Design And Development Of Portable Screw Hydropower Electricity Generator For Waste Water Of Processing Industries

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Abstract- *The treatment of dyeing industry wastewater is a critical environmental concern due to its high levels of color, turbidity, suspended solids, dissolved solids, and chemical oxygen demand (COD).The study was conducted by first reviewing relevant literature to assess previous findings on natural coagulants and then collecting necessary materials and wastewater samples from a dyeing industry. The wastewater sample was analyzed, with initial measurements showing a pH of 9.2, color at 650 NTU, turbidity at 47 NTU, total suspended solids (TSS) of 38 mg/L, total dissolved solids (TDS) of 2980 mg/L, and a chemical oxygen demand (COD) of 760 mg/L. Following these measurements, the natural coagulants were prepared. Then the efficiency of a natural coagulant prepared from Moringa oleifera seed powder and Soya bean powder in treating dyeing industry wastewater. The natural coagulant was compared with alum using conventional jar test experiments, assessing parameters such as pH, color, turbidity, total suspended solids (TSS), total dissolved solids (TDS), and COD. The results indicate that at an optimum dosage of 80 mg/L, both coagulants effectively reduced pollutants to meet the effluent standards set by the Central Pollution Control Board (CPCB). While alum exhibited superior performance in color and TDS reduction, the natural coagulant demonstrated slightly better turbidity and COD removal. Given its eco-friendly nature, the natural coagulant presents a viable and sustainable alternative for wastewater treatment in the textile industry.*

Keywords*:* conveyor Screw turbine, hydropower, wastewater energy recovery, 12V dynamo, renewable energy, micro-hydro

I. INTRODUCTION

A portable screw hydropower generator equipped with a 12V dynamo offers a sustainable solution for harnessing energy from low-head water sources. The Conveyor screw turbine, central to this design, efficiently converts the kinetic energy of flowing water into mechanical energy, even in environments with minimal water drop. This mechanical energy drives the 12V dynamo, producing direct current (DC) electricity suitable for charging batteries or powering small appliances. To ensure compatibility with standard electrical devices, an inverter can be integrated to convert DC power into alternating current (AC). The portability and compact design of this generator make it particularly valuable for remote or off-grid locations, providing a reliable and eco-friendly power source without reliance on traditional fuel-based generators.

Its user-friendly setup allows for easy installation and minimal maintenance, promoting the broader adoption of renewable energy solutions. By leveraging accessible water sources, this technology exemplifies a practical approach to sustainable energy production. Hydropower has long been a cornerstone of renewable energy, harnessing the kinetic energy of flowing water to generate electricity. Traditionally, large-scale hydroelectric plants have dominated this sector, but recent advancements have paved the way for micro-hydropower solutions that are both portable and efficient.

One such innovation is the portable screw hydropower generator equipped with a 12V dynamo. This compact device utilizes the Conveyor screw principle, allowing it to operate efficiently in low-head water environments—situations where the water drop is minimal. The integration of a 12V dynamo enables the conversion of mechanical energy into direct current (DC) electricity, suitable for charging batteries or powering small appliances.The portability of this generator makes it particularly valuable for remote or off-grid locations, providing a sustainable and continuous power source without relying on traditional fuel-based generators. Its user-friendly design ensures easy installation and minimal maintenance, making renewable energy accessible to a broader audience.

In summary, the portable screw hydropower generator with a 12V dynamo represents a significant step forward in micro-hydropower technology, offering an eco-friendly, efficient, and practical solution for small-scale energy needs.The portable screw hydropower generator converts flowing water into electricity using a conveyor screw. As water moves through the screw, it rotates, driving a dynamo to produce power. The electricity can be stored or used directly, ensuring continuous operation as long as water flows.

II. LITERATURE REVIEW

The Conveyor screw, an ancient invention traditionally used for water lifting, has been ingeniously adapted for hydropower generation in recent decades. This adaptation has led to the development of screw turbines, also known as Archimedean turbines or Conveyor screw generators (ASGs), which convert the potential energy of water into mechanical work. These turbines are particularly suitable for low-head sites, operating effectively with heads ranging from 0.1 to 10 meters and flow rates between 0.01 to 14.5 cubic meters per second. The design of screw turbines involves a helical rotor situated within a semicircular trough. Water enters the upper end of the screw, and its weight exerts pressure on the turbine blades, causing rotation. This rotational motion is transferred to a generator, typically through a gearbox, producing electricity. The simplicity of this design results in fewer moving parts, leading to reduced maintenance requirements and increased durability.

