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# Solar and Screw Hydropower Turbine for Power Generation – A Comprehensive Study

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***Abstract***

*Micro-hydro power plants rely on efficient screw pump systems to harness the kinetic energy of flowing watercourses for electricity generation. Landustrie, with nearly a century of expertise in screw pump technology, has been pivotal in advancing the field. This paper examines the evolution of screw pump technology within micro-hydro power generation, highlighting Landustrie's contributions and the introduction of automated screw pump selection software. In contrast, screw hydropower turbines use the kinetic energy of flowing water to produce electricity. Small rivers, streams, and irrigation canals are among the low-head hydropower applications for which they are especially well-suited. Screw turbines are less harmful to the environment and may be erected without drastically changing the surrounding scenery, in contrast to conventional hydroelectric dams. Because of worries about climate change and the depletion of fossil fuels, interest in renewable energy sources has grown recently. Due to their potential to sustainably supply the world's energy needs, two clean, abundant energy sources that have drawn a lot of interest are hydropower and solar power. Through case studies and performance evaluations, the scalability, reliability, and cost-effectiveness of Landustrie's solutions are demonstrated, reaffirming the company's position as a leader in the industry.*

**Keywords:** Hydro-Power, Solar Power, Sustainable development, Screw Turbine, Screw hydropower

## INTRODUCTION

Hydropower stands as a paramount contributor to the renewable energy landscape, offering substantial potential for a sustainable future. As of 1999, approximately 19% of the world's electricity, totalling 2650-Terawatt hours (TWh), was generated through hydropower, a figure that increased to around 3100 TWh by 2009 and was projected to reach 3606 TWh by 2020. Dams serve as crucial infrastructure for water management, providing benefits such as water supply, flood control, navigation, sedimentation control, and hydropower generation. However, the construction and operation of large dams entail significant drawbacks, including land inundation, disruption of fish migration, and alteration of downstream river characteristics. Furthermore, the capital-intensive nature of large dam projects often necessitates national or international funding [1, 2].

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While many developing countries are investing in large dam projects to meet energy, irrigation, and flood control needs, developed nations are increasingly considering dam decommissioning due to environmental concerns and the high maintenance costs of aging structures [21-25]. Hydropower plants are categorized based on their electrical generating capacity, ranging from large hydro (> 10 MW) to micro-hydro (< 5 kW), with approximately 10% of total hydropower production attributed to plants with capacities below 10 MW [3-6].

Run-of-river (ROR) hydropower plants, characterized by their reliance on natural water flow without significant water storage, offer an alternative to traditional dam-based systems. ROR plants typically feature minimal or no reservoirs, mitigating the adverse impacts associated with large reservoirs while allowing for more flexible power generation. Although this approach reduces land and soil destruction, greenhouse gas emissions, and environmental and social impacts, it may result in variable or poorly timed power generation due to limited control over river flow [8-11].

Micro-hydropower plants, which often operate in ROR configurations, present a sustainable development option for electricity generation in both developed and developing countries. These plants eliminate the need for costly dam construction and the associated environmental and social consequences, making them particularly attractive in regions where traditional hydropower development may be impractical or undesirable [25-31]. Emerging technologies like Archimedes Screws Turbines (ASGs) offer further advantages by minimizing ecological disruptions and enhancing energy efficiency in ROR settings.

In summary, the adoption of ROR hydropower technologies, including micro-hydropower plants, represents a promising avenue for sustainable energy development, offering environmental, social, and economic benefits while mitigating the drawbacks of traditional dam-based hydropower systems [7]. Figure 1 Geometrical parameters of the Archimedean screw turbine model drawn thro

## PROBLEM STATEMENT

The efficiency of screw turbines can be compromised by the presence of debris such as sludge, stones, and wood sticks, which pose a risk of damaging the turbines and necessitate costly maintenance. To mitigate this risk, the installation of filter assemblies is essential, albeit at an additional expense. Moreover, the angle of inclination utilized for the turbine must be carefully calibrated to optimize energy production and ensure a consistent flow of water.

