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**MODERNIZATION OF WASTEWATER TREATMENT FACILITIES OF GAS
COMPRESSION STATIONS AND DEVELOPMENT OF WATER REUSE SYSTEMS (IN
THE EXAMPLE OF THE BALTIC OIL AND GAS PRODUCTION DEPARTMENT)**

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Abstract. The paper considers the modernization of wastewater treatment facilities at the gas compressor stations of the Shurtan Oil and Gas Production Department and the development of water reuse systems. The condition of existing facilities and the need for modernization are analysed, and the introduction of membrane and sorption deep-treatment technologies is proposed. The possibility of increasing the share of reused water from 15% to 85% is shown. A closed (zero-discharge) water-circulation cycle returning the treated water to the recirculating cooling system is developed.

Keywords: wastewater, treatment facilities, modernization, membrane treatment, reuse, closed cycle, recirculating water supply, zero-discharge technology.

1.Introduction

Wastewater treatment facilities of gas compression stations have been in operation for many years and are physically and morally obsolete. They are mainly designed for mechanical and simple physical-chemical treatment, and do not provide for deep treatment and reuse of water. As a result, a large part of the treated water is discharged into the basin, and fresh water is repeatedly withdrawn. This leads to waste of water resources in arid climates.

Modern requirements imply treating wastewater to such an extent that it can be reused. This requires modernization of facilities - the introduction of membrane and sorption deep treatment technologies, as well as the development of a closed water circulation system that returns treated water to production.

The Kashkadarya region is a region with scarce water resources, therefore water reuse at industrial enterprises is becoming a priority. In international practice, the share of reused water at oil and gas enterprises is more than 75%, and this indicator is achieved by modernizing treatment facilities. The introduction of this experience at the facilities of the Shurtan Department will have a significant environmental and economic impact.

The purpose of the article is to substantiate the directions for the modernization of wastewater treatment facilities at the gas compression stations of the Shurtan Department and to develop a closed cycle of water reuse.

2 Research object and methods

The object of the study is wastewater treatment facilities and water circulation systems of gas compression stations of the Shurtan Oil and Gas Production Department. The theoretical basis is formed by regulatory documents in the field of water treatment and reuse (CII 32.13330, ShNQ 2.04.03) and scientific literature. The work used methods for assessing the condition of existing facilities, substantiating modernization directions, calculating the water reuse coefficient

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and designing a closed water circulation cycle. The indicators were taken on the basis of generalized (typical) values in accordance with the theoretical description of the topic.

3. Results and their discussion

3.1. Condition of existing facilities and need for modernization

Existing treatment facilities consist mainly of mechanical and simple physicochemical stages, and the quality of the water at the outlet is not sufficient for reuse. The share of water reuse does not exceed 15%. The obsolescence of the facilities, the low level of automation and the absence of a deep treatment stage make modernization necessary. The main direction of modernization is the introduction of modern deep treatment technologies.

The main indicators of existing and modernized facilities are compared in Table 1. As can be seen, modernization not only increases the quality of treatment, but also radically improves the indicators of water reuse and watershed protection.

Table 1. Comparative description of existing and modernized facilities

Indicator	Indicator Existing facility	Modernized facility
Treatment stages	mechanical + simple f.-k.	mechanical + f.-k. + membrane + sorption
Output oil products	15–40 mg/l	< 0.5 mg/l
Water reuse	≤ 15%	≈ 85%
Level of automation	low	high
Discharge to water body	there	none (waste free)

3.2. Modernization trends

A promising direction for the modernization of facilities is the introduction of membrane purification modules (ultrafiltration, reverse osmosis) and sorption filters. The membrane module deeply purifies water from dissolved contaminants and separates it into permeate (purified water) and concentrate (Figure 1). This technology provides a high level of purification in a small volume and is amenable to automation.

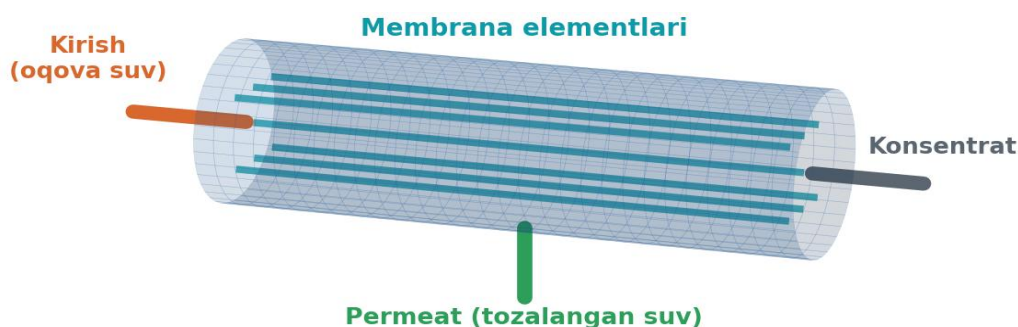


Figure 1. Spatial (3D) view of the membrane purification module

The full modernization program includes the following elements: replacing outdated mechanical treatment units with thin-film sedimentation tanks; installing a pressure flotation unit; introducing a membrane (ultrafiltration or reverse osmosis) module; adding an activated carbon sorption filter; and equipping the entire process with an automatic control and monitoring system. Together, these elements will bring the quality of treated water to the level that meets the requirements for reuse.

