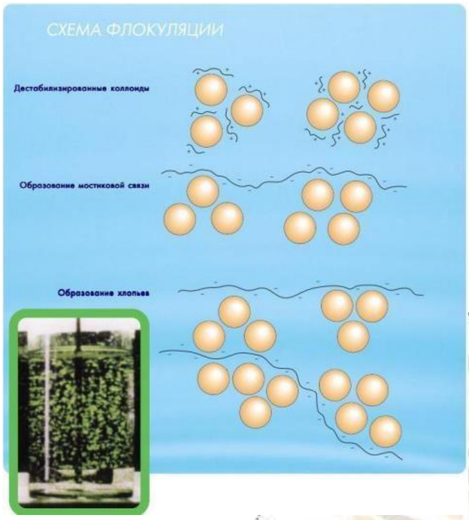

Figure 2. Scheme of flocculation.

Raw turbid water often contains suspended matter, the particles of which almost do not settle. Such particles are in a colloidal state, and their size is less than 10 microns.

As coagulants, as a rule, salts of aluminium, iron or polyelectrolytes are used. For example, "aluminium polyoxychloride". The main difference between coagulants and flocculants is the size of the precipitated flakes, as well as the mechanism of action. The first group of substances precipitates pollution by electrolytic action. As a result, the charge of suspended particles is neutralized, and they combine into larger associations. The second group of reagents works differently, the formation of a polymer bridge between the deposited particles occurs. In this process, there is no change in the electrolytic properties of the system. Coagulants can form a stable precipitate, which is filtered out when water passes through the treatment plant. However, many filters are not capable of retaining fine particles. Flocculants are used for better water purification. These reagents combine the particles obtained during coagulation into larger flakes, which greatly facilitates their mechanical removal.

One of the most common coagulants widely used in Russia is aluminium sulfate. Under normal conditions, it has the form of crystals - colourless or white, with a slight grey, blue or pinkish tinge (Fig. 3).

Figure 3. View of aluminium sulfate crystals

It is convenient in that, firstly, it is easily mined (when processing bauxite or clay with sulfuric acid), secondly, it easily dissolves in water at a temperature of 30 to 40 degrees, and thirdly, it is quite effective for primary treatment. The advantages of aluminium sulfate have already been partially mentioned above: it does not form toxic compounds, it is not poisonous, and it does not require special equipment for cooking (the usual measures to protect the skin from direct contact with chemicals are quite enough). It can be used both in traditional water treatment systems and in membrane water treatment technology. More modern systems focus specifically on aluminium sulfate as the most reliable and relatively neutral coagulant. The disadvantage of the old method for the production of aluminium sulfate granules is the heterogeneity of the granules both in size and in the content of the active element.

pH adjustment is used to shift the chemical equilibrium in hydrate formation reactions. According to current standards, the pH of pure water should be in the range of 6-9 units. (dimensionless unit). But the optimal range for household and drinking purposes is recognized as a range close to neutral 7.0 units. on the other hand, in some water treatment technologies, it may be necessary to adjust the pH level, for example, to improve iron removal or increase the efficiency of demanganization. In the case of a slight deviation in pH, you can do without reagents - with the help of special filter materials. But if the pH of the water differs significantly from the desired one, it may be necessary to correct it with reagents [15-19].

As reagents are usually used: to increase the pH - sodium hydroxide ("pH +" reagent) or baking soda (sodium bicarbonate); to lower - a solution of hydrochloric acid ("pH-" reagent).

Inhibition is used to increase the resistance of the system to corrosion, as well as to slow down the phenomena of crystallization and sedimentation. Inhibitors - substances that slow down, and inhibit any unwanted processes.

In the technology of water treatment in the private sector, such reagents are most often used as antiscalants - sedimentation inhibitors, and biocides - biofouling inhibitors.

All inhibitors are generally toxic. Therefore, neither antiscalants nor biocides are used directly for the preparation of drinking water - only for technical water and equipment washing. Only hydrogen peroxide is used directly in the circulation lines of the pools.

Antiscalants are mainly used for reverse osmosis equipment, where crystallization phenomena on the membrane surface are highly undesirable. Antiscalants are substances based on polyphosphates (remember Calgon, Antinakipin, cartridges for washing machines, etc.).

Biocides are used to prevent biofouling:

1) in swimming pools, water disinfection processes against the formation of algae;

2) pipelines, boilers, membrane flushing reverse osmosis equipment.

Biocides, in their composition, are based on isocyanurates, bromine, peracetic acid, hydrogen peroxide, chlorine dioxide, amines, etc.

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Figure 4. Possible consequences on the human body of residual concentrations of reagents in water on human health with this method

water treatment

The figure (Fig. 4) shows the possible consequences of using the above reagents on the human body and their effects of residual concentrations in water on human health in case of violation of the allowed standards.

Environmental impact of water supply and sanitation systems operating in emergency mode. In case of accidents on water pipes and sewerage systems (ruptures of pipelines as a result of water hammer, external mechanical impact, destruction under the influence of corrosion, etc.), water (often under pressure) and substances in it are released into the environment in large quantities. At the same time, soil moisture content sharply increases at the accident site, and soil erosion and activation of negative geomorphological processes are possible. As a result of an accident, the area of water discharges from pipelines covers, as a rule, from several hundred to several thousand m

In case of accidents at utility and drinking water pipelines, there is a risk of harmful agents from the environment getting into the sections of the water supply system located below the accident site [20-25].

As a rule, it is difficult to immediately localize the places of accidents on water pipes and sewerage systems, since most of these communications are underground. In case of accidents on these communications, one of the negative environmental factors is the subsidence of soils at the accident site, an additional negative environmental factor is the formation of a large amount of construction debris that occurs during the elimination of the accident. Sometimes accidents on water pipes and sewerage systems lead to damage and destruction of buildings and structures, soil erosion, and damage to the vegetation cover of settlements.

Accidents occurring on water pipes and sewerage systems lead not only to environmental violations at the accident site but also form a negative environmental situation in the territories that were served by the emergency section of the water supply or sewerage system. In this regard, accidents on pipelines must be eliminated in a short time - from several hours to several days.

Conclusion

For domestic and drinking water supply, the suitability of water supply sources is approved based on a sanitary assessment of the locations of water intake facilities, an assessment of the quantity and quality of water, a sanitary assessment of surface water supply sources with the territory adjacent to the upstream and downstream of the water intake and the conditions of occurrence and formation of groundwater, a forecast of sanitary the state of water sources, etc. Sanitary protection zones for water supply sources are organized to ensure an appropriate level of drinking water quality, the main purpose of which is to protect water supply sources, water supply facilities and the surrounding area from pollution. They include a restricted zone and a high-security zone.

During the operation of water intakes, various environmental and technological problems arise ice-sand interference, algae ("blooming" of water; biofouling (zebra, algae), as well as fish protection.

The study of technological schemes for the purification of drinking water shows that the main methods of clarification and discolouration of water at water treatment plants are sedimentation and filtration with preliminary water treatment with reagents (coagulants).

In the process of water treatment at waterworks, various types of sediments are formed after sedimentation tanks, washing of drum screens (microfilters), fast filters, and regeneration of membrane devices (ultrafiltration, nanofiltration, reverse osmosis). The problem of treatment of sediments and wash waters is not completely solved at present.

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