OPERATING CONDITIONS AND RELIABILITY PARAMETERS OF HYDRAULIC ENGINEERING FACILITIES ON THE LARGE NAMANGAN CANAL

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Abstract

Based on the methods of reliability theory, the article identifies quantitative indicators of the reliable operation of pumping stations and canal sections in the conditions of abrupt changes in water levels due to unstable water movement in the Big Namangan Canal, depending on the mode of operation of Uchkurgan hydroelectric power station.

Keywords: Pump station, canal section, unstable water movement, water intake structures, reliability theory.

КАТТА НАМАНГАН КАНАЛИДАГИ ГИДРОТЕХНИКА ИНШООТЛАРИНИНГ ИШЛАШ ШАРОИТЛАРИ ВА ИШОНЧЛИЛИК ПАРАМЕТРЛАРИ

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Анатация

Мақолада ишончлик назарияси усуллари асосида, Учқурғон ГЭС иш режимига боғлиқ равишда Катта Наманган каналида содир бўладиган беқарор сув ҳаракати туфайли сув сатҳининг кескин ўзгариши шароитида каналдан сув кўтарувчи насос станциялари ҳамда канал участкаларининг ишончли ишлаш ҳолатининг миқдорий кўрсаткичлари аниқланган.

Калит сўзлар: Насос станцияси, канал участкали, беқарор сув ҳаракати, сув тусувчи иншоотлар, ишончлилик назарияси.

The Big Namangan Canal starts from the upper reaches of the Uchkurgan hydroelectric power station on the Naryn River. The length of the canal is 126.6 km, the maximum capacity is 62 m3 / s. The canal is designed to irrigate 50,000 hectares in Uzbekistan and Kyrgyzstan. The Greater Namangan Canal (KNK) is located in the northern part of Namangan region, its route passes along the right bank of the Naryn River, 3-5 km northwest of the North Fergana Main Canal (SHFMK), and crosses the hilly areas of Namangan region.

Currently, due to the violation of the Uchkurgan hydroelectric power station operation mode, there is unstable water movement in the sections of the Big Namangan Canal, and the reliable operation of pumping stations lifting water from the canal is deteriorating due to frequent changes in the water horizon. Due to the unstable water movement in the canal under the influence of man-made factors, it is necessary to determine the quantitative indicators of the state of reliable operation of pumping stations and canal sections receiving water from the canal due to fluctuations in the water level. These operations are carried out in two stages, the first stage - quantitative indicators of the state of reliable operation of pumping stations. The second stage is to determine the quantitative indicators of the reliability of the canal sections. To do this, we use the methods of reliability theory.

The first stage:

We express the full probability formula in the following view [1].

$$P(A)=P(B_1)\cdot P(\frac{A}{B_1})+...+P(B_n)\cdot P(\frac{A}{B_n}) \quad (1)$$

Here: A - an event observed as a result of an experiment; B_i - a complete group of events.

Bayes formula:

$$P(\frac{B_i}{A})=\frac{P(B_i)\cdot P(\frac{A}{B_i})}{P(A)}, i=\overline{1,n} \quad (2)$$

Here: $P(\frac{B_i}{A})$ - if as a result of an experiment A if an incident occurs, B_i the conditional probability that a set of events will occur.

(2) Using the formula, we assess the reliable operation of the pumping station «Uychi» in connection with a sharp change in the water level in the canal:

the probability of flight of the pump station as a result of interruptions in the power supply $P(\frac{A}{B_1})=0,1;$

the probability of flight of the pump station due to faults in the pumping device $P(\frac{A}{B_2})=0,03;$

the possibility of failure of the pumping station due to a sharp drop in the water level in the channel $P(\frac{A}{B_3})=0,2.$ Probability of hypotheses $P(B_1)=P(B_2)=P(B_3)=\frac{1}{3}.$

(1) taking into account the probability that the pump station will fly completely, ie A determine the probability of the event:

$$P(A)=\frac{1}{3}(0,1+0,03+0,2)=0,11$$

A assuming that the incident occurred, B_1, B_2, B_3 we find the probability that events will occur:

$$P(\frac{B_1}{A})=\frac{1}{3}\cdot\frac{0,1}{0,11}=0,3;$$

$$P(\frac{B_2}{A})=\frac{1}{3}\cdot\frac{0,03}{0,11}=0,09;$$

$$P(\frac{B_3}{A})=\frac{1}{3}\cdot\frac{0,2}{0,11}=0,61.$$

As a result, according to the calculations made on the basis of data related to the pumping station «Uychi», the probability of failure of the pumping station due to the fall of the water horizon in the canal is 0.61. Thus, the quantitative indicator of the reliable operating condition of this pump station was 0.3.

