Screw Hydropower Turbine for Power Generation

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Abstract— The intention of any hydroelectric generating station is to convert potential energy associated with the water in a watercourse passing the station into electrical energy. Industry has broad experience in the field of screw pumps and screw pump installations. For nearly 100 years Micro-hydro power plants has designed, manufactured, supplied, erected and maintained many types of screw pump configurations. Since the early eighties Micro-hydro power plants had available a fully automated screw pump selection This project is used to select the optimum screw pump for a particular application with least or zero head .This can produce some electricity using small generator.

Keywords— **Hydroelectric**, Erected, Ecological services, Microhydro, Hydropower, Economic.

1. Introduction

Sustainable development is described as "the organizing principle for the achievement of human development objectives while at the same time preserving the capacity of natural systems to provide the natural resources and ecological services on which the economy and community rely". Sustainable development often implies "a development that addresses current needs without influencing potential generations' capacity to fulfill their own needs". Adapted from: A. Yoosef Doost and W. D. Lubitz, "Archimedes screw turbines: A sustainable development solution for green and renewable energy generation-a review of potential and design procedures,": This article is an original literature review on Archimedes screw generators that was written by Arash Yoosef Doost Some parts were adopted or updated from original research articles that were written by Arash Yoosef Doost . The figures are all original, or from explicitly referenced sources. 11 In 1979 René Passet proposed a three-sphere framework for sustainable development projects . According to this framework, a development can be considered sustainable only if it simultaneously has positive social, environmental, and economic impacts. If a project satisfies the economic and social aspects but fails to satisfy the environmental aspects, it is categorized as equitable. If a development project can satisfy the environmental aspects but fails one of the social or economic aspects, the development could still be bearable or viable, respectively. If a development cannot satisfy at least two of the three mentioned aspects, it cannot be categorized anywhere in this definition. Some authors consider a fourth sustainability pillar of culture, institutions, or governance , or reconfigure the four domains to be social-ecology, economics, politics, and culture. Overall, the focus of the modern sustainable development concept is simultaneous economic development, social progress, and environmental protection for current and future generations

Renewable Energy Renewable energy is defined as energy that is obtained from resources that are fully replenished 12 on a human time scale. . According to REN21's year 2019 report, renewable resources provided 2378 GW of power capacity, which is more than 33% of the world's total electrical generating capacity. In this list, hydropower capacity (excluding pure pumped storage capacity) is 1132 GW, which is about half of total renewable energy. In 2018, annual new investment in hydropower grew 11% in comparison to the previous year. The majority of hydropower investment is in large dams and associated generating stations that inherently include complex networks of social, economic, and ecological effects, maybe more than any other large infrastructure project

Hydropower Hydropower is one of the most efficient and reliable sources of renewable energy [18] and offers significant value for a sustainable future. By the end of 1999, around 2650 Terawatt hours (TWh) (19%) of the world's total electricity relied on hydropower. It rose to about 3100 TWh by 2009, and it was estimated that it would reach 3606 TWh in 2020 . Dams are essential tools for controlling, storing, managing, and operating water for humankind. Large dams serve various specific purposes for our civilization, including water supply, flood

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control, navigation, sedimentation control, and hydropower. However, they also come with disadvantages, including flooding large areas of land, impeding fish migration, and affecting the physical characteristics of the dam's downstream river. Construction of large dams needs significant capital, so many large dam projects are national (or even international) in scope. Currently, most new large dams are being constructed to provide combinations of energy, irrigation, and flood control in developing countries. At the same time, dam decommissioning is an increasing trend in developed countries because of environmental impacts and the economic costs of maintaining 13 aging structures. Hydropower plants can be classified based on the electrical generating capacity,. Typical categories and associated capacities are: large hydro (> 10 MW), small hydro (< 10 MW), mini-hydro (< 1 MW), micro-hydro (< 5 kW) [24]. It is estimated that about 10% of global hydropower is generated from powerplants with less than 10 MW of capacity .

In a run-of-river (ROR) configuration, hydropower plants utilize the natural flow of water and usually have little or no controlled water storage, meaning that ROR typically has small or no reservoirs. The lack of a large, actively controlled reservoir formed by a dam, or significant control of river flow, avoids or minimizes the disadvantages associated with large reservoirs, at the cost of more variable or poorly timed power generation. It minimizes flooding land and soil destruction, greenhouse gas emissions, as well as environmental and social impacts. However, the resulting reduction in control of river flow can result in more variable or poorly timed power generation. Micro hydropower plants can often be considered a sustainable development option for generating electricity in both developing and developed countries. There is often no need to build expensive 14 dams and flood massive areas for the reservoir. This minimizes land and soil destruction, threats to wildlife, climate change effects, and other environmental impacts, especially on ecosystems, as well as the social impacts of large hydropower plants. New ROR hydropower technologies such as Archimedes Screws Turbines (ASGs) can be particularly advantageous in these regards.

