Technical alternatives for the reconstruction of the «Ternopilskyi» water intake of the «Ternopilvodokanal» Utility Company

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Abstract –Ukraine faces problems with contamination of underground sources of water supply due to a low level of environmental protection and insufficient attention to the problems of drinking water supply. Operational and planned restoration of water supply and drainage systems and facilities is an urgent task for any modern city or settlement..

Keywords – technical alternatives, water intake reconstruction, water quality, environmental impact, environmental safety, environmental impact assessment

Introduction

According to UN data on the state of water resources in the world [1] Ukraine ranks 95th out of 122 possible cities in terms of water quality. Among the main reasons for the unsatisfactory quality of water supplied to consumers, the following can be distinguished: Ukraine is among the countries with a poor supply of fresh water [2]; all sources of water intake in Ukraine correspond only to 3 and 4 quality categories; unsatisfactory state of equipment and use of outdated water treatment technologies; chlorination of water leads to the formation of a number of organochlorine compounds; the service life of 60-70% of the country's water mains has already expired, or they are in an emergency state. In view of the above, it is urgent to carry out the reconstruction of water intakes in small cities in order to ensure the sustainable development of the regions of Ukraine.

On the territory of the operating water intake of the UK «Ternopilvodokanal», where underground fresh water is extracted for the economic and drinking water supply of the city of Ternopil, the reconstruction of the «Ternopilskyi» water intake is planned. The water intake, located northwest of the central part of the city, on the shore of the Ternopil pond, has been in operation since 1949, includes 14 artesian wells. The aquifer is protected from pollution.

The planned activity consists of the reconstruction of the complex of buildings and structures of the «Ternopilskyi» water intake of the UK «Ternopilvodokanal». In the process of reconstruction, the implementation of a set of project measures is foreseen: reconstruction of water intake wells, collection pipelines, the water intake pumping station of the II rise (WIPS No. 1), clean water reservoirs (CWR), a deironing station, the implementation of water softening and defluoridation systems, drinking water disinfection technologies with low-concentration sodium hypochlorite, reconstruction of the power supply, the implementation of an automatic technological process control system, reconstruction of the flushing water drainage system, and improvement of the territory.

According to *technical alternative 1*, the technological process of water preparation includes:

- water deironing;

- water softening;
- water defluoridation;
- water disinfection with low-concentration sodium hypochlorite.

From water intake wells, water is supplied to the deironing station and, after water treatment, is supplied to clean water tanks. Disinfection of drinking water is provided by the dosage of low-concentration sodium hypochlorite.

According to *technical alternative 2,* the technological process is similar to technical alternative 1, except for water disinfection, which takes place with the use of liquefied chlorine.

The disinfecting effect of sodium hypochlorite (technical alternative 1) is based on the fact that when dissolved in water, it forms hypochlorous acid and hypochlorite ions, which have an oxidizing and disinfecting effect, just like chlorine. While maintaining all the advantages of the chlorination process, the sodium hypochlorite disinfection method avoids the main difficulties associated with working with highly toxic liquid chlorine [3]. The use of sodium hypochlorite makes it possible to avoid the main difficulties associated with the transportation and storage of toxic gas. In addition, the use of this reagent makes it possible to eliminate the user's constant dependence on plants supplying liquid chlorine or other chlorine products produced centrally by the chemical industry, as well as on the use of specialized vehicles.

Technological process according to *technical alternative 1*

Water supply from wells

Water from the wells is supplied to the deironing station:

- along the collecting pipeline Ba1 (from the group of wells No. 1-6);
- along collecting pipelines Ba2.1, Ba2.2 (from the group of wells No.7-14).

Switching of pipelines Ba1 and Ba2.1 is planned (according to the existing scheme).

Primary disinfection

In front of the deironing station, low-concentrated sodium hypochlorite from the water treatment station is provided for dosing into the Ba1 and Ba2.1 pipelines through the Вхл0 pipeline.

Deironing of water

In the deironing station, water passes through rapid filters and is collected in the deironed water pipeline.

Washing of rapid filters

The washing of rapid filters is carried out with water from wells from collecting pipelines (Ba1 and Ba2.1), the selection of water for washing is provided in the building of the iron removal station.

Water supply to clean water reservoirs

From the deironing station, purified water flows by gravity through the Bf pipeline to the CWR through a branch:

- Вф1.6 - into CWR -1;
- Вф1.7 – into CWR -2;
- Вф1.8 – into CWR -3.