One of the notable advantages of screw turbines is their environmental compatibility. The slow rotation of the screw ensures minimal impact on aquatic life, making it a fish-friendly solution. This characteristic has led to their application in environments where the preservation of wildlife is a priority.

The versatility of screw turbines extends to their ability to operate in low-head sites, making them suitable for a wide range of geographical locations. Their capability to function effectively across various flow rates and head heights enhances their adaptability.

In summary, the adaptation of the Conveyor screw for hydropower generation has resulted in a sustainable and efficient technology. The development of screw turbines offers a viable solution for renewable energy generation, particularly in low-head scenarios, contributing to the diversification of sustainable energy sources.

III. PROBLEMSTATEMENT

Access to reliable and sustainable electricity remains a significant challenge in remote and rural areas worldwide. As of 2019, approximately 770 million people, or 10.2% of the global population, live without electricity, hindering economic and social development. WIKIPEDIA Traditional electrification methods, such as extending national grids, are often economically unfeasible in these regions due to high infrastructure costs and low population densities. To address this issue, there is a need for decentralized, cost-effective energy solutions that can harness local resources. One promising approach is the development of portable screw hydropower generators equipped with 12V dynamos.

These systems utilize the Conveyor screw principle to convert the kinetic energy of low-head water sources into electrical power.Their portability and ease of installation make them particularly suitable for off-grid communities, providing a renewable and reliable energy source without the need for extensive infrastructure. By leveraging local water resources, these generators can significantly improve energy access, fostering economic growth and enhancing the quality of life in underserved areas.

In remote or limited-grid areas, access to reliable and sustainable electricity remains a significant challenge. Traditional hydropower solutions often require substantial infrastructure, making them impractical for decentralized power generation in such regions. To address this issue, there is a need for a portable, cost-effective hydropower generator capable of harnessing energy from low-head water sources.

IV. METHODOLOGY

The design of the screw hydropower generator aims to efficiently harness kinetic energy from low-head water sources using a compact, durable, and scalable system. This section describes the key design aspects, including the mechanical, electrical, and structural elements, as well as considerations for portability, efficiency, and sustainability.

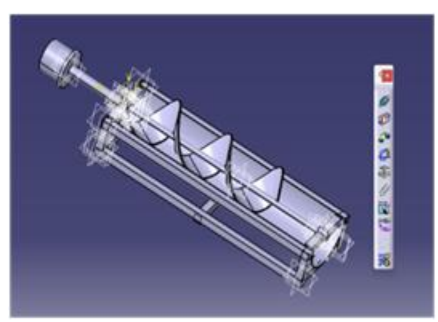

Fig. Software Development of Generator

The manufacturing process of a portable screw hydropower generator with a 12V dynamo involves several key steps to ensure efficiency and durability. Initially, the Conveyor screw is fabricated by forming a helical surface around a central cylindrical shaft, typically using corrosion-resistant materials like mild steel or composites to withstand aquatic environments. This screw is then encased within a hollow pipe, with precise tolerances to minimize water leakage during operation. The assembly is mounted on bearings to facilitate smooth rotation. The 12V dynamo is mechanically coupled to the screw, often through a gearbox that optimizes rotational speed for effective electricity generation. Additional components, such as voltage regulators and inverters, are integrated to condition the electrical output, making it suitable for various applications. The entire system is designed for portability, featuring a compact and modular structure that allows for easy transportation and installation in diverse locations.

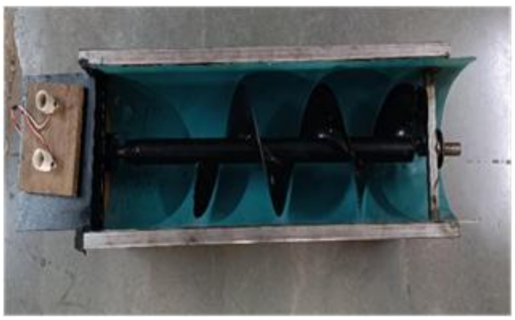

Fig. Working model of Generator

V. WORKING PROCESS

A portable screw hydropower generator equipped with a 12V dynamo operates by converting the potential energy of flowing water into electrical energy through the Conveyor screw principle. The system consists of a helical screw encased within a cylindrical pipe, inclined at an angle to the water flow. As water enters the lower end of the screw, its weight and flow cause the screw to rotate. This rotation is facilitated by the water's pressure exerted on the helical surfaces, effectively transforming the water's potential energy into mechanical energy. WIKIPEDIA The rotating screw is connected to a 12V dynamo via a gearbox, which adjusts the rotational speed to match the dynamo's optimal operating conditions. As the screw turns, it drives the dynamo, converting mechanical energy into direct current (DC) electrical energy. This DC output can be utilized directly to power DC-compatible devices or stored in batteries for later use. For applications requiring alternating current (AC), an inverter can be integrated to convert the DC electricity into AC, ensuring compatibility with standard electrical appliances.

