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PLANNING OF RECONSTRUCTION OF PURIFICATION FACILITIES OF WATER TREATMENT SYSTEM IN THE CITY OF AUSTIN (NORWAY)

In Norway, surface water is used as the main source of drinking water. Natural water from lakes, rivers, water bodies of Norway contains much less pollution than the natural water of other European countries. However, it also contains various organic compounds, which are defined as natural carbonaceous organic matter (NCOM). The total content of NCOMs and compounds of technogenic origin characterizes the general water pollution. In this case, the parameter of dissolved organic carbon (DOC) is used [1]. In addition to organic compounds, there is a danger of contamination by ions of heavy metals that enter the water from the atmosphere: lead, zinc, mercury, etc. A large percentage of mineral fertilizers introduced into the soil is washed out of it by rainwater, pollutes water bodies, and also carried by rivers to the seas and oceans. Nitrogen and phosphorus in surface sources cause rapid development of unicellular algae. In the presence of nitrates and phosphates to water, under the influence of solar radiation and heat, these plants reproduce extremely fast. The relatively high content of humic substances in the water, as well as its color, are the main problems in the field of water treatment in Norway [2, 3]. The requirements for drinking water quality are determined by the Regulations on drinking water, which are published by the Department of Health and Social Welfare. In accordance with the requirements, water must be free from physical, chemical and microbiological particles that can be hazardous to health; should be without smell, taste and color. These rules comply with the requirements of the EU "Drinking Water Quality Directive ..." 98/93 / EC of 1998)

Typical projects of Norwegian plants are based on three stages: coagulation, filtration and disinfection by ultraviolet irradiation. Such a technology currently provides a high degree of purification, but with increasing water consumption, and under the influence of natural factors (for example, after precipitation or melting of sediments), the existing stages of coagulation and disinfection may not be able to cope with the amount of pollutants entering the treatment facilities, which does not guarantee Consumers of obtaining quality drinking water in the future.

Nowadays, the drinking water preparation plant in Austin has a capacity of 250,000 m^3 of water per day. In connection with the constant population growth and the development of the region's industry, the need for clean drinking water will increase. Therefore, the task is to consider the growth conditions up to water consumption up to 350,000 m^3/day, taking into account the minimization of the growth of the area of treatment facilities. In the Austin they are built inside the rock and an increase in the area will require very large material and financial costs. Ways to solve this problem are possible with the use of the ozonation process at the stages of coagulation and disinfection, which, in combination with the existing stage of ultraviolet irradiation, guarantees consumers with quality drinking water.

The technological scheme of the water treatment plant consists of the following stages:

1. Natural water is taken at a depth of 30 meters below the surface of the water.
2. To create a stable and suitable acidity for the processing process, carbon dioxide (CO_2) and lime are added before the coagulant is fed.
3. Then, an aluminum-based coagulant is added that binds to humus (a natural organic substance), forming a gel-like complex state. As a result of the process of coagulation in water, flakes of sol from solids and microorganisms are formed. In addition, micro-sand is added (sand with a particle size of about 130 μm.). Flakes of aluminum sol and micro-sand are mixed. After this, a polymer is added to bind the aluminum sol and sand with the acceleration of the formation of large, durable flakes. Flakes quickly sink to the bottom of the sump and are removed in the

form of slime. Purified water enters the next stage of water purification, and the sediment is transported to the slurry processing section.

Such a coagulation system was called the Aktiflo installation.

