DOI: https://doi.org/10.5281/zenodo.13924577

IMPROVING THE TECHNICAL WATER SUPPLY SYSTEM OF HYDROELECTRIC POWER PLANTS: MAIN RECOMMENDATIONS FOR INCREASING EFFICIENCY

R.R. Ergashev
Ph.D., Professor, National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers"

O.O. Tojiyev
Graduate Student, National Research University "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers"

Abstract: *Hydroelectric power plants (HPPs) play a crucial role in meeting global energy demands by utilizing water power for sustainable electricity generation. The technical water supply system is central to the efficient operation of these stations, ensuring a reliable and uninterrupted supply of water necessary for electricity production. However, with the aging of hydroelectric infrastructure and changing environmental conditions, there is a pressing need for continuous improvement and optimization of these systems. This article presents recommendations aimed at enhancing the technical water supply system of hydroelectric power plants, focusing on key areas for improvement and implementation strategies.*

Key words: *technical water supply system of HPP, advanced turbine designs, hydroelectric power station, remote sensing, improvement.*

Introduction: In the past 5-7 years, President Sh. Mirziyoyev has enacted several decrees and decisions to develop the hydroelectric energy sector, including the construction and reconstruction of hydroelectric power stations, the advancement of renewable electricity generation, and the introduction of modern technologies. Since its establishment in 2017, 12 new HPPs have been built, and 9 more have been modernized. As a result, an additional 244 MW of electricity capacity has been created, and the number of small non-dam hydro plants is increasing, with a special focus on constructing small non-dam hydro plants. According to presidential decrees, compact hydropower stations with capacities of up to 500 kW are being installed on rivers and canals such as the Norin, Sokh, Tankhoz, Aq Bulak, and Ugam. These stations are also

being established in technical, irrigation, and architectural higher educational institutions to train qualified specialists for hydro facility operations.

It has been noted that special attention is necessary to establish construction and hydraulic laboratories in these institutions. The Decree of the President of the Republic of Uzbekistan PF-60 dated January 28, 2022, outlines the "New Development Strategy of Uzbekistan" for the period of 2022-2026. The 24th goal emphasizes the importance of ensuring an uninterrupted supply of electricity to the economy and actively introducing "green economy" technologies across all sectors. By 2026, the strategy aims to increase energy efficiency by 20%, with a target to boost electricity production by an additional 30 billion kWh, reaching a total of 100 billion kWh. Plans include achieving a 25% share of renewable energy sources by 2026, which is expected to save about 3 billion cubic meters of natural gas annually.

Relevance: Hydropower plants play a crucial role in the global energy mix by providing clean and renewable electricity. However, optimizing technical water supply systems is vital to maximizing their production potential and minimizing environmental impact. This article addresses the challenges faced by hydropower plants in managing water supply systems and offers recommendations for improvement. The aim is to provide valuable insights to help address these challenges, test solutions in practice, preserve soil moisture, and achieve sustainable crop yields through efficient water use.

Purpose: To improve the technical water supply system of hydroelectric power stations by developing key recommendations for increasing efficiency.

Tasks:

Recommendations for improving technical water supply systems:

1. Improvement of hydrological data monitoring:
   - Implement advanced monitoring systems for accurate water flow forecasting.
   - Use real-time data to optimize water release schedules.
2. Renovation of water transfer infrastructure:
   - Invest in modern piping and duct systems to improve water transport efficiency.
   - Implement remote sensing technologies for leak detection and infrastructure maintenance.
3. Implementation of water-saving measures:
   - Adopt water treatment and reuse practices at the power plant.
   - Promote the use of water-saving turbines and equipment to reduce water consumption.
4. Strengthening compliance with environmental requirements:

- Ensure strict adherence to environmental regulations regarding water quality and ecosystem protection.
- Implement eco-friendly practices to minimize the station's ecological footprint.

Methodology:

Understanding technical water supply systems: The technical water supply system of a hydropower plant includes various components and processes related to water resource management for power generation. These include water intake structures, penstocks, turbines, cooling systems, discharge channels, and more. The efficiency and reliability of these systems are critical to maximizing capacity and minimizing operational interruptions.

Aging infrastructure: Many hydropower plants around the world are operating with aging infrastructure, leading to increased maintenance needs and susceptibility to failures. Renovating and upgrading key components of the water supply system, such as water intakes and pipes, can enhance reliability and efficiency.

Resilience and reliability: Strengthening the resilience and reliability of technical water supply systems is essential to minimize disruptions and interruptions in energy production. This can include planning redundancies, establishing emergency response protocols, and adopting sound maintenance practices to prevent unexpected events and reduce operational risks.

Comprehensive Assessment: A thorough evaluation of the existing water supply infrastructure, identifying areas for improvement and potential weaknesses.

Stakeholder Engagement: Collaborate with key stakeholders, including plant operators, engineers, environmental experts, and regulatory authorities, to gather insights into system performance and identify issues.

