Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

PUMPING STATIONS TO ENSURE GUARANTEED WATER SUPPLY FROM WATER SUPPLY CHANNELS

Norkulov Bekhzod Eshmirzaevich,
Kalandarova Dilsuz Abdujamilevna,
Nazarova Shokhida Muradboy's daughter
National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers"

Abstract:
The article discusses the need to maintain an optimal water level in the pre-chambers and prevent their oscillations to ensure normal, stable operation of the pumping units. The article presents methods for improving the operation of the units, not only by increasing the maximum possible rise in the water level in the water intake chamber. Based on the developed methods, it is possible to stabilize the supply of pumping stations and increase their efficiency. The article also develops new operating modes of canal robots with maintaining a high water level in the advance chambers, based on recommendations for improving the operating mode of NS-1, development of scientific research and direct practical experience in operation.

Keywords: Avankamera, channel, pump station, cascade, water level, water consumption, upper bef, lower bef, hydrotechnical structure.

Introduction

Issues of increasing operational efficiency of pumping stations in irrigation systems, ensuring their reliable and guaranteed operation occupy one of the leading positions in the world. Elimination of factors that negatively affect the work of pumping stations worldwide, achieving energy and resource savings, using modern methods of managing the technological process of water supply are priority tasks.

Leading scientific institutions around the world are conducting research aimed at optimizing the operating modes of pumping stations, assessing the hydraulic distribution of water flow in water intake chambers, preventing the impact of turbidity on pumping stations, minimizing energy consumption, and developing new structural elements for water intake chambers. In this regard, attention is being paid to scientific research on studying the movement of water flow in the water supply channels of pumping stations, controlling water flow in the pre-chambers of pumping stations, preventing the ingress of turbidity, optimizing the operating modes of pumping units and increasing their efficiency [1].

Modernization and reconstruction of pumping stations in the field of water management in our republic, increasing the operational efficiency of structures and equipment, replacing outdated equipment with modern, energy-efficient equipment, comprehensive measures are being implemented to improve the operational regime of pumping stations and water intake facilities by controlling the hydraulic structure of water flow, and certain results have been achieved.

The object of the study is the Karshi Main Canal, with a total length of about 200 km and divided into two parts: the main (machine) and the working (self-flowing channels). The main water intake of the main canal is located on the right bank of the Amu Darya, near the village of Kyzylayak, and ends at the Talimarjon reservoir. The main part of the canal passes through the territory of the Chorzow region of Turkmenistan, and the last part passes through the Karshi desert of Uzbekistan. The total length of the main part of the KMC is 77.6 km. There are 6 pumping stations of the same type on this route, delivering 200 cubic meters of water per second, with a total lifting height of 132 m [2]. The initial rocky section of the canal from the Amu Darya to Pumping Station No. 1 is 20.6 km long, with unconcreted soil laid in the canal, and the remaining 57 km of the canal is concreted.

Research Method

The process of turbid water flow and sedimentation of turbid particles in water supply channels and vane chambers of pumping stations, operating characteristics and parameters of pumps, pressure-water consumption characteristics of water flow in pipes.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

Results and Analyses

The water levels in the pre-chamber of the first pumping station are completely dependent on the water level in the river. At the Amu Darya and subsequent pumping stations of the cascade, they depend only on the correct schedule of the cascade operation and the skillful implementation by the dispatching service. In NS 2-6, the same OP10-260G pumps are installed, for which it is recommended to keep the fluctuation of the water level in the range of 6-8.5 meters in the channels in front of the pumping stations. This indicator varies depending on the relief location of the pumping station on the site (the length of the intermediate befs) (1-table).

1-table

NS	Working wheel axis horizons		
	Horizon min.	The horizon is maximum	Speed horizon.
1	4.20	7.00	6.00
2	6.50	8.50	10.20
3	6.50	8.20	8.50
4	6.50	8.50	10.20
5	6.50	8.20	9.00
6	6.50	8.50	9.00

The immersion mode in the operating mode of pumping stations is not immediately accepted. It will be accepted only after extensive experience has been gained in the use and reliability of intermediate channels with concrete lining and a height reserve of 1.5-2 meters above the maximum water level according to the project [3]. The most acceptable level indicators for use are as follows: 8.0-9.5 meters for NS-2-4; 8.25-9 meters for NS-3; 8.0-8.5 meters for NS-5; 8.0-9.5 meters for NS-6.