Quantitative indicators of the reliability status of the remaining pumping stations were evaluated in a similar way. The calculation results are shown graphically in Figure 1

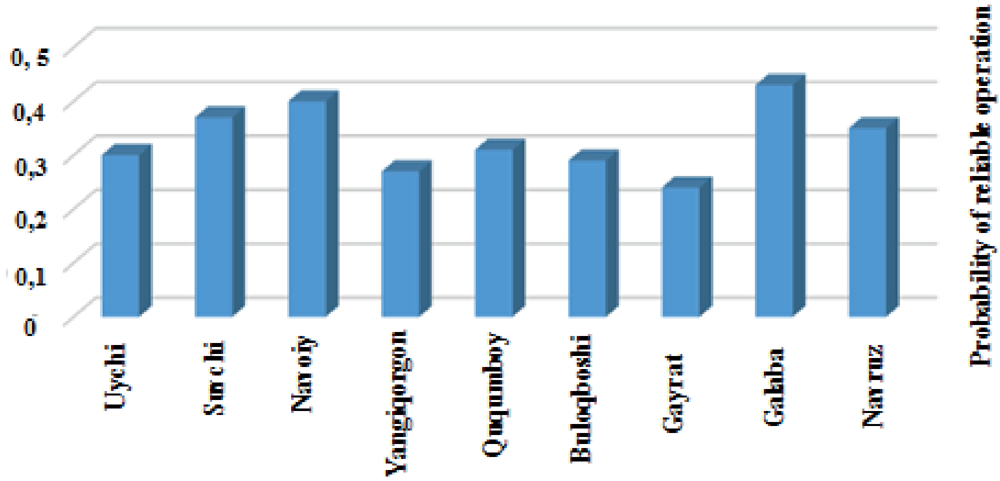
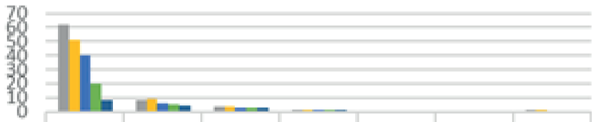


Figure 1. Quantitative indicator of reliable operation of large pumping stations in the Big Namangan canal

The second stage:

The Great Namangan Canal passes through the foothills and intersects with various geological systems of adyrli and adyroldy, the route of which has a very complex configuration.

No major repairs have been carried out on the canal since 1976, with 58% of its route being earthen, with many turning points and no filtration-reducing coating. Information on the hydraulic parameters in force for the channel sections is given in Figure 2.



	Q, max m³/c	The Width of the tube	H	m	i	N	V, m/c
ПК0+00 - ПК272+00	61,9	8	3,5	1	0,00015	0,0225	0,86
ПК272+00 – ПК624+80	51	9	3,5	1	0,00015	0,0225	0,86
ПК0+00 – ПК362+00	40	6	3	1	0,00015	0,0225	0,78
ПК362+00 – ПК642+00	20	5	3	1	0,00015	0,0225	0,75
ПК0+00-ПК146+00	8	4	2,5	1	0,00015	0,0225	0,65