The global energy crisis has spurred researchers to explore alternative sources of green energy, prompting extensive investigations into natural energy reservoirs like solar, wind, wave, and water. Within the realm of water-based energy sources, there has been notable technological advancement in turbine design, tailored to suit specific flow conditions, particularly in rivers with high head disparities, aimed at electricity generation. In contrast, the Archimedean hydro technology, boasting a rich historical lineage, encompasses a diverse array of machines, mechanisms, gears, pumps, and various mills powered by water wheels.

## OBJECTIVES OF THE STUDY

- To comprehend the fundamental concept of screw hydropower turbines.
- To grasp the construction and operational mechanisms of screw hydropower turbines.
- To fabricate a functional model representing the operation of screw hydropower turbines.
- To evaluate the technology in alignment with specific requirements and capacities.

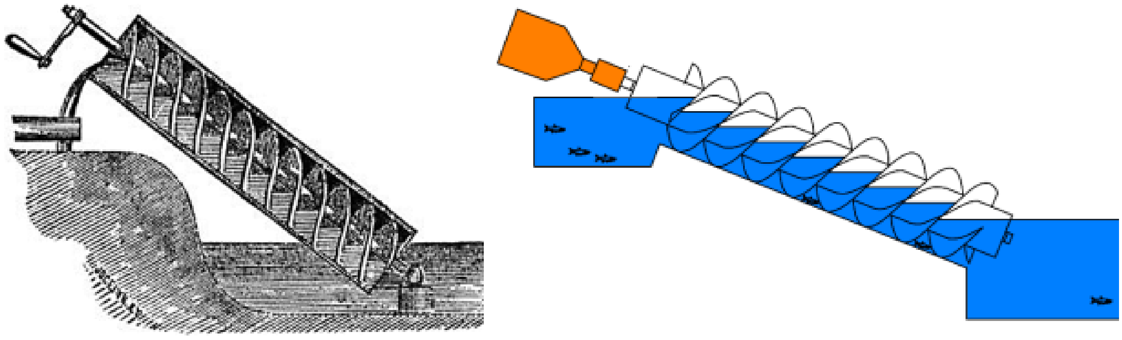

**Figure 1.** Screw hydropower turbine model.

## SCOPE

The application of Archimedes Screw Generators represents a highly environmentally friendly turbine option. As they operate without the need for reservoirs or dams, there is no risk of sudden floods in the vicinity, thus ensuring minimal impact on the surroundings. Additionally, the presence of natural vegetation remains undisturbed, preventing the decomposition of vegetation that could contribute to greenhouse gas emissions, thereby mitigating climate change effects and reducing carbon dioxide levels. Particularly in the context of small-scale Archimedes screw generators used for domestic purposes, the absence of reservoirs or extensive infrastructure requirements further underscores their practicality and sustainability.

## METHODOLOGY

The process of project design, particularly in mechanical engineering, primarily focuses on devising systems that efficiently convert energy into useful mechanical forms and the mechanisms necessary to transform the project's output into the desired form. This design process can result in the creation of a completely new project or the enhancement of an existing one. Project design involves the meticulous arrangement and connection of moving and stationary components to enable the liberation, transformation, and utilization of energy [12-18].

The fundamental procedure of mechanical project design follows a systematic approach, starting from the specified functional requirements of the product and culminating in the comprehensive depiction of the final product through blueprints. This procedure entails several key steps:

### First Step

The initial step involves compiling a comprehensive list of specifications detailing the functional requirements of the product. These requirements may include factors such as output capacity, service life, cost, reliability, appearance, noise level, and ease of operation. Each requirement is assigned weightage and prioritized based on its importance [18-20].

### Second Step:

After analyzing the requirements, the designer generates rough sketches illustrating various possible mechanisms for the project. These mechanisms are then compared based on factors like cost competitiveness, raw material availability, and manufacturing capabilities to determine the most suitable option.

### Third Step

In this phase, a block diagram depicting the general layout of the selected configuration is created. Joining methods such as riveting, bolting, and welding are specified to connect individual components, and rough sketches outlining the shapes of these components are drafted.

### Fourth Step

The subsequent stage involves the design of individual components within the selected configuration. This includes identifying the forces acting on each component, selecting appropriate materials based on functional requirements, predicting potential modes of failure, and determining the geometric dimensions of the components through detailed stress analysis and consideration of manufacturing constraints.