The operation of the counter-main channel cascade in the pressurized mode has significantly improved the operating conditions, increased operational reliability and stabilized the supply of pumping units. In addition, maintaining the water level in the rechamber between 0.5-1.0 meters allowed for the most efficient use of hydraulic devices to ensure stable operation of the pumping units and eliminate

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

vacuum in the siphon dewatering tanks. The water level at the top of the pumping station determines the statistical pressure that determines the water transfer capacity of the station. Therefore, the flow capacity of the cascade depends on the maintenance of the water level at the upper bef after the discharge facilities [4].

For economic purposes, it is desirable to have a minimum level of high pressure, in which case (when the siphon is ideally sealed) we will have a minimum pump pressure, that is, maximum transfer is achieved with a minimum relative consumption of electrical energy. However, it is possible to maintain the minimum pressure level with the help of one or two working units. An increase in the number of working units at the pumping station, respectively, requires a rise in the water horizon above the station, which reduces the transmission of working units, but improves the channel's operating mode. As is known, according to the laws of hydraulics, in order to ensure the passage of large amounts of water through the canal, it is necessary to create a greater difference in horizons, that is, to raise the groundwater level.

Filling the canal between the pumping stations with water to the maximum extent increases the total water volume and allows for smooth control of the canal's operating mode without excessive and undesirable shutdowns of the pumping station units. Each such pump stop reduces the operating life of the pump unit. Therefore, based on the accumulated experience, the most favorable horizons for cascade operation were selected at all six pumping stations. (2-table)

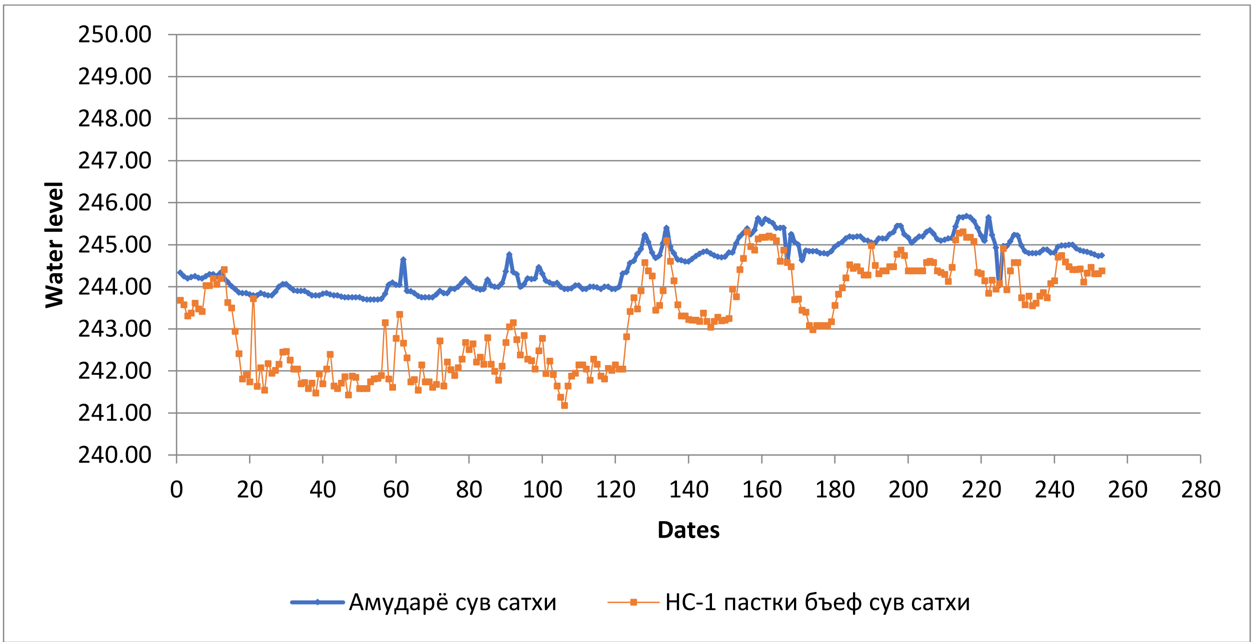
2-table

NS	Siphon peak sign	YuBSS from the pump axis	
		Construction span	Operating range
I	23.8	20.13-23.38	22.0-23.15
2	32.75	29.10-32.35	31.15-32.10
3	32.88	29.43-32.43	31.28-32.15
4	33.12	29.47-32.72	31.62-33.50
5	33.12	29.47-32.72	31.62-32.20
6	33.12	29.47-32.72	31.62-32.70

