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OPERATION OF PUMPING STATIONS IN CONDITIONS OF LIFTING OF WATER CONTAINING SUSPENDED SEDIMENTS

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Abstract
In the field of water resources management of the Republic of Uzbekistan, 8940 pumping stations are used for irrigation and for maintaining the reclamation state of lands, including 24 large ones with a total water consumption of 6.4 billion m^3. The most strategically important structures for the country are the Im-Zang, Amu-Bukhara and Karshi cascades of pumping stations that provide water to almost all irrigated agriculture and the population of Surkhandarya, Kashkadarya, Bukhara and Navoi regions. Along with this, the Amu-Bukhara and Karshi machine canals provide water to the Bukhara oil refinery, Shurtan, Mubarek and other oil and gas chemical complexes, as well as the Talimarjan GRES with a capacity of 3200 thousand kW. The largest of them - the Karshi cascade of pumping stations wich makes transportation the Amudarya river water to a height of 132m.
The relevance of this research is primarily due to a sharp increase in energy prices, the cost of pumps and power equipment, an increase in specific energy consumption for water intake, a decrease in the reliability of operation of a complex of pumping station facilities, as well as an increasing shortage of water resources for the sectors of the economy of Uzbekistan.

Keywords: Cascades of pumping stations, machine irrigation, machine water intake, deigish, sediments, damless water intake, pressure pipelines.

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Introduction

Uzbekistan is considered as one of the largest irrigation farming countries in Central Asia. Proper use of existing water and land resources can increase crop production and yields in the agriculture sector [1]. Currently, 4268.1 thousand hectares of land are irrigated in the republic, of which 1533 thousand hectares (38.3% of the total area) are machine irrigation. The cost of electricity during machine water lifting for irrigation is more than 1.5 million. ha is 7.5-8 billion kW. h per year.

On the balance of the Ministry of the Water Resources of the Republic of Uzbekistan there are over 1580 inter-farm pumping stations with a total installed capacity of 3255 thousand kW, the annual volume of water supply is about 50 km^3. [2,3].

Of the total number of pumping stations, 76 pcs. - unique (supply more than 100 m^3/s) and large, 496 pcs. - medium (supply 1-10 m^3/s) and 561 pcs. - small (supply less than 1.0 m^3/s). A significant part of the pumping stations operate under conditions when the composition of the pumped water contains from 2 to 20 kg/m^3 of suspended sediments. At the same time, a particularly difficult situation has developed with engine water lifting in the presence of a large amount of sediment in the basins of the Amudarya and Zarafshan rivers[4,5].

When designing pumping stations in conditions of lifting water with a high sediment content, special sedimentation septic tanks were provided, however, most of them, due to poor operation and design flaws, either did not work at all, or currently do not fulfill their functional purposes [6,7]. In particular, during the construction of the Karshi cascade of pumping stations, it was envisaged to build a special river hydroelectric complex on the Kzylayak section of the Amu Darya River, and a reservoir on the right bank of the river to reliably provide water intake to the pumping units of the first rise of the reservoir [8,9].

By providing the necessary horizons for cavitation-free operation of pumping units of the first lift of the Karshi cascade, it was supposed to retain the bulk of suspended sediments [10]. Nevertheless, the Kzylayak hydroelectric complex and the reservoir on the right bank of the Amu Darya River were not built, and the supply canal to the first pumping station remained tied to a temporary damless water intake from the river. The Amudarya River in its middle course, in particular in the Kzylayak formation, flows in an unstable canal. The riverbed wanders and in most cases, moving away from the left bank, where the water intake into the Karshi machine channel is located, in order to create normal water intake conditions, straightening works of the riverbed are carried out.

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Materials and Methods

The hydromechanical method of cleaning the supply channel contributes to the perturbation, which erodes the sandy part of its profile, which causes water flow with a greater than natural turbidity to enter the machine channel. All this impedes the normal operation of the entire complex of pumping station facilities. Experience in the operation of irrigation pumping stations, especially in the Amudarya and Zarafshan river basins, shows that due to the content of a large number of suspended sediments in the water, the functioning of the antechamber, water intake is aggravateв, and in places where there are narrowing or expansion of pipes, turns, connection or distribution nodes, and others. elements, local resistances arise. Their presence in the pressure pipelines of pumping stations causes accumulation, and in the future - the formation of serious obstacles to the movement of water.

The presence of suspended sediments significantly affects the operating mode of pumping units, reducing efficiency, increasing energy costs for water lifting and, most significantly, contributing to the risk of biocorrosive destruction of pressure conduits due to the deposition of solid materials of mechanical and organic origin in the inner part of the pipes.

Results and Discussion

The results of field research of the water intake area and supply channels to the pumping stations of the Amu-Zang and Karshi Magistral Canal systems show that water with a high content of suspended sediments enters the canal, the turbidity of which varies according to measurements from 1.6 kg/m^3 to 3.2 kg/ m^3. The fractional composition of bottom sediments is mainly represented by sandy, silty and clay particles. According to the size of the particle diameter, they consist of: fine sand 0.25-0.10 mm, fractions, which make up 10% in relation to the total volume of the sample taken; fine-grained sand 0.10-0.05 mm, which is 24%; dusty particles 0.05-0.005 mm, respectively -35%; clay < 0.005 mm - 31%.

