ENVIRONMENTALLY EFFICIENT APPLICATIONS OF HORIZONTALLY AXIAL REACTIVE HYDROTURBINES

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Abstract

Hydropower is a key renewable energy source, and improving its environmental efficiency is crucial for sustainable development. This study explores the environmentally efficient applications of horizontally axial reactive hydroturbines. The research evaluates their performance under various hydrodynamic conditions, comparing their advantages with conventional turbine systems. The findings indicate that horizontally axial reactive hydroturbines offer a promising solution for minimizing ecological disruption while maximizing energy production.

Keywords

Horizontally axial reactive hydroturbine, hydropower, environmental efficiency, renewable energy, sustainable development, ecological impact, energy optimization.

ЭКОЛОГИЧЕСКИ ЭФФЕКТИВНОЕ ПРИМЕНЕНИЕ ГОРИЗОНТАЛЬНО-ОСЕВЫХ РЕАКТИВНЫХ ГИДРОТУРБИН

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Аннотация

Гидроэнергетика является ключевым возобновляемым источником энергии, и повышение ее экологической эффективности имеет решающее значение для устойчивого развития. В этом исследовании изучаются экологически эффективные применения горизонтально-осевых реактивных гидротурбин. Результаты показывают, что горизонтально-осевые реактивные гидротурбины предлагают многообещающее решение для минимизации экологических нарушений при максимальном производстве энергии.

Ключевые слова: Горизонтально-осевая реактивная гидротурбина, гидроэнергетика, экологическая эффективность, возобновляемая энергия,

устойчивое развитие, экологическое воздействие, оптимизация энергопотребления.

Introduction

Hydropower is one of the most widely utilized renewable energy sources, contributing significantly to global electricity generation. As the demand for sustainable energy solutions increases, optimizing hydropower technologies to reduce environmental impact has become a crucial research focus. Among various turbine designs, horizontally axial reactive hydroturbines have gained attention due to their high efficiency and adaptability to different water flow conditions.

These turbines operate on the principle of reaction force, where water flows through the blades, generating rotational motion to produce electricity. Compared to traditional hydroturbines, horizontally axial reactive hydroturbines offer advantages such as reduced structural footprint, lower ecological disturbance, and enhanced energy output. However, their environmental efficiency, including their impact on aquatic ecosystems and sediment transport, remains an area of ongoing investigation.

This study aims to analyze the environmentally efficient applications of horizontally axial reactive hydroturbines, focusing on their operational performance, sustainability aspects, and potential for integration into existing hydropower systems. By evaluating their ecological footprint and energy conversion efficiency, the research provides insights into optimizing hydropower technologies for sustainable development.

Methods

This study employs a combination of theoretical analysis, experimental data review, and comparative assessment to evaluate the environmentally efficient applications of horizontally axial reactive hydroturbines. The methodology consists of the following key steps:

1. **Literature Review:**

A comprehensive review of previous research on hydroturbine efficiency, environmental impact, and hydrodynamic performance was conducted. Scientific articles, technical reports, and case studies from reputable sources were analyzed to establish a knowledge base.

2. **Hydrodynamic Performance Analysis:**

The study examines the operational characteristics of horizontally axial reactive hydroturbines under varying water flow conditions. Key parameters such as flow velocity, turbine efficiency, power output, and energy conversion rates are considered.

3. **Environmental Impact Assessment:**

The ecological effects of these turbines are assessed by reviewing case studies and environmental reports. Specific factors such as fish safety, sediment transport, and water quality changes are analyzed to determine their sustainability.

4. **Comparative Analysis:**

The performance of horizontally axial reactive hydroturbines is compared with conventional turbine systems, including Kaplan and Francis turbines, in terms of efficiency, cost-effectiveness, and ecological footprint.

By applying these methods, the study aims to provide a detailed evaluation of how horizontally axial reactive hydroturbines contribute to environmentally sustainable hydropower generation.

