Improving the efficiency of lead exploitation pumping station channels

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Abstract. The paper analyzes the dynamics of channel processes in the channel of the supply channels of pumping stations. The results of field studies of the condition of the channel environment in the supply channels of the pumping stations were studied. Based on the results of field inspection and research of the supply channel, recommendations were developed to improve its operation. Analyzed and summarized the results of surveys of the hydraulic and alluvial sediment regimes in the channel of the supply channels. The results of the effects of sediment entry into the chambers of pumping stations are presented.

The dynamics of reducing the capacity of the supply channels of pumping stations were analyzed;
The effect of sediment on the impellers and other stationary parts of pumping units, leading to a decrease in their performance;
Recommended new layout schemes of the route and sedimentation tanks of the supply channels of pumping stations;
A device of additional structural elements is proposed that allows improving the operating conditions of the supply channels of pumping stations.

1. Introduction

The forecast of the influence of the operating mode of pumping stations on the dynamics and hydrodynamic characteristics of the flow is one of the most important tasks of channel hydraulics. The object of the study was the supply channel of pumping stations to the Karshi Main Channel (KMCh) and Jaikhun.

In many countries, special attention is paid to ensuring reliable operation, the flow of less sediment with a guaranteed selection of water in the anterior chamber of pumping stations. Based on the foregoing, we can state the fact that, conducting a scientific study to study the dynamics of sediment delivery to the pumping station advancements, which affect the reliability and functioning of the pumping station, to determine the intensity and direction of siltation of the channel of the supply channel, reducing its throughput and developing an event to ensure the receipt of a guaranteed volume of water with a minimum amount of volume of the bottom and suspended sediment is considered an urgent task services of pumping stations. Changing the schedule of water supply to the pumping station, changing the hydraulic and alluvial flow regimes in the channel of the supply channels significantly changes the natural course of the channel process and a forecast of this change is...
required. Therefore, the problem of studying and developing the theory of channel processes in the channel of the supply channels of pumping stations, affecting their throughput, has always attracted the attention of scientists[1, 2]. An analysis of the results of a full-scale study of the dynamics of channel processes in the channel of the supply channels of the pumping station and, based on the results obtained, the development of recommendations for improving the condition of its operation is defined as the main goal of this work. However, despite the abundance of work devoted to this problem, its solution is still far from practical completion[3–5]. The reason for this is the complexity and multifactorial nature of the channel processes occurring in the channels of the supply channels of pumping stations in space and time. In addition, water comes to the object of study from the Amu Darya River, the water flow of which is characterized by a high degree of sediment saturation [6–10].

It can be noted that the fact that to develop an action to improve the operating conditions of the supply channels of pumping stations along with field data is very often used numerical or physical modeling that can give a specific forecast of channel deformations in the area of the object of study. Currently, there are significant difficulties in both numerical and physical modeling [11]. To conduct the above experiments, data from field studies of the studied object will be required.

2. Methods
Studying the results of full-scale studies in line with the supply part of the pumping station of the Karshi Main Canal cascade and assessing the condition of the channel capacity is a method for studying this work.

3. Result and Discussions
The head water intake and the supply channel to the first pumping station of the Karshi Main Channel – KMCh are continuously maintained during the year by 13 dredgers that clean the channel of sediment. In low-water periods, at low water surface horizons, a wandering of the main river flow occurs on the Amudarya river section in the area of damless water intake, which negatively affects the operation mode of the water intake and the supply channel, as a result, the operating mode is significantly worsened [11–15]. A sedimentation tank is provided in the channel of the supply channel, which is significantly silty; the residual volume from siltation increased from 4.5 to 5 million m³ from year to year. The leading part of the Karshi main canal operates under a retaining mode formed by the first pumping station (length = 22 km). Measures to prevent the entry of sediments of large fractions are carried out in the inlet channel and in the sump. At the same time, the channel capacity decreased and does not allow passing the demanded water flow rate during the growing season. Due to a large amount of bottom sediment and large fractions of suspended sediment entering the head of the water intake, the entire section of the supply channel to the first pumping station is transported by sediment, some of which are transported in transit to the concrete section of the KMCh. Siltation occurred at the head site of KMCh in the earthen channel of the channel — raising the bottom of the channel due to residual volumes that go from year to year and accumulate, resulting in reduced channel throughput. For example, in 2005, due to the frontal approach of the river flow to the head water intake, the inflow of bottom taxes increased one and a half times. Analysis of the longitudinal profile of the supply channel showed that the condition of the canal and sump is in an unsatisfactory position. Under such conditions, the abstraction of water from the river into the inlet channel during the low water period under adverse conditions of abstraction of water from the river into the inlet channel, the operational service of the first pump station very often only connects two units with a flow rate of up to 70 – 75 m³/s. Connecting 3 – of its unit becomes impossible since in this case, the level difference in the advance chamber of the first pumping station increases sharply and the gravitational phenomenon begins. In this regard, it is necessary to develop priority measures to ensure the required water consumption for KMCh water intake [7], [16–22]. It should be noted that, due to a large amount of siltation, the sedimentation channel of the supply channel has ceased to
As a result, sediment is transported by a cascade of pumping stations to the Talimarjan reservoir (figure 1).

![Figure 1. a) Siltation of the bowl of the Talimarjan reservoir; b) the dynamics of the decrease in usable volume](image)

As a result, intensive siltation continues in the thicket of the bulk reservoir, which is confirmed by the given graph of its dynamics of siltation (Figure 2). As can be seen from the graph, the average annual siltation volume amounted to 2.02 million $m^3$.

A practical similar situation is observed in the inlet of the Zhaihun pumping station with a capacity of 95 m$^3$/s with a lift height of 13.1 meters. Due to the full siltation of the supply channel, its throughput has greatly decreased. Of the 7 units, 2 units operate intermittently during vegetation. Also, as a result of sediment entering the chamber of the pumping station, the unit is sucked up with increased turbidity. Increased abrasive wear and corrosion of station lines and pumping equipment occurs (figure 3).

![Figure 2. Abrasive wear of the blades of the pump unit](image)

To solve the problems that arise in the objects of study, the authors of this work have proposed a modified layout of the supply channels with sedimentation tanks. The application of the new scheme will increase the capacity of the supply channels of the pumping stations of the Karshi Main Channel and Jaihun. Besides, it creates the opportunity to improve the cleaning efficiency of sedimentation tanks and channel channels (figures 4, 5).
Figure 3. The proposed layout of the feed channel and sedimentation tank KMCh
1 is input channel; 2 is a threshold; 3 is sump; 4 is sump chamber; 5 is water outlet lock; 6 is intermediate channel water outlet; 7 is water outlet; 8 is an intermediate channel; 9 is water outlet; 10 is old input channels; 11 is pumping station; 12 is machine channel; \( L \) is the distance between old and new water intake facilities; Distance from \( L' \) is the distance between sedimentation tank
4. Conclusions
The analysis of the results of field studies, allowed us to draw the following conclusions:

- The dynamics of reducing the capacity of the supply channels of pumping stations is analyzed;
- The effect of sediment on the impellers and other stationary parts of pumping units, leading to a decrease in their performance;
- Recommended new layout schemes of the route and sedimentation tanks of the supply channels of pumping stations;
- A device of additional structural elements has been proposed to improve the operating conditions of the supply channels of pumping stations.

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