DEVELOPMENT OF AN EXPERIMENTAL SAMPLE OF ARCHIMEDES SCREW TURBINE DESIGNED FOR LOW PRESSURE

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Abstract: The article develops an experimental model of a low-pressure Archimedean screw turbine and installs a 100 W generator on it. The studies were carried out at a turbine deflection angle from 10^0 to 55^0, and the permissible angle of its deflection was 45^0. Having found the optimal angle of the Archimedean screw when using a turbine, it was possible to increase the efficiency factor.

Keywords: Archimedes Screw, generator, hydro, power, flow rate, deflection angle, inner diameter, outer diameter

РАЗРАБОТКА ЭКСПЕРИМЕНТАЛЬНОГО ОБРАЗЦА АРХИМЕДОВОЙ ВИНТОВОЙ ТУРБИНЫ, РАССЧИТАННОЙ НА НИЗКОЕ ДАВЛЕНИЕ

Аннотация: В статье разрабатывается экспериментальный образец архимедовой винтовой турбины низкого давления и устанавливается на нем генератор мощностью 100 Вт. Исследования проводились при угле отклонения турбины от 100 до 550, а допустимый угол ее отклонения составлял 450. Найдя оптимальный угол архимедова винта при использовании турбины, удалось повысить КПД.

Ключевые слова: архимедов винт, генератор, гидро, мощность, расход, угол отклонения, внутренний диаметр, наружный диаметр

INTRODUCTION

The utilization of hydropower, as an ancient and enduring source of renewable energy, holds a unique place in the annals of human history [1]. For over two millennia, humanity has harnessed the power of flowing water to fuel various applications, from mechanical processes to electricity generation [2-4].

Micro Hydel Power has several benefits, including as quick and dependable power dispatch, effective regulation, and the option to operate in standalone or grid-connected mode. These systems have a number of drawbacks, such as high installation capital costs, seasonal variations in power generation, and plant underperformance brought on by complicated sites [5,6]. According to [7], large growth in the use of small hydropower are anticipated in Brazil and India, with over 30% of China's districts currently significantly dependent on this type of energy. To generate hydropower on a small scale, different kinds of water wheels, either fixed or floating, have been constructed. The effectiveness of the water wheel to generate hydropower has been shown in earlier research to be strongly influenced by a few design factors, including the profile of the ridge, the number of blades, and the immersed radius ratio [8].

Table1. Tupes of small hudropower plants [9,10].

Category	Installed Capacity
Small Hudro Power Plants	Less than 25 MW
Mini Hudro Power Plants	100 kW to 1 MW
Mikro Hudro Power Plants	5 k w to 100 kW

Piko Hudro Power Plants	Less than 5 kW

These smaller hydropower plants are environmentally friendly, have shorter development periods, and have garnered international attention in both developed and developing nations as a means to enhance energy production. Small hydropower projects offer numerous advantages, especially for rural areas in developing countries. Hydropower, characterized by its sustainability, cost-effectiveness, and environmental friendliness, has consistently contributed to meeting energy demands while simultaneously mitigating the consequences of fossil fuel consumption. In this context, we embark on a journey to explore a contemporary facet of hydropower technology the floating structured pico hydro power plant. These innovative systems offer an efficient and eco-friendly means of capturing hydropower from small canals, rivers, and streams, and they stand as a testament to the enduring relevance of this age-old energy source [11-14].

METHODS

The parameters that determine the geometry of the AST can be classified as external or internal. The external parameters are those that are likely to be influenced by the site in which the turbine will be deployed, and they include the outside diameter (D) and the total length of the screw (L). The internal parameters are those that are required in addition to the external parameters to fully specify the screw's geometry and which can be modified to optimize the performance of the screw. They are the inside diameter (d), the pitch (Λ), and the number of flights (N).

1. External Parameters

a) Outside diameter (D): The outside diameter is the diameter of the co-axial circle whose circumference coincides with the crests (outer edges) of the screw's blades.

b) Total length of the screw (L): This is the overall flighted length of the turbine.