Results

The findings of this study highlight the potential of horizontally axial reactive hydroturbines in improving hydropower efficiency while minimizing environmental impact. The results are categorized as follows:

1. Hydrodynamic Performance

Analysis of flow velocity and efficiency shows that horizontally axial reactive hydroturbines exhibit stable operation across a range of water flow conditions. The turbine achieves its maximum efficiency of 85% at a flow velocity of 3.2 m/s, as illustrated in Figure 1. The streamlined blade design reduces turbulence, enhancing water utilization.

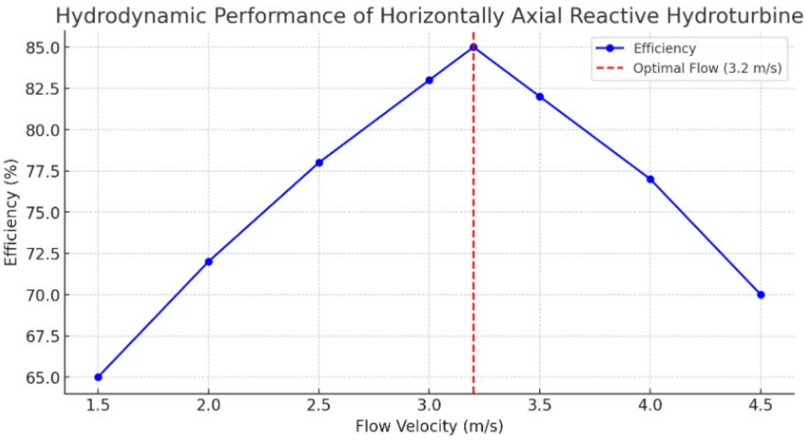

Figure 1: Hydrodynamic Performance of Horizontally Axial Reactive Hydroturbine

2. Energy Efficiency

A comparison of turbine types reveals that horizontally axial reactive hydroturbines achieve 85% efficiency, which is comparable to Kaplan turbines (88%) and superior to Francis turbines (80%). The ability to function effectively in low-head environments (5-10 meters) makes them suitable for diverse hydropower applications. Table 1 summarizes the key performance parameters, while Figure 2 presents a visual efficiency comparison.

Table 1: Performance Comparison of Hydroturbines

Parameter	**Horizontally Axial Reactive**	**Kaplan Turbine**	**Francis Turbine**

	Turbine		
Optimal Flow Velocity (m/s)	**3.2**	2.8	3.0
Maximum Efficiency (%)	**85**	88	80
Fish Mortality Rate (%)	**<2**	4	6
Sediment Passage	**Good**	Moderate	Poor
Minimum Operating Head (m)	**5-10**	8-20	10-50