Archimedes Screw the Archimedes screw (also known as an Archimedean or hydrodynamic screw) is considered to be one of the earliest hydraulic machines. It is composed of one or more helical arrays of blades wrapped around a central cylinder, like a woodscrew. This screw is supported within a surrounding fixed trough. There is a small gap between the trough and screw that allows the screw to rotate freely while allowing only a small amount of water to leak past the blade edges. It is believed that the Archimedes screw was invented by Archimedes of Syracuse (circa 287-212 BCE), the Greek physicist, mathematician, and inventor. However, there is evidence suggesting the invention and use of the screw technology may date back to over three centuries before Archimedes under the reign of King Sennacherib (704-681 BCE) in the 7th century BCE in the Assyrian Empire.

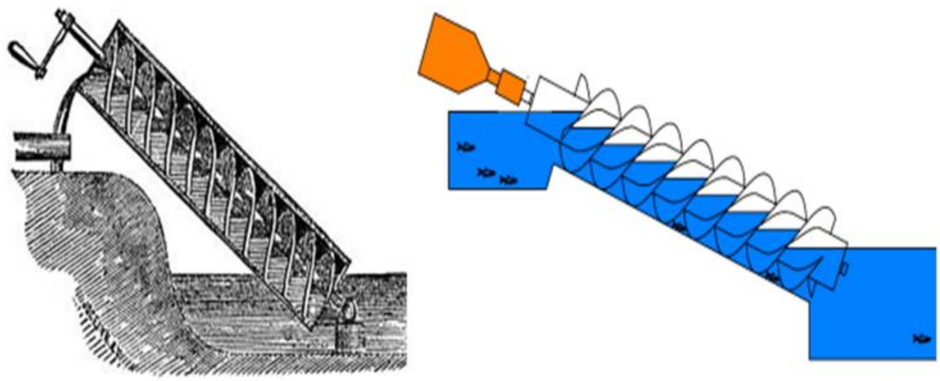

Fig. 1. Proposed design.

2. Objective of the project

i. To generate electrical energy using least or zero water heads available at remote areas mainly having no electricity infrastructure.
ii. To learn the construction and working of screw generator.
iii. Development of the working model and testing.

3. Problem Definition

Energy crisis around the world encourage researcher to pay attention in founding another sources of green energy these days. A lot of research has been conducted by using natural energy sources such as solar, wind, wave and water. According to sources of energy from water to run a turbine, there is a rapid change of technology in using such turbine which suitable for definite kind of flow-river, much of them are used for high head (differences) to produce electricity. Meanwhile, Archimedean hydro technology which had a very long history in the world, with various machines and mechanism, gears, pumps, various mills driven by water wheels etc.

4. Scope of Project

Archimedes Screw Generators square measure one among the foremost atmosphere friendly turbines. Being reservoir or dam-less there's no likelihood of flash floods close to the location. Thus, the installation of Archimedes Screw Generators won't affect the encompassing. Also, natural vegetation close is unaffected, therefore there'll be no decomposition of this natural vegetation which may result in the formation of the greenhouse emission gas that is primarily chargeable for the climate changes, therefore, reducing the carbonic acid gas level. Once it involves small Archimedes Screw Generators that square measure used for domestic functions, there's no would like of a reservoir or a lot of houses.

5. Literature Review

Research on screw turbine has been started in Europe around the year of 2000s. Originally it was designed for pumping water from one location to another, the idea of modifying it for use as a turbine has been seen in the UK since 2004/2005. There are several advantages of screw turbine. It is known as one of the most environmentally friendly turbine in which fish and eels can pass through screw turbine while it operate without injured. It is remarkably cheaper among other kind of turbine, because it does not need guide vane or penstock, trash racks, screens and fish diversion systems. This turbine also known as very low maintenance turbine, that retipping is required every 20 years, with a minimum lifetime of 30 years. The main maintenance issue is the complicated gearbox required. The Archimedes screw turbine operates at low rotational speeds, which means a complex gearbox is required for connection to a generator [5].

5.1 Rorres (2000)

Rorres (2000) lays out an analytical method to optimize design an Archimedes screw geometry for pumping applications. This problem is framed as maximizing the amount of water that can be lifted with each turn of the Archimedes screw pumps. He stated that the geometry of Archimedes screw pump consist of some external parameter which are usually determined by the location of the screw and how much water is to be lifted, and some internal parameter such as inner radius, number of blades and the pitch of the blades. In this research, he developed method to maximize the volume of water lifted in one turn of the screw by combination of inner radius and pitch of screw [6].

5.2 Muller and Senior (2009)

Muller and Senior (2009) created a simplified model for Archimedes screw turbine that idealizes the turbine's blades as moving weirs. Based on this idealization, a comparison is made to the hydrostatic pressure wheel. They concluded that Archimedes screw turbine efficiency is a function of both turbine geometry and mechanical losses, and that efficiency increases with an increased number of flights (N) as well as with decreased installation angle (β) [7].

5.3 Nurenberg and C. Rorres (2013)

Nurenberg and C. Rorres (2013) derived analytical model for water inflow of Archimedes screw turbine to get the optimal value of the inflow parameters. In this paper, they adopted some formulas of Archimedes screw pump that published by C. Rorres (2000), which are radius ratio, pitch ratio, volume ration and volume per turn ratio. For getting efficiency, they considered leakage between the flights and the trough and leakage from overflow. Their analyticalmodel compared with experimental measurement. However, value of highest efficiency of screw turbine is still become a question [8].