2. Internal Parameters

a) Inside diameter (d): This is the diameter of the screw's inner cylindrical shaft around which the blades are wrapped.

b) Pitch (Λ): The pitch is the distance between corresponding points on adjacent threads of the same flight, measured parallel to the axis of the screw. The available literature does not detail the selection process for an optimal pitch for the AST. Pitch selection for most ASGs defers to analyses carried.

Geometry of the AST

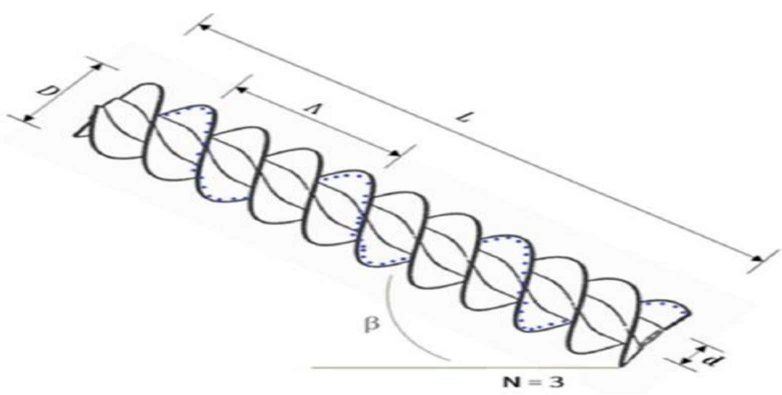

Figure 1. Geometric properties of the AST

RESULT DISCUSSION

The basis of the turbine is a shaft surrounded by spiral-shaped blades. The wings are protected on four sides by supports that serve to hold them at a given angle. The supports are welded from iron and have the shape of a parallelepiped. A 100 W generator is installed on the support frame of the upper part of the turbine shaft.

Tabl 1. Parameters and dimensions of the Archimedean screw turbine

Parametr	Variable	Value
Slope	β	10^0 - 55^0
No.of screw	N	1
Inner diameter	D_i	40 mm
Outer diameter	D_o	170 mm
Pitch	P	50 mm
Screw length	L	1000 mm
Gap width	G_W	10 mm

The Archimedes screw turbine is a hydraulic device that converts the kinetic energy of water into mechanical energy. The flow of water, entering the upper side of the shaft, rotates the spiral blades and ensures the flow of water to the lower side. A generator, belt, pulley or gearbox can be converted into propeller electricity through the propeller turbine shaft. The study was conducted in March. The water pressure was 0.5 m.

Figure 2. Experimental sample of an Archimedean screw turbine (a) and installation location (b)

An experimental sample of the developed Archimedean screw turbine was installed in a low-pressure pit and research was carried out in it. The turbine deflection angle was gradually changed from 10^0 to 55^0. The number of revolutions of the generator shaft was measured using a tachometer. The dependence of the generator shaft speed on the deflection angle is shown in Fig. 3.