Due to the fact that in the source of the Karshi Magistral Canal and the Amu-Zang canal system, the flood period occurs mainly in the summer months, the maximum sediment runoff in the canal falls on this period. A particularly difficult mode of operation of a damless water intake structure in the Karshi machine canal. The functioning of the pumping station in the middle reaches of the river. Amu Darya (where water is withdrawn to the Karshi cascade of pumping stations on the right bank), the deigish process develops (this is a complex hydraulic process of erosion of the banks of the river by landfall currents), as a result, the main flow of water tends to the left bank.

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At the moment, about 80% of the water flow of the Amudarya river has receded to the left bank. As a result, extremely difficult conditions are created for water intake to the Karshi cascade of the pumping station which is located on the right bank of the river, and on the left bank, the intensity of erosion of the coastline increases, creating a serious danger of flushing away the Turkmen village of Kzylayak. Uzbekistan, to ensure the conditions for water intake in the Karshi cascade on the right bank, uses powerful dredgers, with an annual cost of 18-20 billion Uzbek sums (UZS) for their operation.

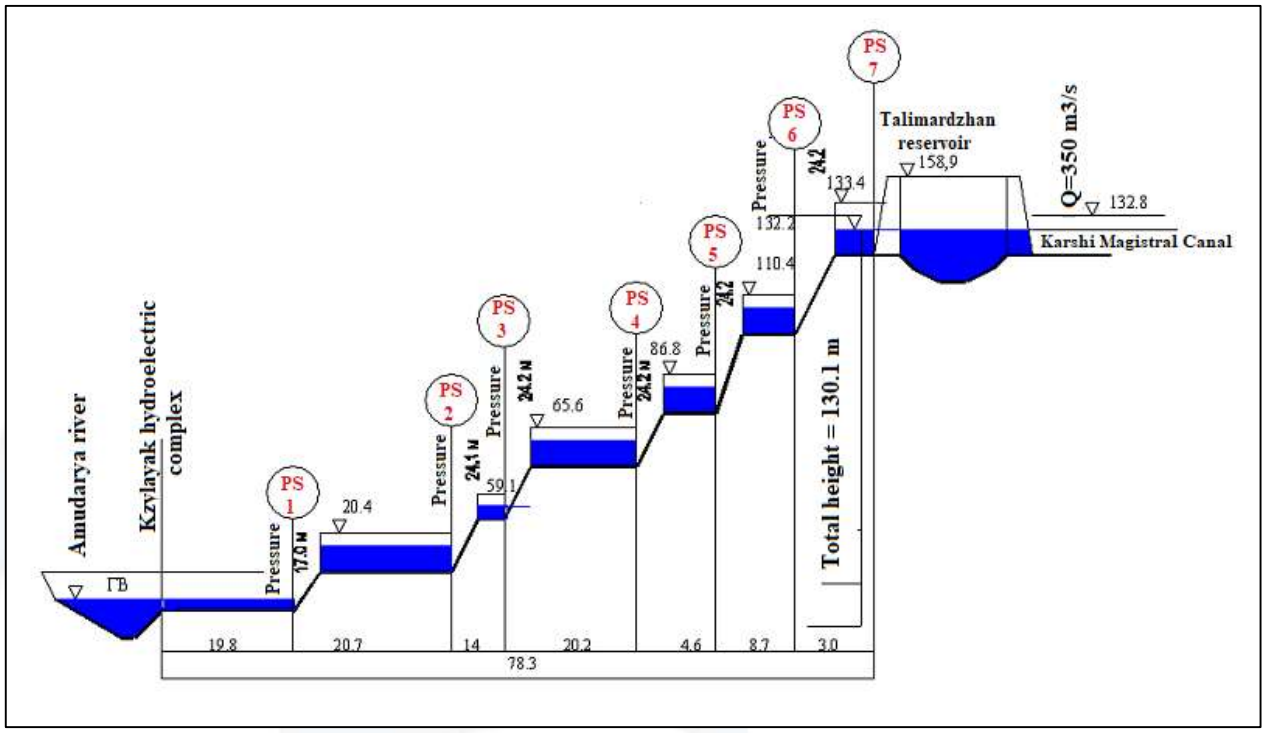

Fig.1. Water intake conditions and functioning of the Karshi cascade of the pumping station

In fact, when the cascade of pumping stations was designed and built, it was assumed that the water intake would be dammed and the Kyzylayak hydroelectric complex on the Amudarya River would be built to regulate the riverbed. However, the Kyzylayak hydroelectric complex was not built and the necessary conditions for water intake from the Amudarya River were not brought to its logical conclusion, from which Uzbekistan and Turkmenistan suffer. Water intake into the inlet canal of the first pumping station of the Karshi cascade pumping station is limited by the water horizon in the river. Amu Darya, which creates serious obstacles to ensure the reliable functioning of the water supply of the southern parts of the country.

Conclusion

Studies have established that with a domestic water horizon (WH) in the water intake site in the supply channel at the level of 243.98 only 6 pumping units are have the ability to work in the desired mode, at HW 243.18 - 5 units, at HW 242.88 - 4 units and at HW 242, 7- 3 units. At present, an extremely difficult situation has developed in terms of observing the necessary domestic water levels in the head of the supply channel of the Karshi cascade of pumping stations.

By order of the Government Inspectorate of Control Over the Safety of Water Objects under the Cabinet of Ministers of the Republic of Uzbekistan, the Institute of Water Problems (IWP) conducted comprehensive research of a number of particularly large pumping stations in Uzbekistan. It has been established that the presence of suspended sediments in the composition of pumped water has a particularly negative effect on the state of pressure pipelines of pumping stations.

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