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

The experience of operating conditions in cascades of pumping stations has shown that in order to ensure normal, stable operation of pumping units, it is necessary to maintain optimal horizons of water in vane chambers and prevent them from oscillating for a certain period of time [5-6]. Raising the water level as much as possible in the Avankamer not only improves the work of aggregates, but also stabilizes the water supply of pumping stations. To increase their efficiency, it is first necessary to develop channel regimes that maintain high water levels in the advance chambers, taking into account recommendations for the use of pumps at the main pumping station, as well as based on scientific research findings and direct practical operating experience.

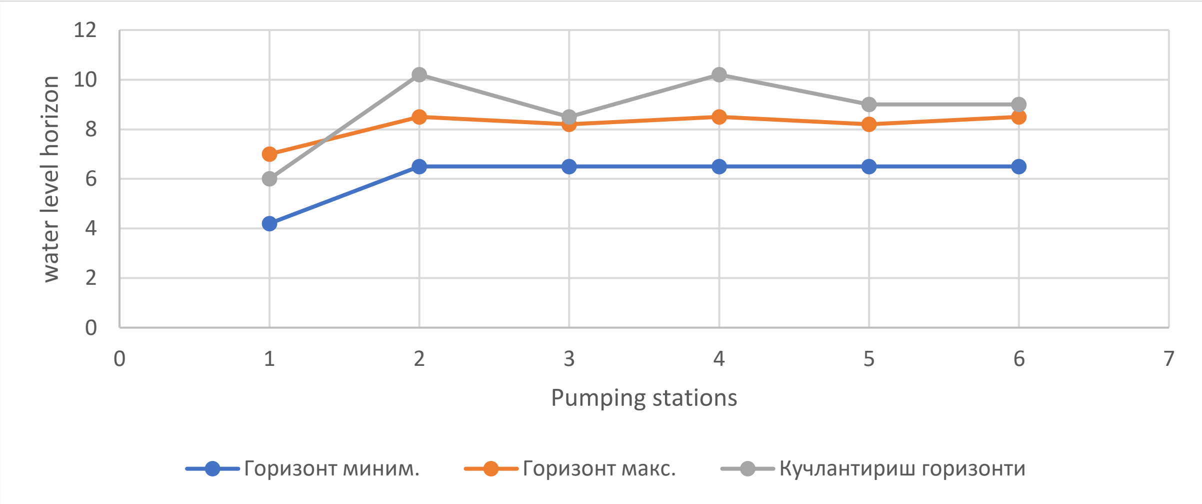
If the water level in the front chamber of NS-1 is completely dependent on the water level in the Amudarya, at the subsequent pumping stations of the cascade, this indicator will depend only on the correctly configured operating mode of the cascade and its skillful execution by the dispatch service (1-picture).



1- picture. Daily water level change schedule. Lower reaches of the 1st NS. 2021

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

Pumping stations 2-6 are equipped with the same type of OP10-260G pumps, for which it is recommended to maintain water level fluctuations in the channels in front of the pumping stations within 6-8.5 meters. This indicator may vary depending on the location of the pumping station in relation to the terrain (length of the intermediate belfries).



2- picture. Fluctuations in water level in canals in front of KMK Pumping stations

