

Problems of wastewater clearing

Inom Sh. Normatov, Ilhomiddin M. Rakhimov, Nurkhon S. Karomatulloeva

Institute of water problem, Hydropower and Ecology Academy of Sciences Republic of Tajikistan, 12, Parvin str., 734002, Dushanbe, Tajikistan, Tel/Fax: +99237 2245231, E-mail:owp@tojikiston.com

Water as one of the main and more dynamic components is especially vulnerable to influence factors of anthropogenic character.

In condition of Tajikistan, in connection with great population percentage in the river valleys and allocation of main industrial objects in this zone, the influence factors of anthropogenic character gain the special description and actuality.

The choice of quality potable water technology which possibility of formation of mutation active combinations during working out is brought to minimum, depends first of all, on physical-chemical and microbiological components of natural water which is determined by climatic and hydro-chemical conditions, characters of water plants, anthropogenic load on natural sources.

The traditional technological schemes of preparation of potable water consisting from pre-chlorination, working out by coagulants, filtering and disinfections by chloride decrease total content of organic admixture to about 50%. In the modern technologies of water preparation one of the sharp problems is formation of additional chloride organic products during chlorination of water, which has instant organic substance.

Presence in water Cu; Mn; Zn; Al; Fe increase the content of trichalogenmethans in 2-3 times and Pb in 5.6 times. As a result, during chlorination there are formed trichlormetan, chloride vinegar acid, chloracetone, polychlorinated phenols and chlorates. It is known that chlorate alongside with chlorite causes hemolytic anemia of animals. During water chlorination there is formed mutagen combination MX (3-chlor-4-dichlormethyl-5 hydroxi-2(5H)-phuranole), presented in potable water in concentration of 2-87 ng.p.dm³.

Conducted onkoepidemic investigations testify the increasing diseases of digestion organs and risk of bladder cancer and thick intestines tumour of people, using long enough chlorinated potable water. Because of possible health damage the World Health Organization (WHO) now considers the question on introduction of Marginal Concentration (MC) on chlorate in potable waters. It is recommended that total content of $\text{ClO}_2 + \text{ClO}_2^- + \text{ClO}_3^-$ in potable water should not exceed 1 mg.p.dm³.

Water quality indexes are divided into two groups: primary and secondary.

The primary indexes characterize the water of source and consist of organoleptic, permanganate oxidization, biological indexes, and concentration of different ingredients.

The secondary indexes characterize the by-products of processing the water reagents, such as chlororganic combinations (chlorination products), aldehydes, ketones (products of ozonization), sedimentary aluminum (while using coagulants on the aluminum base), sedimentary flocculent, etc.

Principal difference between two groups is that primary indexes decrease and secondary ones increase with the tempo growth of its reagents. So, a secondary index strongly limits the dozes of reagents.

During the water-supply systems analysis the main direction is considered to be optimization of water- deliver due to great energy expenditure for water overpumping. Considerably less attention is paid to optimization of reagents expenditure for water processing, though this problem is becoming more and more actual.

During coagulation cleaning of natural surface waters the main part of pollutants, responsible for turbidity and chromacity is removed out of them.

Alongside with it contents of phytoplankton, microorganisms, combinations of different metals is sharply reduces.

In this respect, the great attention should be paid to coagulation unit while working out the modern technological schemes of water preparing.

The most spread coagulants are aluminium sulphate (AS), chloral iron, natrium alumina. Aluminium sulphate is often used both in our country and abroad. However, for the last time in the practice of water preparing and water clearing there is a tendency to use more effective coagulants – main aluminium sulphates (MAS) and main aluminium chlorides (MAC).

The substantial shortcoming of AS is reducing the effectiveness of its coagulating activity at lowed temperature of cleared water. Increasing the stability of aluminium hydroxide under these conditions (1-2⁰C) lower the speed of aggregate formation and sedimentation, what leads, in its turn, to increasing the contents of sedimentary aluminium in cleared water.

Aluminium in living beings does not play any physiological function, though it is included in living substance. Aluminium, coming into organism with water as insoluble phosphate, is taken out with faeces, and partly is absorbed into gastrointestinal tract, blood and is taken out by kidneys. If kidneys activity is violated, aluminium is accumulated and accompanied by bones brittleness, violated metabolism of Ca, Mg, P, F and different forms of anaemia. There were discovered more complicated cases of aluminium toxicity: speech violation, memory loses, reason insanity, convulsions. On the contrary, during MAS and MAC observations, there is achieved the removal of clayey and organic matters, decrease of solute aluminium in cleared water. It was established, that MAS base increase leads to strengthening of forming flakes and improvement of their sedimentation features. In the case of MAC, there is achieved the decrease of reagent dose for 10-30 % in dependence of water quality.

Post-chlorination stage in clearing technology is necessary to preserve the sanitarian quality of water in the nets because of sedimentary biologically oxidized organic matters in the water.

