**Federal State Budgetary Educational
institution of higher education
"North Ossetian State Medical Academy"
of the Ministry of Health of the Russian Federation**

**DEPARTMENT OF GENERAL HYGIENE
AND PHYSICAL CULTURE**

Kusova A.R., Tsilidas E.G.

METHODS OF IMPROVEMENT OF QUALITY OF DRINKING WATER

**Methodical recommendations to a practical training
about hygiene for students**

Vladikavkaz 2016

UDC 613.3
LBC 51.21

Kusova A.R., Tsilidas E.G.

Methods of improvement of quality of drinking water: methodical recommendations to a practical training about hygiene for students

North Ossetian State Medical Academy. - Vladikavkaz, 2016 . – 21 p.

This methodological guide contains material that reflects modern hygienic ideas about the main and additional methods for improving the quality of drinking water. The data on the types of clarification and discoloration of water - sedimentation, coagulation and filtration are presented; on the methods of chemical and physical disinfection of water. Provides information on the main advantages and disadvantages of the most common disinfection methods.

The manual contains situational tasks, test tasks, a list of the main and recommended additional literature that facilitate the assimilation of the material.

Methodical recommendations "Methods of improvement of quality of drinking water", prepared in the discipline "Hygiene" in accordance with the Federal State Educational Standard of Higher Professional Education for students studying in the specialty General Medicine (05.31.01).

UDC 613.3
LBC 51.21

Reviewers:

Kalagova R.V. - Doctor of Chemistry, Associate Professor, Head of the Department of Physics and Chemistry of the FSBEI of HE NOSMA of the Ministry of Health of Russia.

Tuaeva I.Sh. - Candidate of Medical Sciences. Associate Professor of the Department of Hygiene of the PMF with the course FPAE of the FSBEI of HE NOSMA of the Ministry of Health of Russia.

Approved and recommended for publication by the Central Coordination Educational and Methodological Council of the FSBEI of HPE NOSMA of the Ministry of Health of Russia (Minutes No. 1 dated September 12, 2016).

Methods of processing of water are subdivided into the main and additional. (special).

At the initial stage water purification from mechanical, including microscopic impurity is made. At the same time acceptable organoleptic properties are reached, water becomes somewhat colourless and deodorized. For the purpose of epidemic safety use various methods of disinfecting. If use of the main ways is not enough, use special.

Water purification methods

The main objective of water purification — completely to exempt it from a suspension (turbidity), to make transparent (to clarify) and reduce chromaticity. The most effective is the method of sorption cleaning on absorbent carbon.

Upholding. Water is pumped in horizontal or vertical settlers. In horizontal settlers the speed of the movement of water of 2-4 m of m/s, in vertical - 1 mm/sec., passing time through a settler of 4-8 hours. To accelerate and increase efficiency of loss of a suspension and removal of colloid substances in settlers, before upholding coagulation is made.

Water coagulation. Usually as a coagulant use $Al_2(SO_4)_3$ aluminum sulfate. At coagulant solution addition to water there is its interaction to bicarbonate salts of Sa and Mg with formation of flakes. On a surface of flakes finely divided suspended particles, bacteria, seaweed are occluded. It leads to effective clarification of water and promotes its decolouration. As coagulants sometimes use sulfate and chloric salts of iron.

Coagulation of water improves at addition of the flocculants promoting fast formation of large flakes. Treat high-molecular flocculants the activated silicon acid, alkaline starch, sodium alginate, polyacrylamide.

The working dose of a coagulant is established by practical consideration. The coagulant is brought in water in the special *cameras of reaction* located before settlers. Dissolution of a coagulant and process of flocculation lasts 20-45 minutes. Speed of the movement of water - 0,2-0,6 m/s. The "ripened" solution moves in settlers where large flakes settle and clarify water.

For assessment of efficiency of processing at least once a day the analysis of a filtrate on a turbidity, chromaticity, smack, a smell at various stages of processing, including production of the purified water is carried out. At least once in change define residual quantities of a coagulant. Residual content of reagents in the conditioned water should not exceed for aluminum 0,5 mg/l, gland - 0,3 mg/l, polyacrylamide flocculant - 2,0 mg/l.

Filtering - the technical process following after coagulation and upholding. The water exempted from coarse impurity moves on *slow filters.* Filters represent steel concrete tanks with a double bottom: the lower continuous and upper perforated.

Advantages them that the high percent of a delay of bacteria (99%) is noted. Shortcomings: small productivity, large volume of constructions. Slow filters are used on small, is more often than rural water supply systems.