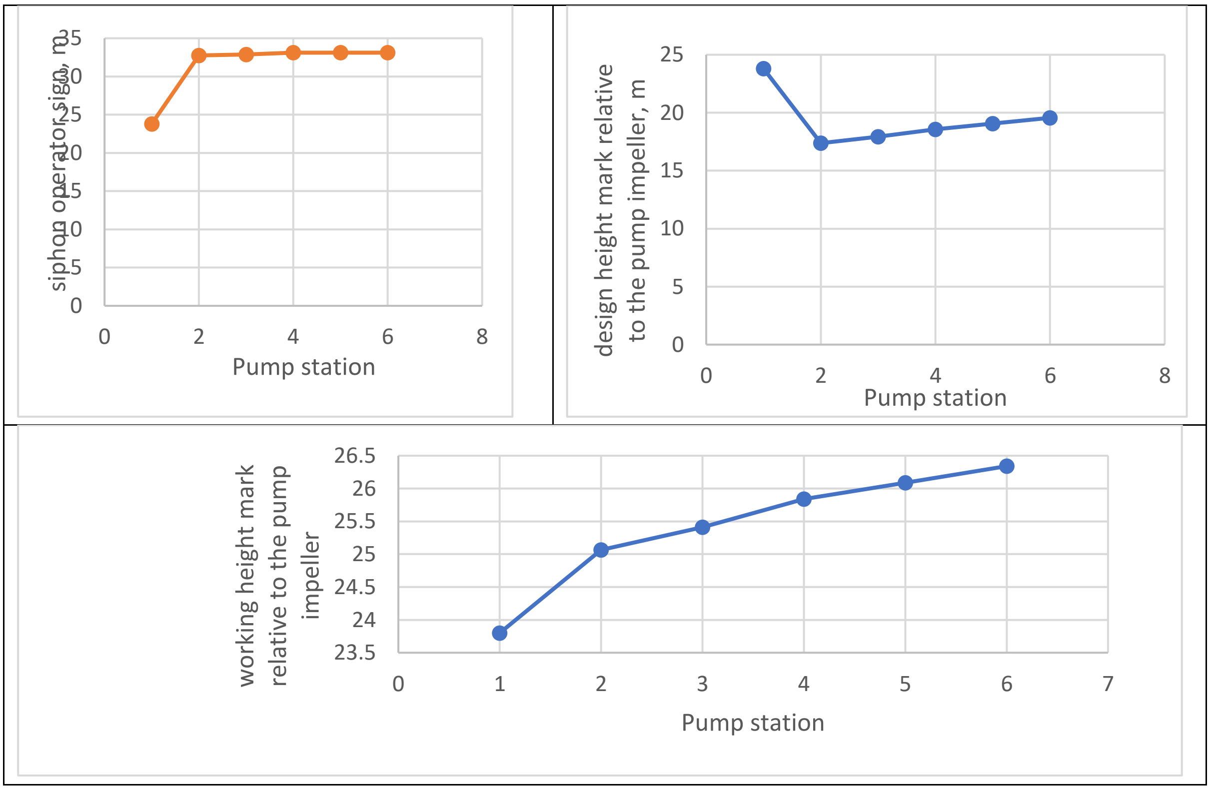
The results of the studies show that it is not possible to immediately adopt the regime of the wet surface in front of the pumping stations. It is possible to adopt it after conducting studies on the operation and reliability of concrete-lined intermediate channels, and with a height of 1.5-2 meters above the highest water level. The most optimal level indicators for use can be considered as follows: 8.0-9.5 meters at pump stations 2-4; 8.25-9 meters at pump station 3; 8.0-8.5 meters at pump station 5; 8.0-9.5 meters at pump station 6. The operation of the counter-main channel cascade at the required humidity level significantly improves the operational conditions, as well as increases the reliability of the operating mode and stabilizes the water transfer of the pump units [7]. In addition, maintaining the water level in the prechamber within 0.5-1.0 meters allows for the most efficient use of hydraulic devices to ensure stable operation of pumping units and eliminate vacuum in siphon dewatering systems.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

The water level upstream of the pumping station determines the statistical pressure, which affects the efficiency of the pumping station. Therefore, the maintenance of the water level in the upstream after the discharge facilities is directly related to the water carrying capacity of the cascade.

It is known that, according to the hydraulic laws, in order to ensure the transfer of a large amount of water through the canal, it is necessary to increase the difference between the upper and lower water levels, that is, to increase the water level of the upper water level.

Filling the channel between the pumping stations with water to the maximum extent increases the total volume of water, allows the units at the pumping stations to operate more efficiently and without interruptions, and allows for smooth adjustment of the channel's operating mode. The temporary shutdown of each of the pump units reduces the operating resource of the pump unit. Therefore, based on the collected data, the most optimal level indicators for the cascade operation mode were selected for all six pumping stations.



Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

It is important to control the water flow of the pumps by changing the angle of rotation of the vanes without stopping the unit (during operation) in order to maintain the water stack in the water outlet in the required operating mode. But nowadays the optimal options of turning angles are selected, and in many cases the turning angle of the working wheel blade is accepted as unchanged. Also, the electrohydraulic drives installed at the Karshi pumping stations have the simplest kinematic scheme, are compactly located in the unit and allow saving electrical energy. Due to the ease and convenience of controlling the hydraulic drive, the duty personnel can set the required angle of rotation of the impeller blades in a matter of seconds.

The operating mode of the pumping stations can vary from 27 to 195 m3/s depending on the number of operating units and the change in the water intake of each pump by turning the impeller blades. It should be borne in mind that short-term water flows along the cascade should not exceed 195 m3/s in total, and each pump should not exceed 39 m3/s. However, due to the lack of irrigation water in irrigated areas during the growing season, pumping stations were required to increase water delivery in 2011, 2014, and 2018. This led to the constant use of five out of six units during the growing season, making repairs and maintenance difficult.

3- picture. Karshi Main Canal Cascade 7-NS and Tolimarjon Reservoir upstream.

Intermediate water intake is carried out from the main channel between pump stations 4 and 5 to the Mirishkor channel with a maximum water flow of 60 m3/s.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

Filling of the intermediate channels of the pump stations begins with the start-up of one unit of the NS-1. After the pre-chamber of the NS-2 is filled with water, one of the units of the NS-2 is started. The pump in the NS-2 is started when the KSV is open. Their closing is carried out after the exit section of the siphon water outlet is buried in water. It takes 60 minutes for the pumping stations NS-2 and NS-3 to fill the intermediate canals up to the water level of 8.5 m with a water consumption of 30 m3/s. Filling the channel between pump stations 3 and 4 with one unit, up to 8.5 m in the pre-chamber of pump station 4, takes approximately 12 hours, filling between pump stations 4 and 5, also with one unit, takes 4 hours, and filling between pump stations 5 and 6 takes 6.5 hours.

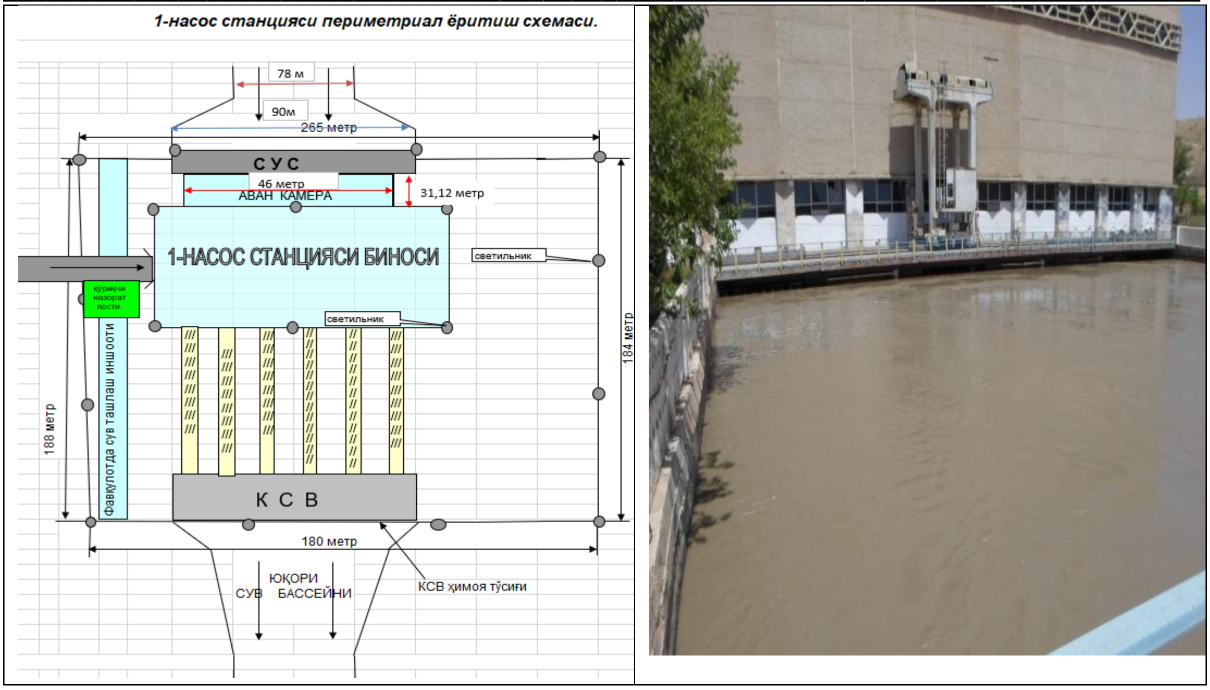
After the NS-6 pre-chamber is filled to 8.5, one of its units is put into operation. Then the cascade is adjusted to the given water head. When one unit is operating at each pumping station, the total time for filling the entire channel is approximately 2 days. This time interval can be reduced when 2 or 3 units are operating at each pumping station.