In 2015, there was an article about compilation of Archimedes screw in application as a pump and as a turbine (S. Waters, G.A. Aggidis). They said there is currently a lack of research on the topic due to infancy of technology as a turbine. Screw turbine that was developed are visually similar to the inclined pump and often treated the same during the design. However, there are some key differences. When it comes to creating and optimizing a pump device, the key is to increase the amount of water moved during each turn of device. For the turbine, the maximum amount of energy in the flow needs to be extracted [9].

5.4 J. Rohmer et al (2016)

J. Rohmer et al (2016) did research about modeling and experimental results of an Archimedes screw turbine. Their model based on what C. Rorres (2000) did for Archimedes screw pump with some developments. Their research shows upstream level, mechanical efficiency and mechanical torque, as a function of the rotational speed and flow rate. Comparison between numerical and experimental data show the same trend and tend to slightly different [10].

5.5 Guilhem Delinger et al (2016)

Guilhem Delinger et al (2016) also did experimental research of Archimedes screw turbine. They derived some formulas based on C. Rorres (2000). Their research shows both theoretical and experimental values of efficiency decrease when screw inclination increases [11].

In the wide range of microhydro technologies, Williamson et al. discussed the relative advantages, includes a design approach for selecting an appropriate technology for particular site [12]. Compared to other generation technologies, screw turbine has greatest potential at low head site (less than 5 m), and unlike conventional reaction and impulse turbines, screw turbine has the potential for maintaining high efficiency even as the head approaches zero .

6. Methodology of project desig

Decision making comes in every stage of design. Consider two cars of different makes. They may both be reasonable cars and serve the same purpose but the designs are different. The designers consider different factors and come to certain conclusions leading to an optimum design. Market survey gives an indication of what people want. Existing norms play an important role. Once a critical decision is made, the rest of the design features follow. For example,once we decide the engine capacity, the shape and size, then the subsequent course of the design would follow. A bad decision leads to a bad design and a bad product.

Design may be for different products and with the present specialization and knowledge bank, we have a long list of design disciplines e.g. ship design, building design, process design, bridge design, clothing or fashion design and so

6.1 Working of the project

The screw turbine was known for the low pressure turbine. It consists of screw shaped bucket arrangement which rotates when water pressure was applied on them. This are inclined at particular angle to maintain the water pressure needed for rotation

Generator is designed in such a way that the speed of the turbine generates power. It is coupled with turbine with gear drives which maintain the speed of the generator in circular manner. It rotated at constant of rated RPM which generally for this turbine is 10-20 revolution per minute. These generators are designed for most expensive as compared to conventional one.

6.2 Advantages of the project

Advantages of the projects per following like as:

i. Highest possible efficiency under any possible condition
ii. Self-regulating to changing water flow Simple and small installation
iii. Easy implementation in existing situations
iv. Entirely fish friendly
v. Open and robust construction
vi. Ultra long life time of at least 30 years Insensitive to clogging
vii. Operates completely without fine screen
viii. Low maintenance costs 24/7 energy supply

6.3 Disadvantages of the project

Dis-advantages of the project as per following like as:

i. High installation cost

6.4 Application of the project

Our project should use for following various applications like as:

i. Rivers
ii. Cooling water outlets from power stations
iii. Industrial process water (for example Project or steel mills)
iv. Water treatment inlets (Municipal and Industry)
v. Water treatment outfalls (Municipal and Industry)
vi. Replacement of waterwheels and other types of generators

7. Experimental Setup

Fig. 2. Experimental Setup.

8. Future Scope

The project has covered almost all the requirements. Further requirements and improvements can easily be done since the as per requirements is mainly structured or modular in nature. Improvements can be appended by changing the existing modules.

To get optimum parameter design, it needs to be done more research in other angle of trough and blade, and also addition on number of blade and influenced of length of blade screw.Thus we can successfully make this screw generator.

9. Result and Discussion

The Micro hydropower based on Archimedean turbine is an eco-friendly, fish friendly & there is no requirement of deforestation as well as people displacement and other harassments. In these types of plant there are no requirements of big dam, high Discharge, high Head & penstock etc. The efficiency of plant does not vary with load, but Power output & Speed of this plant vary with discharge at same Head condition. Hence this type Micro hydropower based on Archimedean turbine plant is most suitable hydro power plant in the present as well as future.

Screw turbine is built successfully with locally available simple material and this turbine can generate power . By considering equipment's and measurement tools that used, this result is promising to be continued.

10. Conclusion:

This project demonstrates the effective utilization of screw pump technology in micro-hydro power generation, especially in scenarios with minimal or zero head. By leveraging nearly a century of industrial expertise and automation in screw pump selection, the system enables the conversion of low-potential water energy into usable electrical power through a small generator. The approach presents a sustainable and practical solution for decentralized energy production in low-head environments.

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