Fast filters are used for city water supply. Their productivity is 50 times higher, than slow (5 m3/h), however ability to detain a bacterium - is 4% lower. *The upgraded fast filters* have big productivity.

Filtering speed - 5-6 m3/h. A method of contact clarification - the most perspective for water supply of large settlements.

Water disinfecting methods

Now on treatment facilities of water supply systems the basic is the chlorination method. The increasing implementation receives an ozonization method, including in a combination with chlorination. The effect of disinfecting depends on biological microbes, their stability, from activity and time of action, quality of the water.

Chlorination is characterized wide antimicrobic action concerning vegetative forms of microorganisms, profitability, simplicity of technology, a possibility of operating control behind disinfecting process. Use chlorine-containing reagents: chloroamines, calcium hypochlorites and sodium, chloric lime, gaseous chlorine, chlorine dioxide. Most often at waterworks use gaseous chlorine.

Chlorine destroys enzymes of a respiratory chain of bacteria - dehydrogenases,

blocking SH groups.

Chlorine absorptivity of water - amount of chlorine which at chlorination of 1 l of water is spent for oxidation of the organic, easily oxidized inorganic matters and disinfecting of bacteria within 30 minutes.

Chlorine requirement of waters — the total quantity of chlorine necessary for satisfaction of chlorine absorptivity of water and ensuring existence of necessary amount of residual chlorine.

Types of chlorination

Usual chlorination (chlorination by normal doses of chlorine).

Chlorination with a preammonization.

Water hyper chlorination

Control definitions of residual chlorine in water are made each 30-60 minutes. On large water supply systems automatic control is carried out. Once a day the bacteriological research is conducted.

Chlorination shortcomings. Chlorine and its drugs are toxic connections, work with them demands strict observance of safety measures. Chlorine affects, generally vegetative forms of microorganisms. Gram-positive forms of bacteria are steadier against its action, than gram-negative. After chlorination in water halogen containing connections (GSS) can be formed. Their sources are the humic acids derivative of phenol, aniline, products of metabolism of seaweed. Accumulation in the GSS drinking water is hazardous to health of the population in connection with their biological activity. GSS have the expressed all-toxic properties, give the remote effects - embriotoksichesky, mutagen, cancerogenic.

Ozonization is a perspective method of disinfecting of water. Strong oxidizing properties provide the expressed bactericidal effect of ozone. Ozonization is deprived of the shortcomings inherent in chlorination. Ozone is used not only for disinfecting, but also for deodorization of drinking water, removal of toxic organic matters. The disinfecting effect of ozone by 15 - 20 times, and on sporous forms of bacteria is 300-600 times stronger than effect of

chlorine. The high virulitsidny effect of ozone is noted at acceptable concentration. Ozone is highly effective at destruction in water of pathogenic protozoa.

Advantages of ozonization:

- ozone works quicker than chlorine, reliable disinfecting is reached in several minutes;

- ozone has no taste and a smell in itself, at connection with the substances which are contained in water;

- in addition to disinfecting, ozone decolours water, eliminates smells and smacks;

- success of ozonization depends on change of temperature, pH, organoleptic properties of water a little;

- at ozonization mineral composition, pH of water do not change;

- excess of ozone, unlike chlorine, does not denature water, ozone in large numbers in water is non-toxical since within several seconds it turns into oxygen;

Ozonization shortcomings. Ozone is explosive and toxic reagent, it is more expensive way in comparison with chlorination. Bystry decomposition in the fulfilled water (in 20-30 minutes) limits its use, after ozonization significant growth in microflora owing to reactivation of bacteria and secondary pollution is quite often observed. Even high doses of ozone and long exposure do not provide completely effective disinfecting concerning bacterial spores. When processing water collateral toxic products can be formed by ozone: bromates, aldehydes, ketones, carboxylic acids, etc. connections. These products can cause mutagen, etc. adverse effects.

Other reagent ways of disinfecting of drinking water (use of peroxide of hydrogen, oligodynamic effect of silver and copper, iodine drugs) did not find broad application and are used for processing of an individual or small group deposit of moisture on navy, spaceships, in field conditions and extreme situations.

Ultraviolet radiation (UFI) - the most effective and widespread way of physical disinfecting. Method advantages: speed of action, efficiency of influence not only on vegetative, but also on sporous forms of bacteria, eggs of helminths and

viruses.

Ionizing radiation. Gamma radiation possesses the expressed bactericidal action. The dose 25 000 - 50 000 P causes death practically of all species of microorganisms, and the dose 100 000 P exempts water from viruses.