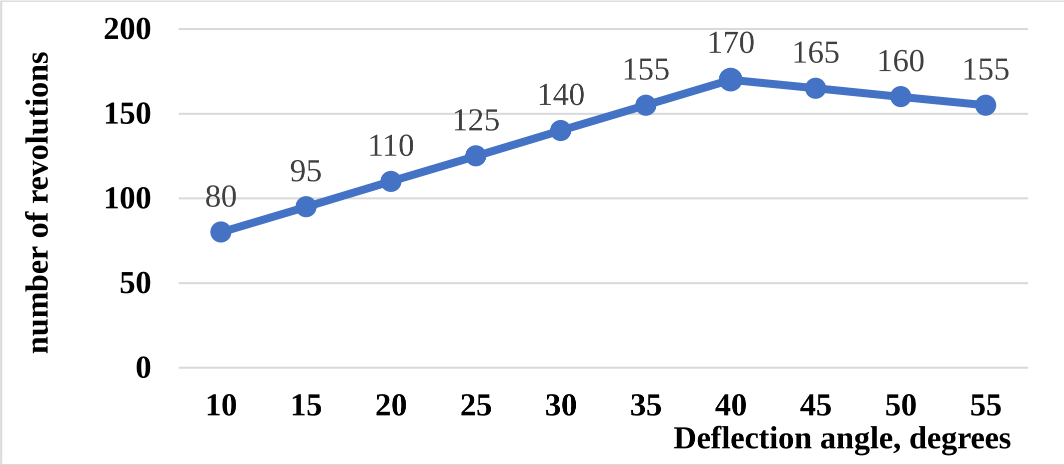

Figure 3. Graph of the dependence of the number of generator shaft revolutions on the turbine deflection angle

As can be seen from the graph in Figure 3, at a turbine deflection angle of 40^0, the number of revolutions of the generator shaft using a belt drive was 170 revolutions per minute. With an increase in the turbine deflection angle from 10^0 to 40^0, the number of revolutions of the generator shaft increased from 80 to 170 times per minute. Between 45^0 and 55^0 degrees of the propeller axis relative to the horizontal axis, the number of revolutions of the generator shaft decreased from 165 to 155 revolutions per minute.

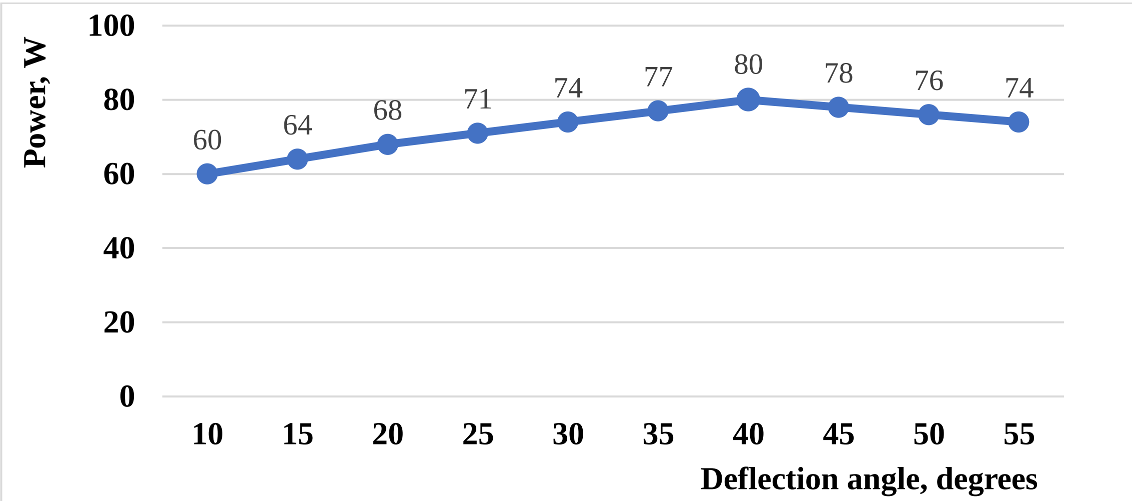

Figure 4. Graph of power versus turbine deflection angle

As can be seen from the graph, at a turbine deflection angle of 40^0, the maximum power is 80 W, and at 10^0, the minimum power is 60 W.

CONCLUSION

The use of hydraulic turbines in the production of electricity from water energy is important in the field of hydropower. Taking this into account, an experimental model of an Archimedean screw turbine was developed. During the research, the reservoir where it is planned to install the Archimedes screw turbine was studied, and parameters such as water speed and pressure were taken into account. Because there are functional dependencies between a number of parameters, such as the diameter of the rotating propeller, the material and weight of the blades. The listed physical quantities have a direct impact on the output energy parameters of the device, for example, turbine torque, electrical power and efficiency indicators.

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