### Fifth Step

The final stage entails preparing blueprints of both the assembly and individual components. These drawings specify the materials, dimensions, tolerances, surface finishes, and machining methods required for each component. Additionally, the designer creates separate lists for standard components to be procured from the market and special components to be manufactured in-house.

**Figure 2.** Actual model of screw hydropower turbine.

In essence, project design or mechanical design follows a methodical, step-by-step approach, guiding the transition from known specifications to an innovative solution. In Figure 2. Shows the Actual Model of Screw Hydropower Turbine.

## CONCLUSION

The utilization of micro hydropower systems employing Archimedean turbines represents an environmentally friendly and fish-friendly approach, eliminating the need for deforestation, displacement of people, or other disruptive practices. Unlike traditional hydropower plants, these systems do not require large dams, high discharge rates, high head conditions, or penstocks. The efficiency of these plants remains consistent regardless of the load, although the power output and speed may vary based on discharge levels at the same head condition. Therefore, micro hydropower plants utilizing Archimedean turbines are deemed highly suitable for both current and future hydroelectric applications.

Significant insights into the performance characteristics of screw turbines were garnered from experimental investigations. These turbines were successfully constructed using locally available materials, demonstrating the ability to generate 0.098 watt of power with an impressive efficiency of 41%. Considering the equipment and measurement tools employed in these experiments, these findings present promising prospects for further exploration. However, additional research is necessary before the widespread deployment of these turbines, particularly in remote areas.

## REFERENCES

1. Aigner, D. (2008). Uberfalle - Asserbauliche Mittelungen - Aktuelle Forschungen im Wasservau 1993-2008. Institut fur Wasserbau und Technische Hydromechanik der TU Dresden. Selbstverlag der Technischen universitat Dresden, Dresden, 36.
2. Bard, N. (2007). River Dart Hydro Performance Assessment by Nick Bard Hydro Services For Mannpower Consulting Ltd. Nick Bard Hydro Services, 44(0). Retrieved from http://www.mannpower-hydro.co.uk/research.php
3. Brada, K. (1996). Schneckentrogpumpe als Mikroturbine, in Wasserkraftanlagen - Klein- und kleinstkraftwerke. expert-Verlag, Malsheim, 1st edition.
4. Brada, K. (1999). Wasserkraftschnecke ermöglicht Stromerzeugung über Kleinkraftwerke [Hydraulic screw generates electricity from micro hydropower stations]. Maschinenmarkt Würzburg, (14), 52–56.
5. Hawle, W., Lashofer, A., & Pelikan, B. (2012a). Lab Testing of the Archimedean Screw. hidroenergia.