If there are no disinfection's reagents, the number of bacteria in the water may achieve 10⁷ p.cm³. Chlorine introduction even in number of under 0.1-0.2 mg.p.dm³ has limited influence on already formed biofilm and does not exclude the possibility of its formation on pure surface. Biologically oxidized organic matters, contained in the water, play a great role in biofilm formation, i.e. nutritious environment for bacterial growth. If we lower the concentration of solute organic carbon (SOC) down to 0.1-0.2 mg.p.dm³ at the input to the net, it is possible to prevent the biofilm from formation on the walls of pipelines.

Thus, if to achieve complete SOC extraction from potable water, it is possible to decline the post-chlorination.

World Health Organisation formulated the conception of creating the technologies of quality water preparation. This conception includes:

- creation of various barriers in the water clearing process for complete removal of pathogen agents, pollutants and biodecomposed combinations before complete disinfections.
- optimisation of chemical reagents using during water clearing and working out physical and biological methods of clearing to reduce necessary doses of chemical reagents.

For the last time the most interest attracts such strong gaseous oxidant as ozone. This is caused, first of all, by the fact that during it's using no adding admixtures are inserted into flows. And what is the most important, disinfection's matter ozone acts in 15-20 times faster, than chlorine. Ozone is produced on the place of utilization. Ozonization promotes water oxygen saturation.

The main expenditures, influencing the ozonization process, are capital expenditures on equipment and electric power costs. At the present there is a number of improving ways of this perspective process, in particular, at the account of increasing raw material concentration on the base of complete exchange of atmospheric air by technological air.

According to world achievements analysis in the sphere of the most perfect technologies of potable water preparation, one or two ozonization stages followed by water filtration through granular activated coal are included in modern water preparation technology.

Perspective is the technology, using non-aerated filters with fixed heterophase active biomass and with ethanol as a carbon. It allows reaching the filtration speed up to 10 m³.p.m²* h

and reducing nitrates ratio from 40-65 to 15-17 mg.p.dm³, ammonium from 2-3 to 0.02 mg.p.dm³.

It is remarkable that denitrified bacteria without oxygen or with its low concentration use nitrates to oxidize organic matters. If there are plenty of organic matters, necessary to be oxidized and if there are available respective bacterial cultures, nitrate reduction is implemented to molecular nitrogen.

According to the results of the last years' research, we can state that coagulation method, based on using natural powdery silicates as additives and basic coagulating reagent – aluminium sulphate is perspective and promising.

For example, clinoptilolite bringing into clearing water together with coagulant in correlation of 1:1 allows increasing to clear water from turbidity for 73 %, from chromacity for 55 %, and from sedimentary aluminium for 65 %, comparing with traditional coagulation method.

The most important is reducing of sedimentary aluminium in cleared water to the norm, recommended by WHO, that is less than 0.2 mg.p.dm³.

Optimal dose of coagulant ($Al_2(SO_4)_3$) to clear water with the turbidity of 5.1 % mg.p.dm³ and with chromacity 49 hailstones is 15 mg.p.dm³, taking into account Al_2O_3 . Co-using of aluminium sulphate and powdery clinoptilolite allows economizing coagulant consumption for 10-15%. Besides, during clinoptilolite adding hydraulic greatness of flakes considerably increases and their sedimentation features improve.

Aluminium hydroxide, precipitated onto grained material, extracts fluorine effectively out of water. Therefore, water defluorination is implemented by means of using the sand, ceramist, crushed clinoptilolite, processed by saline aluminium. Maximal aluminium capacity has alum modified clinoptilolite (0.5-0.10 mg.p.g), which in its natural shape does not extract fluorine.

Thus, in order to achieve high indexes for potable water quality and to realise the WHO conceptions it is necessary to strengthen research and practical work in modernization of traditional and working out of modern water preparation technologies. There should be applied local alum silicate material of Tajikistan Republic.

Today we know 8-9 ml chemical matters, which can be synthesised and used this or that way. Out of this great number approximately 5,000 matters are produced on a mass scale, and about 50,000 on a large scale. Their production almost always is accompanied by water using of this or that volume. A part of it, saturated with various intermediate and partly with end products, then is thrown into basins.

Human beings influence greatly the hydrosphere, while mining the minerals. Passage of mining output, mines construction, well-boring, quarries creating change natural regime conditions of underground and surface water. The deepest mines now are of 4 km, and open mining are of 0.8 km. For 1 ton of coal there is pumped out in average 2-3 m³ of water. Influx of underground water into coalmines and quarries of our country exceeds now 2.2 km² annually, into iron ore mines and quarries – 0.5 km³. Total volume of extracted while mining water reaches several cubic kilometres as a whole around the country. In underground mining region in the result of water pumping out there reduces the underground water level. Consequently, sources dry up, water intake chinks are drained, and pumped out waters are thrown into surface basins or pumped through the chinks into other water carrying horizons. That changes water quality. Sometimes pumped out waters are used for industrial demands and irrigation.

Thus, human being, influencing the underground waters, first of all influences the standing level of these waters. Level falling causes underground reservoir exhaustion and in future the cessation of it's using. Level increasing of underground waters leads to soil salting, swamping, ground destabilisation. In many cases there is changed the water quality, fresh water is substituted by a little bit salty or more saline water, there is the ground subsidence on great territories.