When pumping 195 cubic meters of water per second from the Amu Darya through the water intake canal, especially when all six pump units are operating, it is necessary to precisely and strictly maintain the water level in the pre-chambers in front of the pump stations, namely, NS 2-9.8 m, NS 3 - 8.8 m; NS 4 - 9.8-10.0 m; NS 5 - 8.7 m; NS 6 - 8.7-9.0 m.

The operation of the canal with the design and accelerated water flow depends on a highly reliable system of automatic water level measurement in the canals, as well as the precise operation of hydromechanical, electrical and auxiliary equipment.

During periods of increased water flow, the connections between pumping stations should be well established. It should be noted that there are many influencing factors that need to be taken into account when managing the cascade operation, which is why it will be necessary to improve the automated control system (ACS).

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org



4-picture. Scheme of the hydrotechnical facilities of the 1st Pumping Station of the Karshi Main Canal

Emergency situations occurred as a result of failure of hydromechanical equipment, shutdown of a station - activation of the protection system. In case of a sudden stoppage of the unit at any station in the cascade, the backup unit is started. In the event of a power outage at one of the cascade stations, which operates partially on water consumption, emergency response measures will involve changing the water level in the channels between the pumping stations. When calculating the operating time of a particular pumping station, the water level in front of the pumping stations can be lowered to a level not lower than 6.0-6.5 m, and the short-term rise in front of NS-2 and NS-4 can be raised to a level not higher than 10.0 m, in front of NS-5 and NS-6 to a level not higher than 9.0 m, and in front of NS-3 to a level not higher than 8.5 m.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

3-table Information on the operation of pumping stations on the opposite main channel on 02.10.2024

NS stations	At pumping stations (m)			At pumping stations		
	Water level		Pressure			
	In the low tide	In the upper part		Working aggregates	Reserve aggregates	Aggregates under repair
1- NS	4,30	22,60	18,30	3,5,6	2	1,4
2- NS	10,20	32,70	22,50	2,3,4	1,6	5
3- NS	8,60	31,10	22,50	1,2,3	4,5	6
4- NS	10,20	32,40	22,20	1,2,3	4,6	5
5- NS	8,90	32,50	23,60	1,3,4	2	5,6
6- NS	8,90	32,50	23,60	1,2,5	3,6	4
7- NS	6,95			3,5,8	1,2,4,6,7,9	

Analysis of operating conditions shows that in many pumping stations, due to the lack of water metering equipment to control the water delivery of pumps, design values are used, which leads to significant errors [1]. Failure to account for water in the water supply system and, as a result, inconsistency in its supply and water consumption leads to frequent start-up and shutdown of units and, as a result, premature wear of their elements, as well as excessive consumption of electricity and significant waste of water discharge. The results of experiments conducted to study the nature of changes in the concentration and dispersion of solid suspended particles showed that the maximum average monthly concentration of effluents is 2.5..3.8 kg/m3, and sometimes in rainy weather the maximum turbidity of water reaches 7 kg/m3. Particles with a grain size of 0.1-0.05 mm are found in large quantities in solid mechanical mixtures. Observations have shown that at low flow rates in the pre-chamber and water intake chambers, particles larger than 0.01 mm easily settle in them. The sludge deposition rate at various stations ranged from 20 to 60%. As a result, hydraulic resistance increased, which led to a decrease in the water delivery of pumps.