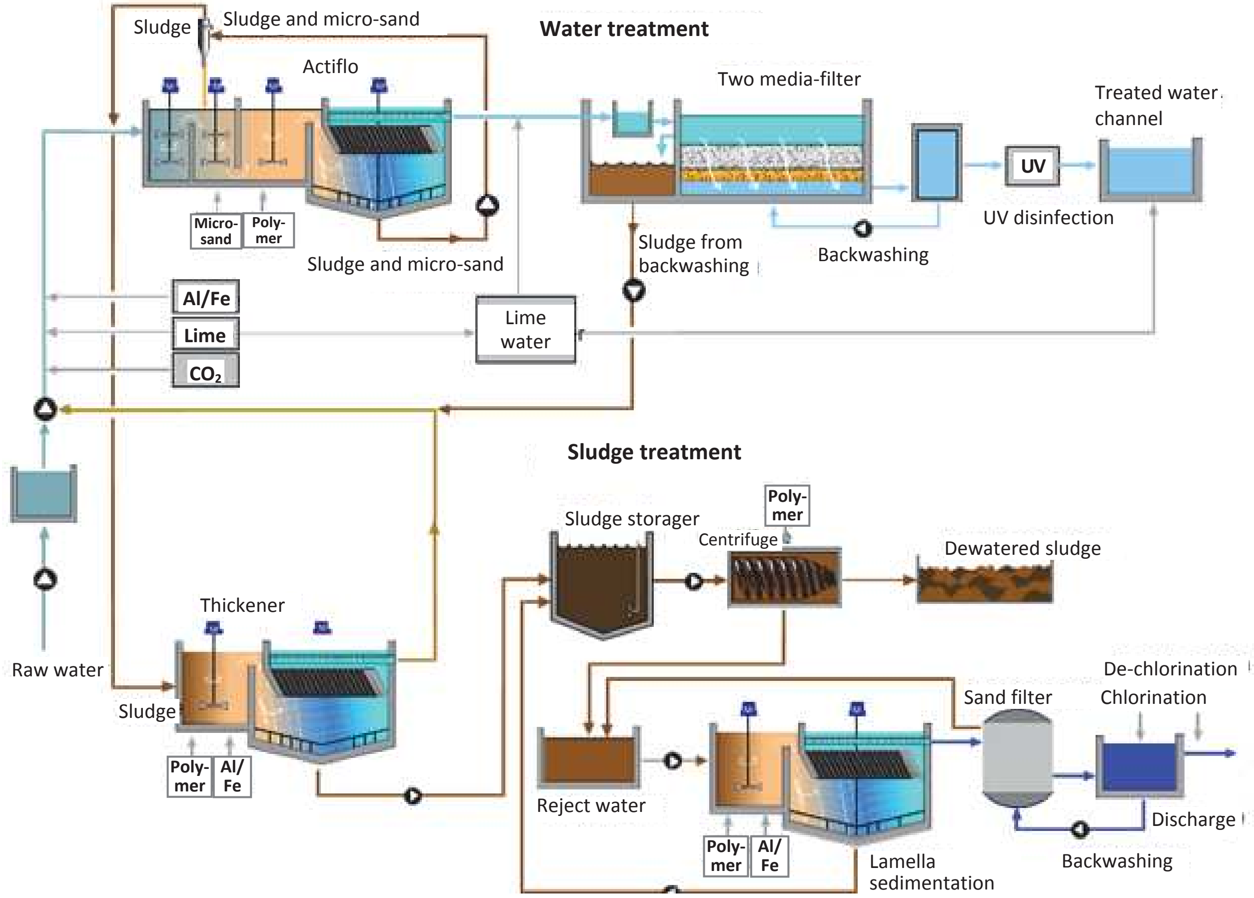

Figure 1 – Flow chart of the water treatment plant in Oset

4. In the filters, water is passed through a layer of filter cloth and a layer of sand. Coagulation and filtration complete the first hygienic barrier in accordance with the requirements of the Regulations on drinking water.

5. UV disinfection is the second hygienic barrier. UV irradiation penetrates into cells of microorganisms and damages their DNA in such a way that organisms can not reproduce. UV disinfection is effective against bacteria, viruses, parasites and spores.

6. At the end of the process flow, lime is added in order for the water to have a pH of 8.0. Correlation with pH is necessary to minimize the corrosive capacity of drinking water, which increases the duration of operation of pipes in municipal and private ownership.

