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An Analysis on Performance of Pico-hydro with Archimedes Screw Model Viewed from Turbine Shaft Angle

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ABSTRACT

The use of energy, especially for daily needs, is important. Pico hydro is an environmentally friendly power plant model that can take advantage of low flow rates and generate electricity below 1 kW. The purpose of this research is to obtain the best performance of pico hydro with a screw-shaped turbine model or what is called Archimedes Screw Turbine. The research method was carried out experimentally by adjusting the angle of the Archimedes screw turbine shaft, namely 30°, 45° and 60°. Observations at a discharge of 15 m^3/h with an angle of 30° provide information that the screw turbine power obtained is 111.4 W with an efficiency of 57%. For an angle of 45° the power is 165.7 W and an efficiency of 77% while at an angle of 60° it produces 186 W of power with an efficiency of 87%. The results of this analysis prove that the pico-hydro model with a screw turbine by adjusting the angle variation on the turbine shaft gives the conclusion that the greater the given angle is, the greater the obtained performance will be, in terms of power and efficiency.

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NOMENCLATURE

$P_{Hydraulic}$	The hydraulic power of the screw turbine (W)	A	Cross-sectional area (m^2)
$P_{Turbine}$	Turbine power (W)	V	Flow velocity (m/s)
Q	Water discharge (m^3/s)	**Greek Symbols**	
R	Turbine Radius	ρ	Density of water (kg/m^3)
F	Force (N)	τ	Torque (Nm)
U	circumferential speed of screw	Ω	Angular velocity (rad/s)
F_R	the resultant force on the blade	η	Efficiency
H	Height of water falling (m)	**Subscripts**	
g	Gravity (m/s^2)	P	Power

1. INTRODUCTION

Power plants using renewable energy sources by utilizing water energy can be made on a large or small scale. This depends on the water source that will be used to drive water turbines and waterwheels. Currently, several types of hydropower plants have been made by many people independently, in groups, or at the company level. The types of existing hydropower plants as sources of renewable energy are micro-hydropower plants and large-hydropower plants that produce above 1 MW electricity. Making large-hydro power plants requires great investment and detailed procedure, as mentioned by Phrakonkham et al. [1]. The power plant with a pico-hydro model that is currently starting to be developed is a hydroelectric power plant that utilizes small-scale flows. These power plants use hydropower as their driving force, such as irrigation channels for rice fields,

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rivers around the house, or natural waterfalls by utilizing the height of the falls (head), and the amount of water discharge [2, 3]. One of the most important components in a pico-hydro power plant is the turbine serving as the drive for the generator shaft or alternator. Therefore, the researchers conducted measurable research in this study which focused on the angle of the turbine shaft in the form of a screw. This screw turbine is very important because it can provide a lighter kinetic effect in rotating the water turbine blades, as stated by Julienet al. [4], Rosly et al. [5] and Noori et al. [6].

A pico-hydro power plant is a type of power generation system that uses hydropower on a small scale with a capacity of under 5 kW, as confirmed by Williamson et al. [7] and Kaunda et al. [8]. A pico-hydro power plant intended to be built should meet several requirements, such as a good flow of river water and a place that meets the criteria to be used as a pico-hydro location. The situation based on the requirements can be seen from the slope of the corner of the water channel [9, 10]. One of the studies that became as a basis of in this research was a study that has been carried out by Adam et al. [11] and Assari et al. [12]. They revealed that a water block using a bulb turbine on a pico-hydro had higher efficiency compared to other types of pico-hydro turbines but is constrained by backflow in the bulb blades. This problem causes disturbances, such as unstable power and the output that becomes smaller and also affects the performance results on other properties, as underlined by Kozyn and Lubitz [13]. Gianlucaet et al. [14] and Shahverdi et al. [15] conducted studies by comparing the results of experiments in the laboratory and the results of simulations using software on a computer, in which the most important component that is examined is the slope of the support shaft. Their findings focused section on the slope of the shaft had an effect on the maximum efficiency of the generator with low discharge. In other words, the more inclined the shaft was, the more optimum the results would be obtained [14-16].

A study conducted by Ihfazhet et al. [17] concerning a method of implementing a pico-hydro power plant using a TC 60 open flume propeller turbine revealed that the obtained results were 71 W of electrical power with the highest voltage of 5.5% from 220 volt, a decrease in voltage to -13.3% from 220 volts, and a decrease in frequency to -19% from 90 Hz. In certain geometric parts of an Archimedes screw, it is determined by several external parameters, namely the radius of the outermost tip, the length of the thread, and the slope which is adjusted to the desired condition, as explained by Guilhem et al. [18].