3.3. Modernization Effect

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The introduction of deep treatment technologies will bring the quality of treated water to the level of reuse. As a result, the share of water reuse will increase from 15% to 85% (Figure 2). The reuse coefficient is determined as follows:

$$K_{qf} = Q_{qayta} / (Q_{qayta} + Q_{chuch}) \cdot 100\% \quad (1)$$

here: K_{qf} - water reuse coefficient, %; Q_{qayta} - recycled water consumption; Q_{chuch} - consumption of fresh water from outside.

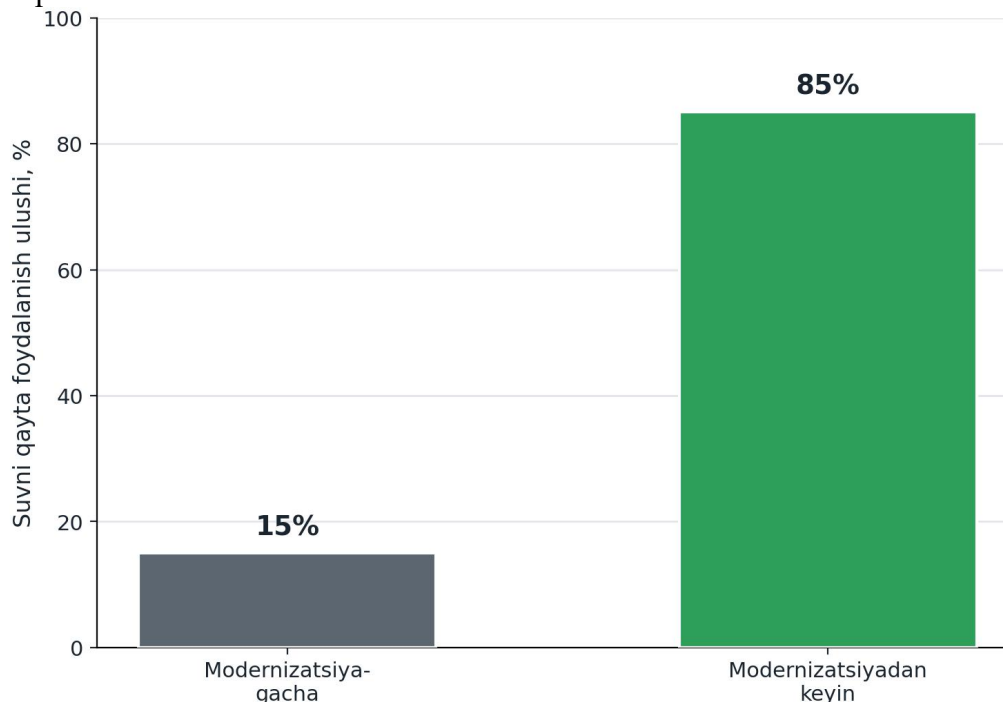
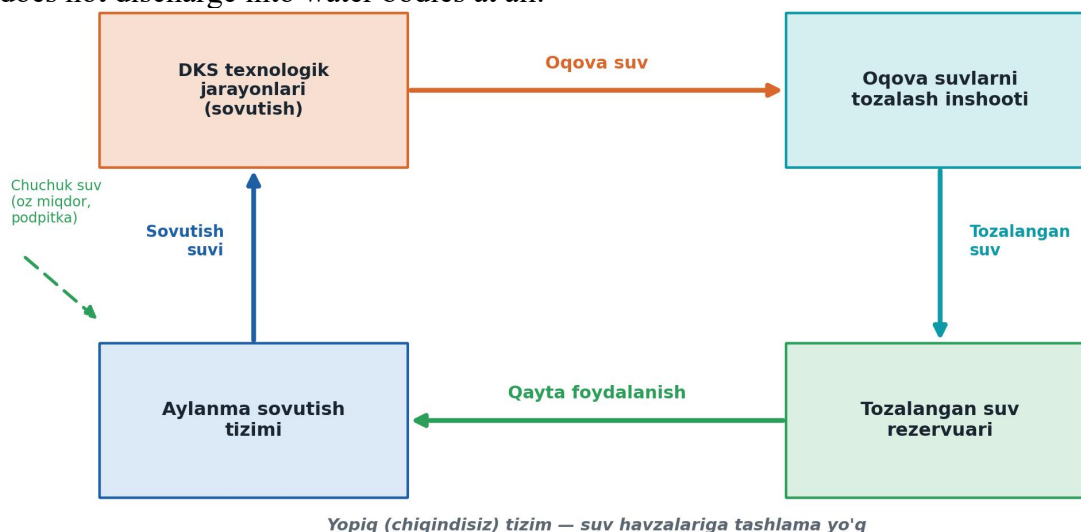