7. From clean water reservoirs in Oset, drinking water is pumped through the water reservoir Ervoll to the northeast and south-eastern parts of Oslo. In the rest of the city, water is fed by gravity through the Gripsen tunnel and the Nydals pipeline.

To increase the efficiency of the coagulation process, the following technological methods are used:

- preliminary treatment of water with oxidants;
- increase in the mixing time;
- use of filter washing water and settling sediments;
- use of a mixture of coagulants;
- use of flocculants;
- using the method of concentrated coagulation;
- electric and magnetic fields.

In this work, the use of ozonization at the stage of disinfection using the residual ozone-air mixture in the preliminary ozonation of water is considered. The method of pre-ozonaton is the most effective of the methods considered for the integration of the coagulation process and the subsequent stages of purification. Pre-ozonization, as follows from the practice of its use, increases the efficiency of coagulation and filtration.

In addition, pre-ozonation has the following positive effects:

– transfer of dissolved organic high-molecular compounds into a colloid form;

– more complete removal of DOC (during subsequent deposition, flotation or filtration;

– reduction of the dose of coagulants necessary to achieve the required degree of clarification of water;

– displacement of the distribution of pollutant particle sizes towards larger ones;

– Increase the rate of precipitation of flakes and the duration of the filter cycle.

It has been experimentally established that small doses of ozone, often 0.5-1.5 mg/dm^3, and in general <3 mg/dm^3, are the most effective. A further increase in the dose when water is treated with a coagulant leads to a breakthrough in the filtrate of a fine fraction of the sand loading and an increase in the concentration of residual aluminum. Water hardness also affects the flocculating ability of pre-ozonation. Optimal coagulation under the influence of ozone is observed in natural water with a stiffness ratio to the DOC content exceeding 25 mg $CaCO_3$ per 1 mg of C, and at ozone doses in the range 0.4-0.8 mg O_3/1 mg of C.

Ultraviolet irradiation is considered to be the optimal method due to its economy, safety of nonreagency in comparison with other disinfection methods. The effectiveness of UV disinfection of water is inferior to ozonation, however, when water contains any particularly resistant bacteria or organic compounds, the use of UV disinfection of water with ozonation is the most effective option.

Based on forecasts of changes in surface water quality in the future, as well as increasing the capacity of the treatment plant, ozonation will make it possible to increase the efficiency of the weakest part in the current technological scheme - the process of disinfection, which is currently provided with water treatment only with ultraviolet irradiation.

Ozonation and UV irradiation will lead, on the one hand, to the formation of $HO^{\cdot}$ and $HO_2^{\cdot}$ radicals, which will increase the rate and depth of processing of organic impurities, and on the other hand, completely decompose toxic dangerous residual ozone in the final product - drinking water. Reactions of formation of $HO^{\cdot}$ and $NO_2^{\cdot}$ have the highest yield with UV-irradiation of ozonized water, which once again confirms the multi-purpose positive effect on the ozonation process [4].

Our data [5, 6] confirm that ozonation has a positive effect on the removal of chromaticity (natural organic matter) and the removal of different types of bacteria, such as heterotrophic bacteria and colibacilli. The degree of color removal, in general, for different types of water at a wavelength of 410 nm is 8-45 %, at a wavelength of 254 nm - 3.5-31 %. The degree of removal of heterotrophic bacteria for natural surface waters is 9-24 % at an ozone concentration of 0.5 mg/l, and 91-97.5 % at an ozone concentration of 2 mg/l. The degree of coliform removal in natural and model water at an ozone concentration of 0.5 mg/dm^3 reaches 24.9-27.7 %, and at a concentration of 2 mg/dm^3 it is 89-91 %.