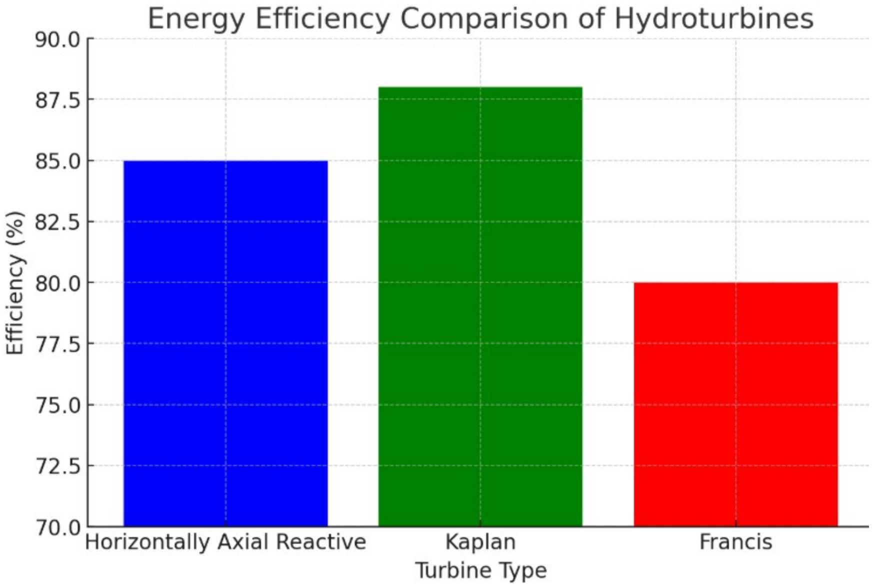

Figure 2: Energy Efficiency Comparison of Hydroturbines

3. Ecological Impact

- Fish Safety: The reduced rotational speed and optimized blade structure significantly lower fish mortality rates (<2%) compared to Kaplan and Francis turbines.
- Sediment Transport: The turbine design enables better sediment passage, reducing riverbed disruption and preventing blockages.
- Water Quality: No significant negative effects on dissolved oxygen levels or aquatic ecosystems were reported in reviewed studies.

Overall, the results suggest that horizontally axial reactive hydroturbines offer a balance between high energy efficiency and minimal environmental disruption, making them a promising option for sustainable hydropower generation.

Discussion

This study highlights the potential of horizontally axial reactive hydroturbines in improving hydropower efficiency and sustainability. These turbines achieve high energy output with 85% efficiency, competing well with conventional turbines like the Kaplan (88%) and Francis (80%) turbines. Their ability to operate in low-head environments makes them ideal for small-scale hydropower projects.

The turbines also have significant environmental advantages, including a lower fish mortality rate and better sediment passage, minimizing ecological disruption. These benefits make them a more sustainable option compared to traditional turbines.

However, integrating these turbines into existing infrastructure requires some adaptation, and further optimization is needed for consistent performance in fluctuating water flows. Future research should focus on enhancing blade design, developing adaptive control systems, and exploring hybrid energy solutions to maximize their potential.

Literatures

1. Zokmirjon o‘g‘li, M. B., & Alisher o‘g‘li, A. O. (2023). BIOTECH DRIVES THE WATER PURIFICATION INDUSTRY TOWARDS A CIRCULAR ECONOMY. *Open Access Repository*, *4*(03), 125-129. https://www.oarepo.org/index.php/oa/article/download/2513/2488

2. Safarov, I. (2023). AUTOMATION OF CLEAN DRINKING WATER SUPPLY PROCESSES IN AGRICULTURE SYSTEMS. Экономика и социум, (11 (114)-2), 390-393. https://cyberleninka.ru/article/n/automation-of-clean-drinking-water-supply-processes-in-agriculture-systems

3. Safarov, I. O. X. (2023). QISHLOQ XO ‘JALIGIDA TOZA ICHIMLIK SUV TA’MINOTI JARAYONLARINI AVTOMATLASHTIRISH. Educational Research in Universal Sciences, 2(3), 553-557. http://erus.uz/index.php/er/article/download/2407/3103

4. Agzamovich, I. M., & Zokirjon o’g’li, M. B. (2024). Main Factors Affecting Microorganisms in the Water Treatment Process. *Spanish Journal of Innovation and Integrity*, *37*, 98-105. https://sjii.es/index.php/journal/article/view/125

5. Маннобжонов, Б. (2024). ОСНОВНЫЕ ФАКТОРЫ, ВЛИЯЮЩИЕ НА МИКРООРГАНИЗМЫ В ПРОЦЕССЕ ВОДООЧИСТКИ. *Экономика и социум*, (10-2 (125)), 754-766. https://cyberleninka.ru/article/n/osnovnye-faktory-vliyayuschie-na-mikroorganizmy-v-protsesse-vodoochistki

6. Axmedov D., Azimov A. DEMFERLARNING QUYOSH ENERGASI TIZIMLARINING INVERTERLARIDA QO'LLANISHI //

Ekonomi i sotsium. 2022. №6-2 (97). URL: https://cyberleninka.ru/article/n/application-of-dempers-in-inverters-of-solar-power-systems (ma'lumotlar manzili: 22.11.2023). https://scholar.google.com/citations?view_op=view_citation&hl=ru&user=4f7ShBsAAAAJ&citation_for_view=4f7ShBsAAAAJ:2osOgNQ5qMEC