ПК0+00 - ПК272+00 ПК272+00 – ПК624+80 ПК0+00 – ПК362+00
ПК362+00 – ПК642+00 ПК0+00-ПК146+00

Figure 2. KNK hydraulic parameters

Based on the methods of reliability theory, we determine the quantitative characteristics of the section of the Big Namangan Canal (PK0 + 00-PK272 + 00). We use analytical expressions for quantitative characteristics of reliability [1,2]:

$$P(t) = \exp(-\int_0^t \lambda(t)dt) = 1 - \int_0^t f(t)dt \quad (1)$$

$$q(t) = 1 - P(t) \quad (2)$$

$$f(t) = \frac{dq(t)}{dt} = -\frac{dP(t)}{dt} \quad (3)$$

$$\lambda(t) = \frac{f(t)}{P(t)} \qquad (4)$$

Here: $P(t)$ - he probability that the canal section will operate without requiring repair; $q(t)$ - the probability of failure of the canal section; $f(t)$ - change in the probability of failure density; $\lambda(t)$ - intensity of failure over time.

n the Greater Namangan Canal, the dynamic processes change according to exponential laws. Therefore, we express formulas (1-4) for the exponential law in the following form [1,2]:

$$P(t) = \exp(-\lambda t) \qquad (5)$$

$$q(t) = 1 - \exp(-\lambda t) \qquad (6)$$

$$f(t) = \lambda \exp(-\lambda t) \qquad (7)$$

$$\lambda(t) = \lambda \qquad (8)$$

In this case, the time until the loss of capacity of the section of the channel (PK0 + 00-PK272 + 00) varies according to the exponential distribution:

$$\lambda = 2{,}5 \cdot 10^{-5} \frac{1}{\text{hour}}, \qquad t = 87600 \text{ hours (10 years).}$$

We calculate the probability that the canal section will work without requiring repairs according to formula (5):

$$P(t) = \exp(-\lambda t) = \exp(-2{,}5 \cdot 10^{-5} \cdot t);$$

$$P(87600) = 0{,}11.$$

Calculate the probability of failure of the channel section according to formula (6):

$$q(87600) = 0{,}89.$$

The results of the calculations show that the part of the Greater Namangan Canal passing through the territory of the Kyrgyz Republic is likely to fail in 10 years.

By analogy, we determine the quantitative indicators of the state of reliable operation of the remaining sections of the Big Namangan Canal (Figure 3).

	Q max m³/c	The Width of the tube	H	m	i	N	V, m/c
ПК0+00 - ПК272+00	61,9	8	3,5	1	0,00015	0,0225	0,86
ПК272+00 – ПК624+80	51	9	3,5	1	0,00015	0,0225	0,86
ПК0+00 – ПК362+00	40	6	3	1	0,00015	0,0225	0,78
ПК362+00 – ПК642+00	20	5	3	1	0,00015	0,0225	0,75
ПК0+00-ПК146+00	8	4	2,5	1	0,00015	0,0225	0,65

ПК0+00 - ПК272+00 ПК272+00 – ПК624+80 ПК0+00 – ПК362+00
ПК362+00 – ПК642+00 ПК0+00-ПК146+00

Figure 3. Quantitative indicators of reliable operation of sections of the Greater Namangan Canal.

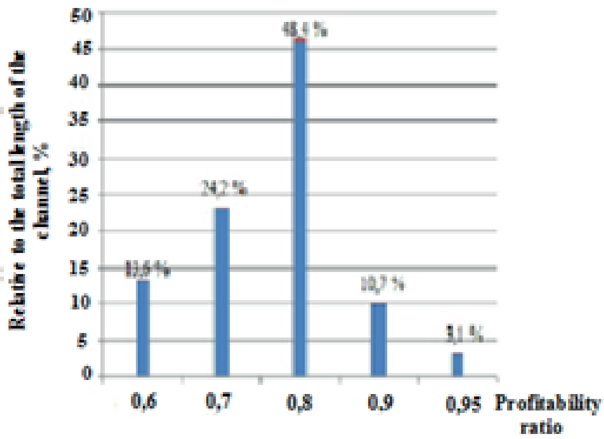
As a result of the study (Figure 3), the reliability status of the Big Namangan Canal for the next 10 years was determined as follows: the probability of operation of the canal sections without repair was 0.49, the probability of failure of the canal section was 0.51. These figures call for the immediate completion of systematic repair and reconstruction work on the canal.

While the efficiency of the large Namangan canal (Figure 4) ranged from 0.65 to 0.88, only 3.1 percent had a value greater than 0.94. It is known that according to the normative documents, the main and its irrigation canals should not be less than FIK 0.90. The efficiency of the canals determines not only the water permeability of the canals, but also the amount of water lost in them, which in turn indicates the low hydraulic efficiency and reliability of the analyzed canals.