In the conditions of increasing shortage of fuel and energy resources, there is a need to improve the mechanism of saving electricity consumption in existing pumping stations. The main lever for controlling the specified mechanism is the

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

normative value of energy consumption for a certain period, which is based on the normative comparative indicator of energy consumption and the volume of driving, respectively, for each specific or typical object.

With the help of individual norms of energy consumption, graph of additional energy supply and some other additional initial data, the full normative value of energy consumption for the given period of use of the pumping station is determined. Comparison of the actual and normative values of energy consumption allows to objectively assess the technical quality of operation.

There are several ways to calculate the relative energy consumption of pumping stations. From the point of view of reliability and practical convenience, the perfect method is to determine the useful work ratio of the pumping station, that is, multiplying the height of the geometrical rise per unit of weight of the pumped water by the full useful work coefficient of the pumping station for the relevant operating modes.

The relative energy consumption obtained for the relevant operating modes and the relevant technical condition of the machines and facilities of the pumping stations are shown as individual standards of energy consumption for certain objects in a certain period of time.

Conclusion

1. The water regimes in the water intake chambers of the Karshi Main Canal pumping stations were analyzed. It should be noted that water intake without a dam could not fully ensure the stable operation of Pumping Station 1 due to sharp changes in the water level in the river.
2. Operational experience has shown that, for many reasons, it is impossible to create a stable regime of water movement along the entire length of the canal, as revealed in field studies.
3. Maintaining the water level difference in the pre-chamber within 0.5-1.0 meters ensures stable operation of the pumping units and allows for the most efficient use of hydraulic devices to eliminate vacuum in siphon dewatering systems.

Modern American Journal of Engineering, Technology, and Innovation
ISSN(E): 3067-7939
Volume 01, Issue 03, June, 2025
Website: usajournals.org

References

1. Базаров Д.Р., Норкулов Б.Э., Суюнов Ж.Ш., Жумабаева Г.У., Жамолов Ф.Н. Особенности неустановившегося движения потока при бесплотинном водозаборе в условиях меандрирующих русел рек. Проблемы архитектуры и строительства (научно-технический журнал). 2021 г. №4 С.56-62. (05.00.00;№14).
2. Базаров Д.Р., Курбонов И.У., Норкулов Б., Курбонов А И., Курбонов А И. Насос станциялари сув келтириш каналида сув лойқалигининг тақсимланишини математик моделлаштириш ва сонли тадқиқот натижалари. Меморчилик ва қурилиш муаммолари. (илмий-техник журнал), 2023 г. №1, (2-қисм) Б.87-93. (05.00.00;№14).
3. Гловацкий О.Я., Рахимов Ш.Х., Махмудов Э.Ж. Насос станциялари ва гидротехник иншоотларни ишончлилигини баҳолаш ва эксплуатацион кўрсаткичларини ошириш. “Проблемы повышения эффективности использования электрической энергии в отраслях агропромышленного комплекса” мавзусидаги халқаро илмий-амалий анжуман. Тошкент, 25-26 май, 2015.-Б 174-176 .
4. Гловацкий О.Я., Рахимов Ш.Х., Уралов Б.Р., Эргашев Р.Р. Повышение надежности эксплуатации водоподводящих сооружений крупных насосных станций. «Ўзбекистон Республикаси мелиорация ва сув хўжалигини ривожланишининг замонавий муаммолари» мавзуидаги халқаро илмий-техник конференция материаллари. – Тошкент-2008,октябр, Б.235-237
5. Bazarov D, B. Norkulov, Vokhidov, B.Shodiev, I Raimova. Regulation of the flow in the area of the damless water intake. E3S Web of Conferencesthis link is disabled, 2021, 263, 02036, www.scopus.com. (01.00.00;№16)
6. Bazarov D. R., B.Norkulov, A. I. Kurbanov, F.N. Jamolov, G. U. Jumabayeva. Improving methods of increasing reliability without dam water intake. AIP Conference Proceedings 2612, 020026 (2023); www.scopus.com. (01.00.00;№16)
7. Bazarov D.R., O. Norkulov B., Voxidov.O.F Kurbanov A., Raimova I. Bank destruction in the middle section of the Amudarya River. E3S Web of Conferencesthis link is disabled, 2021, 274, 03006, www.scopus.com