Other affecting parameters were internal parameters (i.e., the radius measured at the deepest part, the number of blades, and the blade pitch) and external parameters (i.e., the location of the Archimedes thread placement and how much water would be lifted or pushed by each screw) [19]. Meanwhile, Pallavet et al. [20] and Muhammad et al. [21] argued that the importance of internal parameters which was independently determined to optimize the performance of the thread. On the other hand, the Archimedean screw pump is the oldest type of pump, invented since people paid attention to fluid transfer. Currently, this type of pump is still widely used because of having several advantages. This pump can work optimally at an installation angle of 30° to 40° [20, 21].

The working principle of the Archimedean hydrodynamic screw turbine is the reversal of the Archimedean pump in which this turbine utilizes water flow energy to be mechanical energy. The power output range is from 1 to 250 kW, the flow rate is from 100 to 5000 l/s, and the slope is from 22° to 36° [22]. Because the impact of the water-energy converted by the turbine becomes larger, the gear type that must be chosen is the first-level transmission. It is because the first-level shaft with a small rotation will make the torque value larger. Furthermore, by taking into account the aesthetic dimensional factor due to the low turbine rotation and intention to get the turbine dimensions as compact as possible, the pulley-and-belt transmission system should not be used, as revealed in studies conducted by Budiarso et al. [23, 24]. If the pulley-and-belt transmission system is used, the dimensions will be very large because of using type C pulleys with more than two lanes, as illustrated by Joel and Bakthavastsalam [25] and Scott et al. [26].

In this research, the problems that arise are related to the power and performance produced by the pico-hydro power plant which is less than optimal, most of the research results obtained efficiency below 50%, so further research required to get an idea of what or which parts of pico-hydro power plant can improve the plant performance. Therefore, we conducted this research by choosing to examine the angle of the turbine shaft. In determination of the shaft angles of 30°, 45° and 60° were carried out to find the best angle position in the pico-hydro power plant application.

2. METHODS

In this study, the researchers employed an applied experimental method on a prototype basis before being tested industrially to be applied to the actual system conditions. In addition, at the end of this study, the researchers correlated the results obtained with the results of previous studies, especially those that applied a similar theory. Furthermore, the researchers also analyzed the prototype made in the relation to usable or applicable standards concerning optimal pico-hydro performance. In general, the main stages in this study were preparation, implementation, analysis, and report writing. All of those stages are carried out by the research team.

Figure 1 demonstrates the installation of the tools used in this study, all components were installed according to their functions starting from the main equipment, supporting tools to measuring instruments for data collection. In general, the way it works is that after the pump is turned on, the water from the water reservoir will flow through the distribution pipe to the water flow meter, after the valve is opened according to the desired opening, the water will go to the screw turbine to turn the screw which in turn rotates the turbine shaft. The rotation is forwarded to the gearbox to regulate its stability so that the rotation of the turbine shaft will drive an electric generator, the cycle occurs repeatedly in operational conditions.

Figure 2 is an illustration related to the condition and position of the turbine screw shaft angle variation model, where this screw model was made to ensure the latest in pico hydro power research, where some existing references are micro hydro power plants. The turbine shaft is made permanently attached to the screw blades, this condition ensures that the construction is installed

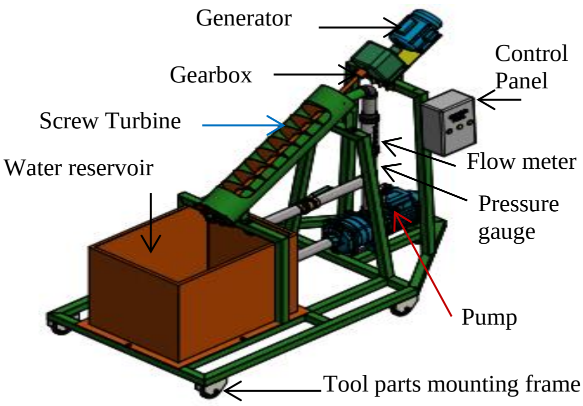
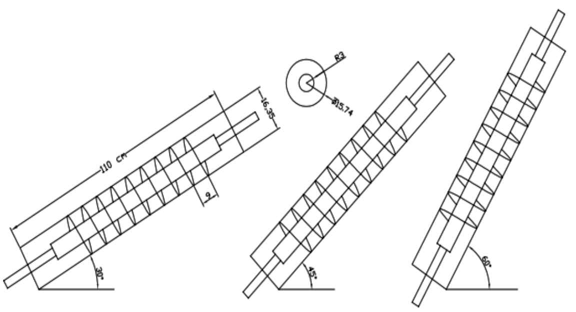


Figure 1. Complete installation of test equipment of pico hydro screw turbine



(a) (b) (c)

Figure 2. Model of shaft angle variation of screw turbine: (a) 30°, (b) 45°, and (c) 60°

and can operate perfectly. The water fluid enters through the bottom side of the screw, where the acting force starts at the tip pressure to strike the first screw surface. Furthermore, the water pushes the sides of the screw to rotate all parts of the screw blade starting from the first part to the end of the screw, so that the water pushes each part of the screw which eventually turns the turbine shaft.