Water softening

Part of the iron-free water from the Вф pipeline through the B3.1 pipeline is taken to the water softening department of the preparation station by pumps Q = 68m^3/hour.

The softened water is returned to the Вф pipeline through the B6H pressure pipeline.

Defluoridation of water

From the defluorination station, sodium fluoride solution is metered into the Bф pipeline through the Bф pipeline.

Disinfection of drinking water

Disinfection is carried out with low-concentration sodium hypochlorite (depending on the consumption of pure water) in the Bф pipeline. Dosing is carried out from the water treatment station through the inlet pipeline.

Supply of drinking water to consumers

From the clean water reservoirs, drinking water of drinking quality is supplied to consumers by pipelines B1.1, B1.2, B1.3 by the WIPS No. 1, according to the existing scheme.

Washing water

Washing water from the rapid filters of the iron removal station is discharged into the averaging tanks by the sewage collector.

Washing water for the regeneration of ion exchange filters from the water treatment station is discharged to the averaging tanks by the sewage collector.

Washing water from the CWR (performed once a year) is discharged to the project sewage pumping station (SPS):

- from CWR -1 along collector K3.1;
- from CWR -2 along collector K3.2;
- from CWR -3 along collector K3.3.

From the SPS, the washing water is pumped to the averaging tanks through the technological pressure sewerage pressure collector.

Washing water is discharged into the sewage network of Utility Company "Ternopilvodokanal" using the K3.4 self-pressure collector from the averaging tanks.

Domestic and household wastes

Wastewater from sanitary premises is discharged:

- from WIPS No. 1along the pipeline K1 to SPS;
- from the deironing station - to the existing collector Ø800 mm;
- from pump station of washing waters - to the project collector K3.1.

The difference in the technological process according to technical alternative 2 is the washing of fast filters with iron-free water from CWR -1.

Washing of rapid filters

From CWR -1, water is taken by pipeline B3 by the project pump station of washing water and supplied by pipeline B3.2 to the iron removal station for washing filters.

Water supply to CWR

From the deironing station, purified water flows by gravity through the system of pipelines Bф2, Bф1.6 to CWR -1, through the Bф1 pipeline to through branching:

- Bф1.7 – to CWR -2;
- Bф1.8 – to CWR -3.

Water softening

De-ironed water from CWR -1 pump station of washing water through pipeline B3.1 is supplied by pumps to the water softening department of the preparation station Q=68m^3/hour.

Softened water is supplied to the Bф1 pipeline through the B6H pressure pipeline.

Defluoridation of water

From the dofluorination station, sodium fluoride solution is dosed through the Bфт pipeline into the Bф1 pipeline in the iron removal station building.

Disinfection of drinking water

Disinfection is carried out using liquefied chlorine.

Technical alternative 1 has the following advantages:

- lower construction cost compared to technical alternative 2;
- lower cost of prepared water.

The disadvantages of the technical alternative are:

- when washing 1 fast filter, it is necessary to adjust the water supply to other working filters.

Advantages of *Technical Alternative 2:*

- iron-free water is used for washing the fast filters;
- filter washing is easier to adjust and does not affect the operation of other filters.

Disadvantages of *Technical Alternative 2:*

- higher cost of construction compared to technical alternative 1;
- higher cost of prepared water.

Conclusions

Each of the technical alternatives has its advantages and disadvantages. The main disadvantage of using liquefied chlorine for water chlorination is the increased risk of poisoning of the service personnel of water treatment plants and, in the event of an accident, of residents of settlements adjacent to the filtration plant (technical alternative 2). According to technical alternative 1, it is planned to disinfect drinking water with low-concentration sodium hypochlorite. Purification of water with sodium hypochlorite instead of liquid chlorine has the following advantages: safe storage and transportation, ease of dosing, a long-lasting effect of disinfection, a low probability of the threat of man-made accidents, and the avoidance of negative impacts on the health of city residents. Safety and protection of the population, and safe operation of the water treatment plant when using low-concentration sodium hypochlorite are the main reasons for choosing the technical alternative. 1.

The reconstruction of the «Ternopilskyi» water intake will contribute to the improvement of the quality of drinking water and the conditions of its operation, ensuring a high-quality water supply for the population's comfort. The expected positive environmental effect from the implementation of the project is the transition to a safer technology for the decontamination of drinking water with low-concentration sodium hypochlorite.

References

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