The design's efficiency allows it to operate effectively across a range of flow rates and head heights, making it suitable for various low-head hydropower applications. Additionally, the system's portability and compactness enable easy deployment in remote or off-grid locations, providing a renewable and reliable energy source without extensive infrastructure requirements.

The operation of the Archimedean screw turbine is based on the conversion of potential energy from water at a higher elevation to kinetic energy as it descends through the screw. The helical blades of the screw capture the energy from the flowing water, causing the screw to rotate. This rotation drives the dynamo, which generates electricity. The efficiency of this system allows it to operate effectively across a range of flow rates and head heights, making it suitable for various low-head hydropower applications. Additionally, the system's portability and compactness enable easy deployment in remote or off-grid locations, providing a renewable and reliable energy source without extensive infrastructure requirements. Conveyor screw generators (ASGs) can be used in low-head hydro sites as a source of micro-hydroelectric power generation. ASGs are an adaptation of the Conveyor screw, a helical surface surrounding a central cylindrical shaft inside a hollow pipe that is used to carry water to higher elevations.

Water at higher elevations can be translated down the length of the screw due to the hydrostatic forces from the fluid on the screw’s surfaces, the resulting rotation of the screw drives a generator that creates efficient, cost effective and clean electricity. Such a device is often referred to colloquially as aConveyor Screw Turbine (AST), although the AST is actually a quasi-static pressure machine, rather than a true turbine. Micro hydro is a type of hydroelectric power that typically produces from 5 kW to 100 kW of electricity using the natural flow of water. Installations below 5 kW are called Pico Hydro, whereas up to 10000 kW it is called as Small Hydro. They can provide power to an isolated home or small areas, or are sometimes connected to electric power networks, particularly where net metering is offered. There are many of these installations around the world, mostly in developing nations as they can provide an economical source of energy without the purchase of fuel. Micro 2 hydro systems complement solar PV power systems because in many areas, water flow highest in the winter when solar energy is at a minimum. Micro hydro is frequently accomplished with a Pelton wheel for high head, low flow water supply. The installation is often just a small dammed pool, at the top of a waterfall, with several hundred feet of pipe leading to small generator housing.In low head sites, generally water wheels and Conveyor screws are used.

Condition	Flow Rate (L/s)	Hydraulic Power (W)	Electrical Power (W)	Generator Used	Number of 12W Bulbs
Minimum	3	12.27	7.36	12V Dynamo Generator	1 bulb
Medium	4	14.72	8.83	12V Dynamo Generator	2 bulbs
Maximum	5	17.18	10.31	12V Dynamo Generator	Maximum 3 bulbs

VI. RESULT AND TESTING

This project successfully demonstrates the potential of a small-scale screw hydropower generator using a 12V dynamo generator to harness energy from flowing water, such as wastewater or irrigation systems. The system operates efficiently at flow rates of 3 to 5 liters per second, generating sustainable electrical power ranging from 7.36W to 10.31W, with an approximate output current of 0.61A to 0.86A at 12V DC. The results validate the feasibility of utilizing low-head water flows for energy generation, providing a cost-effective and eco-friendly solution for decentralized power generation.

Testing and evaluation of portable screw hydropower generators with 12V dynamos have yielded insights into their performance across various configurations. For instance, a study involving a 3-phase Brushless Direct Current (BLDC) generator tested with a 12V LED load ranging from 5 to 20 watts demonstrated that at a water discharge rate of 0.00634 m^3/s, the system achieved a mechanical power output of approximately 36.4 watts and an electrical power output of around 7.86 watts, resulting in an efficiency of about 22%.

These studies collectively highlight that factor such as water flow rate, turbine inclination angle, and system design significantly influence the efficiency and power output of portable screw hydropower generators. Optimizing these parameters is crucial for enhancing performance and ensuring the viability of these systems for sustainable energy generation.

Fig. During Testing of generator

VII. CONCLUSION

We have studied the characteristics of the Conveyor screw turbine using numerical study method using Fluent software by varying its parameters like mass flow rate, inclination angle and the number of blades. We have obtained results according to the various conditions of the screw turbine.

We can see from the result that in the case of mass flow Arte the behavior of the efficiency and the torque generated is directly proportional to the mass flow rate that is as the mass flow rate increases the efficiency increases linearly whereas the torque is parabolically changes with mass flow rate increment

VIII. ACKNOWLEDGMENT

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