The theoretical concepts and equations used in this study are as follows.

- Determine turbine power

The performance of the turbine is the mechanical power generated from a turbine. To get the value of turbine power, the data needed are angular velocity (ω) and torque (τ) as stated by Arismunandar and Susumuku [27], using Euler equation:

$$P_{Turbine} = \tau \,.\, \omega \quad (1)$$

where: $P_{Turbine}$ = Power (Watt); τ = Torque (Nm); ω= Angular velocity (rad/s). In addition, concerning hydraulic power, it can be calculated using the following formula, Euler equation:

$$P_{Hydraulic} = \rho . g . h . Q \quad (2)$$

where: $P_{Hydraulic}$ = The hydraulic power of the screw turbine (Watt); ρ= The density of water (kg/m^3); h= Height of water falling (m); Q= Water discharge (m^3/s). For turbine efficiency, it can be calculated using the following formula Euler:

$$\eta = \frac{P_{Turbine}}{P_{Hydraulic}} = \frac{\tau . \omega}{\rho . g . h . Q} \quad (3)$$

where: η= Efficiency; $P_{Turbine}$= Turbine power (Watt); $P_{Hydraulic}$= Hydraulic power (Watt)

- Torque

The following is the formula to calculate torque (τ).

$$\tau = F \; x \; r \quad (4)$$

where: F = Force (N) and r = Turbine radius

- The force acting on the screw

To calculate this force, using the rule of movement force with the formula is.

$$F = Qx\rho xU \quad (5)$$

where: F = Force (N); Q = Water flow rate (m^3/s); ρ = Density of water (kg/m^3); and U= Circumferential speed of screw. For the mass rate of flowing water, it is calculated using the following formula.

$$m = Qx\rho \quad (6)$$

where: m = Mass flow rate of water (kg/s); Q=Water flow rate (m^3/s); ρ= The density of water (kg/m^3). Forces that occur on the inlet side can be observed in Figure 3.

For the resultant force on the blade, it is calculated using the following formula.

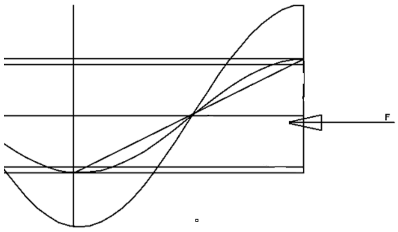


Figure 3. Water inlet side on the screw

$$F_R = \sqrt{F_s^2 + F_c^2 + 2.Fc.Fs\cos \propto} \tag{7}$$

where: F_R = Resultant force (N); Fs = fForce on screw turbine blade (N); Fc = Critical force on blade surface (N).

- Determine flow rate

To calculate the flow rate of water, it uses the following formula Continuity equation.

$$Q = AxV \tag{8}$$

where: Q = Water discharge (m^3/s); A = Cross-sectional area (m^2); V = Flow velocity (m/s)

- Determine flow velocity

The flow velocity in open flow is calculated using Manning's equation, as follows.

$$V = \left(\frac{1}{n}\right) m^{2/3}\sqrt{i} \tag{9}$$

where: n = Manning's roughness constant; i = Theslope of the energy line; m = Hydraulic mean depth. Moreover, the formula to calculate the hydraulic mean depth is as follows.

$$m = \left(\frac{(into\ the\ water)xA}{(into\ the\ water)x\pi D + 0{,}8\ D}\right) \tag{10}$$

3. RESULTS AND DISCUSSION

3. 1. Making the Prototype of Screw Turbine

The preparation of the prototype design is carried out using technical drawings with predetermined dimensions and taking into account manufacturing standards when assembling all pico-hydro components. In the manufacturing process, it is made on a small scale (laboratory scale) while still paying attention to the scale and approaching the actual conditions. This is to facilitate the retrieval or collection of the desired data if, one day later, it is applied to the actual water flow in the field. The shape and dimensions of the prototype of the screw turbine can be seen in Figure 4. The prototype of the screw turbine made in this study is a small-scale screw turbine, in which the tilt angle of the screw turbine shaft varies, namely 30°, 45°, and 60°.