6. Hawle, W., Lashofer, A., & Pelikan, B. (2012b). State of technology and design guidelines for the Archimedes screw turbine. University of Natural Resources and Life Sciences Vienna (BOKU), 1–8.
7. Kibel, P. (2008). Archimedes Screw Turbine Fisheries Assessment. Phase II: Eels and Kelts. Report. Fishtek Consulting Ltd. (UK).
8. Kibel, P., Pike, R., Coe, T. (2009). The Archimedes Screw Turbine: Assessment of Three Leading Edge Profiles. Report. Fishtek Consulting Ltd. (UK).
9. Mali S. C., Vyavahare R. T., (2015). "An Ergonomic Evaluation of an Industrial Workstation: A Review", International Journal of Current Engineering and Technology, vol.5, pp. 1820-1826, 2015.
10. Mali S. C., Vyavahare R. T., (2015). "RULA Analysis of Work-related Disorders of Foundry Industry Worker Using Digital Human Modeling (DHM)", International Research Journal of Engineering and Technology (IRJET), vol.2, Issue 5, e-ISSN: 2395-0056, p-ISSN: 2395-0072
11. Mali S. C., Vyavahare R. T., (2020). "A Systematic Ergonomics Approach of Maintenance Workstation", IOP Conf. Series: Materials Science and Engineering 814 (2020) 012032.
12. Dr. Altaf O. Mulani. (2024). A Comprehensive Survey on Semi-Automatic Solar-Powered Pesticide Sprayers for Farming. Journal of Energy Engineering and Thermodynamics (JEET) ISSN 2815-0945, 4(02), 21–28. https://doi.org/10.55529/jeet.42.21.28
13. Sandeep Kedar and A. O. Mulani (2024), IoT Based Soil, Water and Air Quality Monitoring System for Pomegranate Farming, NATURALISTA CAMPANO, Vol. 28, Issue 1.
14. Bhanudas Gadade, A O Mulani and A.D.Harale (2024). IOT Based Smart School Bus and Student Monitoring System. NATURALISTA CAMPANO, Vol. 28, Issue 1.
15. Anil Dhanawade, A. O Mulani and Anjali. C. Pise. (2024). Smart farming using IOT based Agri BOT. NATURALISTA CAMPANO, Vol. 28, Issue 1.
16. Dr. Shweta Sadanand Salunkhe and Dr. Altaf O. Mulani. (2024). Solar Mount Design Using High-Density Polyethylene. NATURALISTA CAMPANO, Vol. 28, Issue 1.
17. Sarda, M., Deshpande, B., Deo, S., &amp;amp; Karanjkar, R. (2018). A comparative study on Maslow's theory and Indian Ashrama system.". International Journal of Innovative Technology and Exploring Engineering, 8(2), 48-50.
18. Deo, S., and Deo, S. (2019). Cybersquatting: Threat to domain name. International Journal of Innovative Technology and Exploring Engineering, 8(6), 1432-1434.
19. Shambhavee, H. M. (2019). Cyber-Stalking: Threat to People or Bane to Technology. International Journal on Trend in Scientific Research and Development, 3(2), 350-355.
20. Deo, S., and Deo, D. S. (2019). Domain name and its protection in India. International Journal of Recent Technology and Engineering.
21. Sarda, M., Deshpande, B., Deo, S., and Pathak, M. A. (2018). Intellectual Property and Mechanical Engineering-A Study Emphasizing the Importance of Knowledge Of Intellectual Property Rights Amongst Mechanical Engineers. International Journal of Social Science and Economic Research, 3(12), 6591-6596.
22. Takale, S. (2022). DWT-PCA Based Video Watermarking. Journal of Electronics, Computer Networking and Applied Mathematics (JECNAM) ISSN, 2799-1156.
23. Takale, S., and Mulani, D. A. Video Watermarking System. International Journal for Research in Applied Science and Engineering Technology (IJRASET), 10.
24. Utpat, V. B., Karande, D. K., and Mulani, D. A. Grading of Pomegranate Using Quality Analysis‖. International Journal for Research in Applied Science and Engineering Technology (IJRASET), 10.
25. Deshpande, H. S. and Karande, K. J. (2014, April). Efficient implementation of AES algorithm on FPGA. In 2014 International Conference on Communication and Signal Processing (pp. 1895-1899). IEEE.
26. Kashid, M. M., Karande, K. J. (2022, November). IoT-based environmental parameter monitoring using machine learning approach. In Proceedings of the International Conference on Cognitive and Intelligent Computing: ICCIC 2021, Volume 1 (pp. 43-51). Singapore: Springer Nature Singapore.

27. Deshpande, H. S. and Karande, K. J. (2015, April). Area optimized implementation of AES algorithm on FPGA. In 2015 International Conference on Communications and Signal Processing (ICCSP) (pp. 0010-0014). IEEE.
28. Gadade, B. (2022). Automatic System for Car Health Monitoring. International Journal of Innovations in Engineering Research and Technology, 57-62.
29. Kamble, A., (2022). Google assistant-based device control. Int. J. of Aquatic Science, 13(1), 550-555.
30. Dr. Altaf O. Mulani. (2024). A Comprehensive Survey on Semi-Automatic Solar-Powered Pesticide Sprayers for Farming. Journal of Energy Engineering and Thermodynamics (JEET) ISSN 2815-0945, 4(02), 21–28. https://doi.org/10.55529/jeet.42.21.28
31. Amruta S. Bankar, A. D. Harale and K. J. Karande (2021). Gestures Controlled Home Automation using Deep Learning: A Review, International Journal of Current Engineering and Technology (IJCET), Vol.11, No.6, page no. 617-621.