Technical Analysis: Use advanced modeling and simulation tools to assess water flow dynamics, hydraulic performance, and potential bottlenecks in the supply system.

Prioritize Upgrades: Rank upgrades and investments based on their potential impact on system reliability, efficiency, and cost-effectiveness.

Innovative Technology Integration: Explore the integration of cutting-edge technologies, such as remote sensing, predictive analytics, and automation, to enhance monitoring, control, and decision-making capabilities.

Long-term Planning: Develop a long-term strategic plan for the continuous improvement and optimization of the water supply system, taking into account future energy demand, regulatory requirements, and environmental changes.

Implementation Strategies:

- **Pilot Projects**: Conduct pilot projects to test and validate the proposed recommendations in real-world conditions before full-scale implementation.

- Capacity Building: Provide training and capacity-building programs for plant personnel to ensure the proper operation and maintenance of upgraded systems.

Results:

- Environmental Challenges: Changes in environmental conditions, such as fluctuating water levels, sediment accumulation, and climate change, create challenges in managing water supplies at hydroelectric facilities. Implementing adaptive management strategies and incorporating environmental monitoring technologies can help mitigate these issues and promote sustainable water use.
- Optimizing Efficiency: Enhancing the efficiency of water intake, conveyance, and turbine systems is crucial to maximize energy production and reduce energy losses. Upgrades in advanced turbine designs, optimization of flow control mechanisms, and the use of intelligent monitoring and control systems can improve overall system efficiency.
- Partnerships and Collaborations: Foster partnerships and collaborations with industry experts, research institutions, and technology providers to leverage expertise and resources for the implementation of improvements.
- Regulatory Support: Secure supportive regulatory frameworks and incentives to facilitate investments in water supply system upgrades and enhancements.

Monitoring and Evaluation: Establish robust mechanisms to monitor the implementation of recommendations and evaluate their effectiveness, while identifying areas for further improvement.

Conclusion: Improving the technical water supply systems of hydroelectric power stations is crucial for optimizing electricity production, enhancing durability, and ensuring stable operation in the face of evolving challenges. By developing and implementing targeted recommendations, stakeholders can increase the efficiency, reliability, and environmental sustainability of these critical infrastructure systems. This will contribute significantly to the global expansion of clean and renewable energy production. The optimization of technical water supply systems at hydroelectric plants is essential for sustainable energy production and environmental protection. By adopting the recommended strategies and embracing innovation, hydropower plants can improve performance and play a pivotal role in the green energy transition. This study can serve as a foundation for the development of a comprehensive article that provides practical recommendations.

REFERENCES:

1. O‘zbekiston Respublikasi Prezidentining 2020 yil 10 iyuldagi PF-6024-son “O‘zbekiston Respublikasi suv xo‘jaligini rivojlantirishning 2020-2030 yillarga mo‘ljallangan konsepsiyasini tasdiqlash to‘g‘risida”gi Farmoni. Qonun hujjatlari ma’lumotlari milliy bazasi, 11.07.2020 y., 06/20/6024/1063-son. https://lex.uz/docs/4892953.

2. O‘zbekiston Respublikasi Prezidentining 2020 yil 11 dekabrdagi PQ-4919-son “Qishloq xo‘jaligida suvni tejaydigan texnologiyalarni joriy etishni yanada jadal tashkil etish chora-tadbirlari to‘g‘risida”gi Qarori. Qonun hujjatlari ma’lumotlari milliy bazasi, 12.12.2020 y., 07/20/4919/1616-son. https://lex.uz/docs/5157168.

3. Xoliqulov Shodi Turdiqulovich, Tuproqni mulchalash orqali innovatsion issiqxonalarda ekinlar hosildorligini oshirish texnologiyasini joriy etish. Dissertation, Samarqand, 2015.

4. Mamatov S.A., Ibragimov F.I., Akbarova K.X., Tuproqda yetarli namlikni yaratish. O‘zbekiston qishloq xo‘jaligi, 2013, № 9. p. 12.

5. Rayes D., 2009. The ETo Calculator: Evapotranspiration from a Reference Surface. (Reference Manual, Version 3.1), FAO, Rome, Italy, p. 38.

6. Priyestley C., Taylor R., 1972. On the Assessment of Surface Heat Flux and Evaporation Using Large-scale Parameters. Mon. Weather Rev. 100:81-92.

7. “Tomchi” mobil ilovasi. Shvetsariya Konfederatsiyasi hukumati tomonidan moliyalashtirilayotgan “O‘zbekistonda suv resurslarini boshqarish milliy loyihasi”. OQXJ loyihalarni amalga oshirish agentligi, Toshkent, 2018.

8. Thornthwaite C., 1948. An Approach Toward a Rational Classification of Climate. Geograph. Rev. 38(1):55-94.