Ultrasonic fluctuations (UZK) promote mechanical destruction of bacteria in the ultrasonic field.

Thermal ways of disinfecting: open flame (high-temperature plasma), hot air, superheated steam, boiling. Boiling is used for disinfecting of individual or group reserves of drinking water in house conditions, on autonomous objects and transport, at a difficult epidemiological situation.

The combined chemical ways: use of chlorine and ozone, chlorine drugs with hydrogen peroxide, ions of silver and copper, hydrogen peroxide with ozone, some other combinations.

The combined physical ways: combination of UFI and UZK, heat treatment to UZK or gamma radiation, complex of electric influences.

Now the possibility of use of the pulse electric discharges (PED) for disinfecting of drinking water (so-called "electrohydraulic effect") is considered.

Physical and chemical ways: U FI combination to ions of silver and copper, UFI to chlorine and peroxide of hydrogen, UZK and chlorine. The high antimicrobic effect, existence of an after-effect are characteristic of them.

Practical work No. 1

Definition of a potrebny dose of a coagulant

The working dose of a coagulant depends on water temperature, pH, a turbidity, coloring, the size of removable rigidity. The more rigidity, the more is required a coagulant. However at surplus of a coagulant a part it remains nerazlozheiny, water becomes muddy, develops an acid taste. In very soft water coagulation proceeds badly since there is no sufficient formation of the flakes of hydroxide of aluminum settling on a bottom. In such cases add hydropotassium carbonate or lime to water to increase removable rigidity and to provide flocculation.

Definition course:

In three glasses pour 200 ml of the contaminated water. In the first glass flow 2 ml of 1% of solution of sulfate aluminum, in the second - 3 ml, in the third - 4 ml. Contents of glasses are mixed a glass stick within 1-1.5 minutes and left for 20-30 minutes, watching the coagulation course. For calculation choose togas a glass where reaction is expressed better at the smallest quantity of a coagulant. If coagulation proceeds inertly, with insignificant formation of small flakes, water alkalinize by addition in each glass 1% of solution of soda in quantities, half smaller, than is taken a coagulant.

Situational task. Water analysis

1. Transparency - 26 cm
2. Color - slightly yellowish
3. Smell - 3 points
4. Turbidity - 2,0mg/l
5. Rigidity the general -11,5 мг-ecv/l
6. Ammonium salts - 0,1mg/l
7. Nitrites - 0,004 mg/l
8. Nitrates - 50,6 mg/l
9. Oxidability - 7,3 mg/l
10. Chlorides - 54,7 mg/l
11. Sulfates - 20,0 mg/l

23

12. Iron salts - 0,5 mg/l
13. Fluorine - 0,4 mg/l
14. Coli-index - 4
15. Quantity of bacteria in 1 ml - 450
16. Flora and fauna - β - mesosaprobes

Questions:

1. To compare indicators about the SanPiN 2.1.4.559-96 and to specify on what of them water is not suitable for drink.
2. What indicators characterize chemical pollution of water?

3. To estimate prescription of pollution of water.
4. What is saprobity?
5. Offer methods of improvement of quality of drinking water.

Answer standard

1. Water is not suitable for - drink on all organoleptic indicators, on physical and chemical (high general rigidity, the content of salts of ammonium, nitrates, high oxidability is increased, the content of iron, insufficient content of fluorine is increased) and to bacteriological indicators. Existence of mesosaprobes says that it is a reservoir of average pollution where the content of organic matters rather small and their disintegration reaches a full mineralization.
2. Nitrogen-containing substances, oxidability.
3. Pollution is older since the content of salts of ammonium and nitrites is normal.
4. Saprobity - ability of water organisms to develop at a certain content in water of organic matters and products of their disintegration.
5. Water needs to be subjected to cleaning, disinfecting (normal doses of chlorine). From additional methods softening, an obezzhelezyvaniye, fluoration are necessary.

Literature

1. Avchinnikov A. V. Hygienic assessment of modern ways of disinfecting of drinking water//Hygiene and sanitation. - 2001. - No. . — Page 11 - 20.
2. Krasovsky G. N., Egorov N. A. Water chlorination as a factor of the increased health hazard of the population//Hygiene and sanitation. - 2003. - No. 1. - Page 17-21.
3. Muzychuk N. T. Water disinfecting by ions of heavy metals in electric field in the small inhabited places//Hygiene and sanitation. - 1990. - No. 1.-: Page 24-27.