Figure 2. Impact of modernization on water reuse

3.4. Closed loop of reuse

The ultimate goal of modernization is to create a closed water reuse cycle. In this case, the waste water from the DKS technological processes is returned to the treatment plant, then to the purified water reservoir and from there to the circulation cooling system (Fig. 3). Only a small amount of fresh water (podpitka) is added from outside. This scheme is waste-free (besstochni) and does not discharge into water bodies at all.



Yopiq (chiqindisiz) tizim — suv havzalariga tashlama yo'q

Figure 3. Closed water reuse cycle

As a result of the transition to a closed cycle, the composition of water consumption will change radically: if before the modernization 100% of fresh water was used, then after the

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modernization its share will decrease to 15%, and the remaining 85% will be covered by reused water (Figure 4). This is the most effective way to save fresh water resources.

For the stable operation of the closed cycle, a system of continuous monitoring of the quality of treated water is necessary, since salts can accumulate in the circulating water. Therefore, the system provides for water quality adjustment (softening, reagent treatment) and, if necessary, partial renewal nodes. This approach ensures a high level of water reuse, as well as protection of equipment from corrosion and deposits.

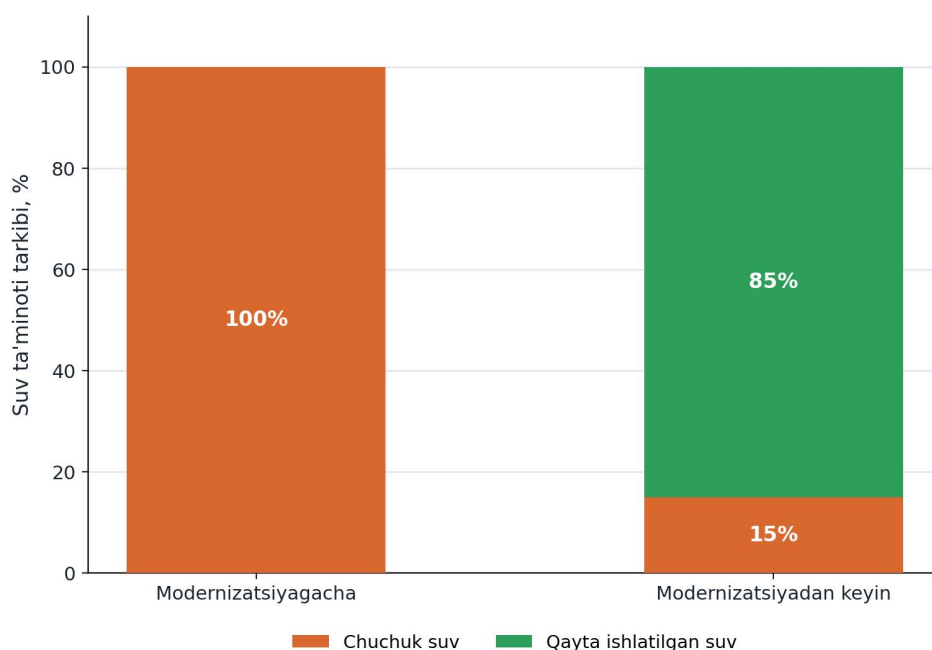


Figure 4. Changes in the composition of water consumption after modernization

3.5. Economic and environmental impact

Modernization of facilities and transition to a closed cycle will be effective in three directions. Economically - the volume of fresh water taken from outside and payments for it will be sharply reduced, and separated oil products will be returned as an additional resource. Ecologically - pollutant discharges into water bodies will be stopped, scarce water resources will be saved. Technologically - automation of the process will increase the stability of treatment and reduce the human factor. Together, these indicators will ensure a quick payback of modernization.

Conclusions

1. The existing treatment facilities are outdated, and the water reuse rate does not exceed 15%; this makes modernization necessary.
2. The introduction of membrane and sorption deep treatment technologies will bring the quality of treated water to the level of reuse.
3. As a result of modernization, the water reuse rate will increase from 15% to 85%.
4. A closed (waste-free) cycle that returns treated water to the circulating cooling system will eliminate discharges into water bodies and dramatically reduce freshwater consumption.

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