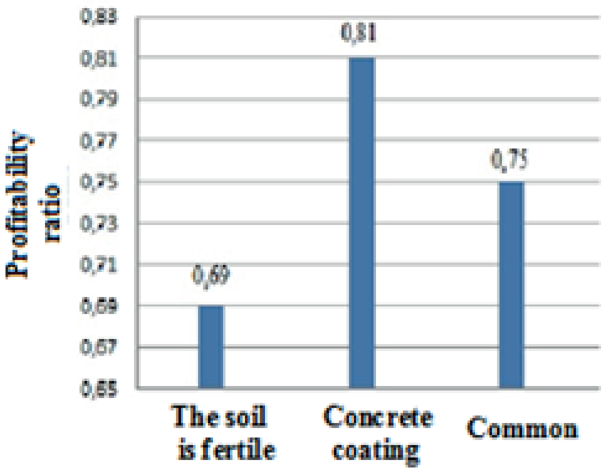
The results obtained from field experiments of the efficiency of irrigation canals are shown in Figure 4 in the form of histograms. The analysis of histograms shows that in

48.4% of the trunk channel the efficiency is 0.8, this value is 0.1 units from the FIC specified in the normative documents, in 24.2% - 0.7 from the FIC specified in the normative documents. per unit and 0.6 per 13.6 per cent, which is 0.3 per cent lower than the FIK set out in the normative documents.

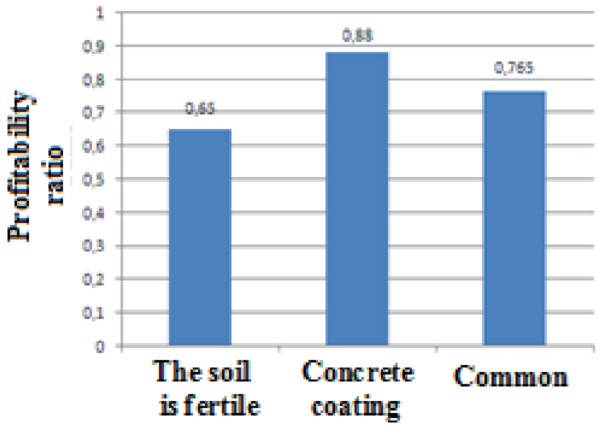
Figure 4 below shows the values of the useful work coefficient along the length of the route of the Greater Namangan Canal.



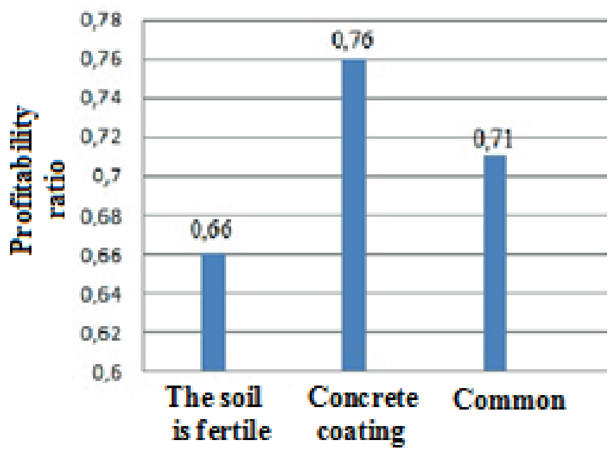
Section I of the channel



Section II of the Channel



Section III of the Channel



Section IV of the Channel

Figure 4. Hydraulic characteristics along the length of the canal route.

Based on the analysis of the results of the experiments, it was found that an average of 31% (102.2 million m3) of water resources was wasted in comparison with the water resources obtained in the Big Namangan Canal.

Based on the results of field research, there is a need to develop a set of measures aimed at improving water efficiency, including: drastic reduction of existing filtration water losses in canal channels; identification and elimination of the causes of water discharged as transit; equipping water intake with engineering structures and devices; We consider it very important to take measures to improve the technical condition of the canal and its facilities, as well as to improve the technical level of water distribution management.

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