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# IMPROVING THE RELIABILITY AND EFFICIENCY OF WATER USE IN IRRIGATION CANALS UNDER VARIABLE HYDRAULIC PARAMETERS OF WATER FLOW

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The analysis of scientific literature shows that many domestic and foreign researchers have worked on the issues of reliability and safety of irrigation systems. The scientific solutions obtained by these researchers are presented in the form of scientific recommendations and regulatory criteria. However, despite this, some problems related to the reliability and safety of irrigation structures still remain unsolved. In particular, the issue of decreasing water transportation capacity in irrigation networks under variable hydraulic parameters of the water flow has not yet been resolved.

As is well known, the main requirement for an irrigation network is to reliably supply irrigation water to all water users. Under current conditions of water scarcity, many irrigation canals fail to receive the required amount of water resources, and due to a decrease in the hydraulic elements of the flow, the transportation capacity of the canals sharply decreases. As a result, the reliability and efficiency of irrigation canals are significantly reduced.

The object of scientific research is the inter-farm irrigation canals of UR-10, hydraulically connected to the Mirishkor main canal. The Mirishkor main canal supplies irrigation water to more than 100 thousand hectares of agricultural land in the Kashkadarya region. The total length of the canal is 118 km, and 12 inter-farm irrigation canals are hydraulically connected to it. Water intake is carried out from the section between the 4th and 5th pumping stations of the Karshi main canal using a head structure, and it is strongly dependent on the water level in the upper reach. In other words, its operation depends on the operating mode of Pumping Station No.4 of the Karshi main canal, as shown in Figures 1 and 2.

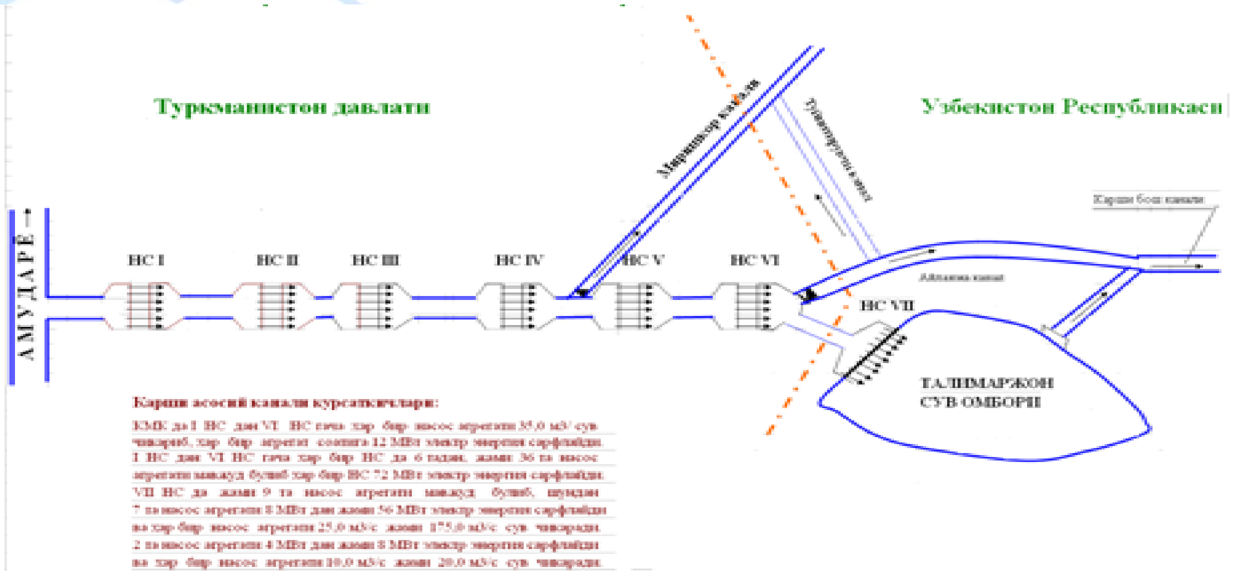


Figure 1. Schematic diagram of the Mirishkor Canal intake section

Figure 2. Water intake structure of the Mirishkor Main Canal from the KMC, PC 0+00

Research results show that if 5 units of the 4th pumping station are in operation, 136 m³/s of water is taken through the head structure; if 4 units are operating, 83.2 m³/s; and if 3 units are operating, the Mirishkor Canal receives 62.1 m³/s. Under such variable values of the hydraulic elements of the water flow, four water-regulating structures operate along the length of the Mirishkor Main Canal to solve the problem

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of water transportation. However, when only 3 pumping units are operating at Pumping Station No.4 of the Karshi Main Canal, the inter-farm irrigation canals UR-2, 4, 6, 9 and 10, which intake water from the Mirishkor Canal, cannot receive the required amount of water discharge, and their transportation capacity drastically decreases.

In addition, most irrigation networks were built at the end of the last century. Their canal elements were designed and constructed with reserve capacity to supply irrigation water to future agricultural areas. Under today's conditions of water scarcity, this factor has led to serious problems in supplying water to consumers in many irrigation networks.

For this reason, we set the objective to develop scientific and methodological foundations for efficient and reliable use of water in canals under variable (decreasing) flow conditions. The problems of determining the hydraulic interrelations of flow parameters under randomly changing conditions are diverse. When developing a model of the hydraulic relationship between discharge Q and flow depth h in open channels, one of the three fundamental laws of hydromechanics can be used: the law of conservation of mass, the law of conservation of momentum, or the law of conservation of energy. In describing unsteady water movement in open channels, the one-dimensional Saint-Venant equation is widely applied, and many researchers have proposed scientific developments in this field.

In our hydraulic modeling, we used the law of momentum change. After performing the required mathematical operations, we obtained a one-dimensional hydraulic model describing the dynamics of velocity changes in irrigation canal flow under the exponential operating mode of pumping stations:

$$p(\tau)\frac{\partial u}{\partial \tau}=\frac{\partial^2 u}{\partial \bar{x}^2}-\mathrm{Re}\frac{\partial u}{\partial \bar{x}} \qquad (1)$$

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Here $p(t) = e^{-\int_0^t \lambda dt}$ he reliability state of the irrigation canal, or the probability of its proper functioning, **Reynolds criterion**.

After performing the necessary mathematical operations, we obtained a one-dimensional law describing the change in flow velocity under exponential discharge conditions in the canal:

Now, according to the objective of the study and based on control theory, for equation (1) $h_{\min} \prec h(\bar{x},\tau) \le h_{\max}$ winging the condition $h(\bar{x},\tau)$ we define management.

For this, we reduce (2) to the following form:

We assume that the consumption of water in the irrigation channel will change according to the decreasing exponential law $Q(\bar{x},\tau) = Q^0{}_{np}(\bar{x})\exp(-\lambda t)$ (3)

According to equation (3), for an irrigation canal with a trapezoidal cross-section, under variable values of the hydraulic elements of the water flow, we obtain the depth control equation.

Thus, for an irrigation canal with a trapezoidal cross-section, the depth control equation under variable flow parameters has been derived. However, since our field studies have not yet been completed, it was not possible to determine the accuracy of this model.

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