In the cities human beings almost completely transform the territory surface, making it waterproof, destroying surface river network and changing other water objects. At the same time

there is created artificial drainage network to drain both natural rainwater, melted water and processed water, coming to cities through the drainage transference system or from underground sources. In Moscow more than 100 water flows disappeared from the surface. Now they are either heaped or hidden in underground galleries. According to some observations the city considerably changes water balance and deposit balance on its own and adjoining territory, which is much greater. And still, it is not the most negative feature of the city. In its influence the cities produce a great number of waste matters, which finally goes into surface and partly into underground waters, into ocean and atmosphere part of hydrosphere.

Even 5-6 thousand years ago there were conducted flow regulation works on the rivers Tiger and Ephrata, there were constructed great canals, used not only for irrigation, but for water supply to populated areas, and for transport demands.

During the last thousand years B.C. there was the period of hydromechanics prosperity. At that time there were created complicated systems with close water supply. They are known by different names depending on countries, where they were created. These systems were underground canals-galleries, spreading on many kilometres, and there were gathered both surface an underground waters.

At the first phase of human development artificial irrigation and water supply systems of populated areas were usually joint. But with urbanization and popularisation there appeared the necessity to construct separate water supply systems of populated areas. It was the second success in the development of water supply per capita.

Tajikistan, having great water resources, till 1990 took a little more than 14 cubic km. or 17.4 % of water to meet own demands according to given limit. As a result at present there are developed and irrigated 720 t. ha. (45 %) out of potentially profitable 1.6 ml. ha. Construction of new irrigation systems and land irrigation are temporarily stopped because of economical crisis in our country in post-Soviet time.

In our republic scientific-based irrigation norms are approved at the average 14.8 t. m³.p.ha, including for Sogdian Oblast 12.2, for Kulob region 14.1, for Kurgan-Tube region 16.9 and for republican subordination regions (Hissar Valley) 15.6 t. m³.p.ha.

Because of non-regulatory drainage of water sources there is water deficiency for 140 t. ha (20 %) of irrigated lands in the republic. In Istravshan regions water supply for 30 t. ha of irrigated lands is not more than 55 %, in Kulob region water supply for 60 t. ha. is on the level of 60-65 %, and in Hissar Valley – 20 t. ha.

To improve the water supply of these lands it is necessary to take a number of measures, such as:

- re-organization of irrigation network and increasing the efficiency of canals;
- application of water preserving technologies for watering;
- conducting moisture accumulating watering and cultivating cultures, requiring less water on the lands with complex relief and subsidence soil grounds;
- reservoirs, tunnels construction, interbasin water transference.

Under the conditions of strong water limit, established for Tajikistan, rational use of irrigational water by improving principles of soil-ameliorative and hydrounit regioning, development and application of scientific-based irrigation regimes, progressive water preserving technologies are the most important.

Technology of dropping irrigation allows accumulating in soil additional 450-470⁰ C warmth and to obtain 28-30 centers per ha of unprocessed cotton and the economy of irrigation water is 3,100 m³ or in 1.5 times less than at furrows watering. During cotton dropping watering with broadness between rows of 90 cm the yield of unprocessed cotton increases for 40-45 % and irrigation water economy is 35-40 %.

Questions of water division and distribution along transeboundary rivers in Central Asia were regulated by the decisions of Scientific Technical Committees (STC) in former Soviet Minvodhoz and by the Schemes of Water Resources Complex Use, confirmed by the republics.

Amudarya and Syrdarya basin drain was distributed among the CA republics by the protocol decision of STC, Minvodhoz USSR of 03.12.1987 # 566 and of 07.1984 # 413. For Tajikistan Republic there were given resources of 14.3 cub. km, including Amudarya basin – 10.63 cub. km: 7.92 cub. km for irrigation; Syrdarya basin – 3.66 cub. km: 3.17 cub. km for irrigation.

By means of this water volume Republic can increase the irrigated territory up to 838 t. ha, if there are applied water preserving technologies and irrigation norm is reduced to 13.2 m³.p.ha. in this case 0.1 ha will be per capita, that is in 2 times less than in average for Aral Sea basin.

Taking into account meeting the demands of future generations in food products and economical development, it is necessary for Tajikistan to use in perspective about 20-22 cub. km of water resources out of 64 cub. km of these formed in its territory.

Following the “not-to-damage” principle it is possible to increase water intake gradually during decades. Each person, town, area, oblast, state and region on the whole must strictly realize peculiar strategy of rational, careful water using. The main points of this strategy must be:

- to keep to acting and in future agreed by 5 CA States, irrigation norms for different watering ways and, first of all, for surface way, which will be dominating for a long time yet;
- to create, first of all, such economical mechanism, when it is not profitable “not to economize water”;
- to organize everywhere water users associations and to improve economical interrelations between water users and water suppliers;
- to inform land owners about using the simplest ways of water economy, from current land planning, night and concentrated watering, water circulation, dosed water volume supply etc., to taking anti-filtration measures, reconstructing irrigation systems and applying new irrigation technologies.