At ozone concentrations of 0.5-2 mg/dm^3, after 10 minutes of contact with the tested water, positive results were observed: removal of chromaticity for natural surface waters by 21-43 %, and by 10-40 % for model waters based on humic compounds. Also, the number of heterotrophic bacteria decreases by 91-94 % and coliform bacteria by 88-90 % in natural and model waters. The results of the studies show that ozonation positively affects the removal of chromaticity, which is due to the presence of natural organic substances, as well as the removal of heterotrophic bacteria and colibacilli.

Thus, ozone acts not only as a strong oxidizing and disinfecting agent, but also decomposes complex organic substances.

The basic technological scheme of the drinking water treatment plant of the city of Oset after the reconstruction is shown in Figure 2.

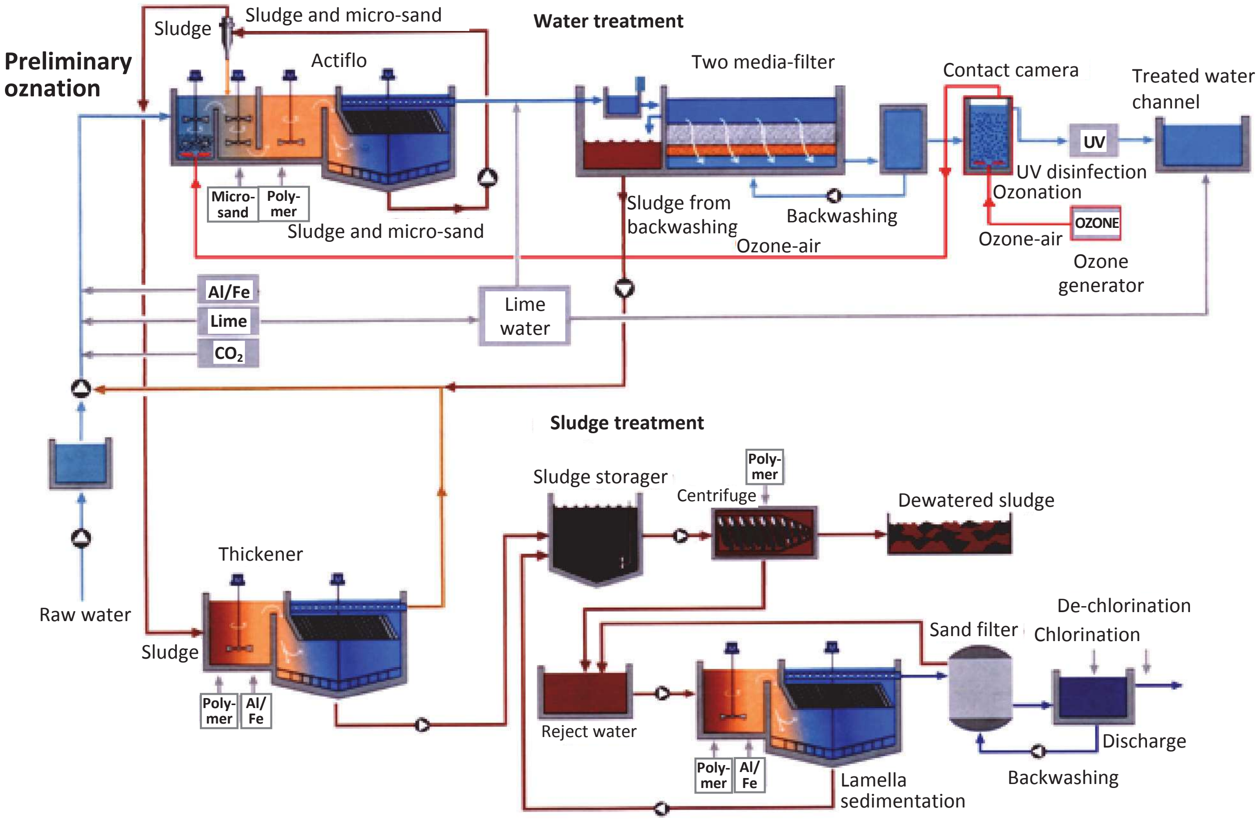

Figure 2 – The planned reconstruction of treatment facilities of the water treatment system in the city of Austin

Taking into account the chosen water consumption, a technological calculation of the water ozonation unit was made for a minimum dose of ozone. The calculation of the size of the bubbling contact chamber for pre-ozonization at the stage of coagulation, the selection and calculation of the number of ozonizers, the calculation of the refrigeration unit, the calculation of the drying block, the heat balance of the regeneration process, the calculation of the dust filter and the ejector are determined by calculation.

Conclusions

1. The main advantage of the installed technology is that it provides a high degree of treatment while minimizing the growth of the area of treatment plants and ensuring that consumers receive quality drinking water in the future.

2. Deep-treated water treated with ozone is discolored, deodorized, released by 92-95 % of organic substances, disinfected and saturated with oxygen. To achieve the desired effect, the ozone dose should be 1.5-1.6 mg/dm^3.

3. After the ozonation stage, water enters the UV treatment stage, where, under the action of ultraviolet irradiation (when the residual ozone is decomposed to oxygen-containing radicals), it is completely freed from organic compounds and can be used as a drinking

4. When ozone is introduced into the pipeline by ejection, its losses are minimal, and the cleaning effect is higher than when ozonizing in bubbling chambers. The advantage is the simplicity and compactness of the mixing device, its low cost, as well as the possibility of fine adjustment of the residual ozone (0.4-0.5 mg/dm^3) in the ozone-air mixture, which enters the head of the water treatment coagulation stage.

5. Ozonization and UV-treatment of water for its further purification not only provides high- quality water treatment performance, but also technically and economically efficient.

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ПОИСК НОВЫХ МАТЕРИАЛОВ ДЛЯ ОЧИСТКИ СТОЧНЫХ ВОД ОТ ИОНОВ ТЯЖЕЛЫХ МЕТАЛЛОВ

Проблема очистки производственных сточных вод отсоединений тяжелых металлов является одной из наиболее важных и труднорешаемых. Несмотря на огромное число отечественных и зарубежных разработок, данную проблему нельзя считать решенной. Известно, что попадание тяжелых металлов со сточными водами в водоемы приводит к накоплению данных соединений в организме гидробионтов, растительной массе, что в последующем может приводить к гибели водных организмов, угнетению растительности, снижению биоразнообразия водоемов, миграции ионов металлов по пищевым цепям и т.д. Вред, причиняемый населению и народному хозяйству сточными водами, содержащими тяжелыми металлами, делает обезвреживание этих вод важной задачей.

Одним из значимых источников образования сточных вод, содержащих ионы тяжелых металлов, являются гальванические цеха металлообрабатывающих, приборостроительных, машиностроительных предприятий. В Республике Беларусь более чем 140 промышленных объектов имеют гальванические производства. Наиболее часто на таких предприятиях осуществляется нанесение цинковых, хромовых, никелевых и медных покрытий [1]. Вследствие этого сточные воды данных производств содержат значительное количество соединений тяжелых металлов в своем составе.

Цель работы заключалась в поиске новых материалов для извлечения ионов тяжелых металлов из сточных вод.

Анализ номенклатуры и свойств отходов, образующихся на промышленных объектах Республики Беларусь, позволил установить, что на теплоэнергетических объектах, а также на ряде предприятий, где организована водоподготовка, образуются отработанные ионообменные смолы. Данные отходы в настоящее время не находят применения и подвергаются хранению или захоронению. Для извлечения ионов тяжелых металлов из воды в работе использовали отработанные ионообменные смолы разных классов: анионит марки АВ-17-8 и катионита марки КУ-2-8. Данные отходы согласно [2] имеют 3 класс опасности (анионит) и 4 класс опасности (катионит).

Для увеличения поверхности соприкосновения твердой (ионообменная смола) и жидкой (раствор металла) фаз проводили измельчение ионообменных смол до размеров