This research is based on pico-hydro scale generators, for efficiency and better power already exist, but for micro hydro power plants at an angle of 40° as has been studied by Phrakonkham et al. [1] and Kaunda et al. [8] by explaining that for micro hydro power plants the angle should be turbine shaft is made above 40°.

The selection of angles of 30°, 45° and 60° in this study was carried out to find the characteristics of the best angle position resulting from the three choices for pico-hydro power plant applications, because some references as stated by Shahverdi et al. [15, 22] that the angle of inclination 22° the efficiency obtained is below 50%, so it is very important to do research to determine the best turbine shaft tilt angle for pico-hydro power plants.

3. 2. Selection of Turbine Materials

In the turbine material section, it is very important to choose the type of material used. This is to provide the right effect when the pico-hydro operation is running. For example, the condition of being not too heavy and or not too light in getting the impetus from the water will push the screw turbine blades. In other conditions, mass also has an important impact on the material selection process. Therefore, because the number of pitch screws is 9 pieces, the total mass, if calculated, becomes as follows: 9 x 0.10 kg = 0.9 kg.

- The following is the calculation in finding out the average radius (Rm).

  Thread depth, $\frac{t}{2} = \frac{102}{2} = 51$ mm

  Then :

$$Rm = \frac{147mm - 51mm}{2} = 48 \text{ mm}$$

In this study, in the initial planning for the manufacture of test equipment, a comprehensive selection of construction materials was carried out following the applicable standards in design and material selection, such as the selection of shafts. The diameter of the shaft is the most important part in supporting this study. The diameter of the shaft used to support a bearing is 20 mm. This condition has been adjusted to the standard nominal diameter following ASME standards and ASTM materials. Therefore, the shaft used is safe to

Figure 4. The models of the screw turbines

Figure 5. Screw turbine shaft

apply because the allowable diameter is smaller than the diameter used (13 mm < 20 mm). For this reason, according to the textbook, the shaft used in this screw turbine is declared safe in its use. Safety in determining these parts will be very useful when the operational conditions of pico-hydro are on running. Because the Reynolds number obtained from this studyis larger (10604.65 > 2000), then the flow is considered to be turbulent (Re> 2000) [28], which greatly affects the performance of the system.

3. 3. Testing the Rotation of the Screw Turbine without Load In this section, after installing the screw turbine on the housing and engine frame that has been made in such a way, further testing is carried out to obtain experimentally measured data by first testing the pico-hydro condition without giving a load, meaning that the load is made zero. To find out the rotation produced by the turbine before being given a load, a test is carried out with a predetermined angle of laying the turbine shaft (α) and discharge (Q).

Figure 6 presents the results obtained by the no-load test. In this figure, it can be seen that the relationship between the given flow rate and the rotation produced by the pico-hydro. If considering the color of the line graph, we can see the dominance of the blue color. In this study, it is the largest angle, namely 60°. This situation is caused by the variation of the opening of the tilt angle. In other words, the greater the flow of water is, the heavier and tighter the pressure will be. Consequently, it increases the thrust of the water that presses the blades of the screw turbine. From the graphic shown in Figure 6 above, we can see the difference in rotation produced at each different angle with a discharge from 4 m^3/h to 14 m^3/h, in which the largest rotation is at an angle of 60° with the resulting rotation of 295 rpm at a discharge (Q) of 14 m^3/h. Meanwhile, the smallest rotation is at an angle of 30° with the resulting rotation of 120 rpm at a discharge (Q) of 4 m^3/h. This condition is highly precise with the principle that occurs in a flow at a certain height and angle.

3. 4. Turbine Power and Water Power Used In this discussion, before describing in detail related to the power generated in this study, we firstly review the fluid flow capacity which determines the power obtained during this study. This condition is indirectly closely related to the angle of the screw turbine shaft which is the single object in the observation process. Determination of the screw tilt angle will have a significant impact on the system being served, namely the screw. The screw model which is used as a single model by varying the angle of the turbine shaft will have a lot of effects if the capacity, of the water fluid flow used as a source of energy to drive the turbine blades, increases.

In the pico-hydro model, the head is needed as an implementation of falling-water height and also flowing discharge to produce power, which is useful as a system in changing power that works by absorbing energy from the flow and altitude of the water. After that, it channels energy in the form of power. This statement is in line with what was conveyed by Edwin et al. [29] Cobb and Sharp [30]. and Eswanto et al. [31] that friction, heat, sound, and others are forms of energy lost due to changes in energy that cannot be transferred as much as has been received or absorbed.

Figures 7, 8, and 9 are graphs of the relationship between flow discharge variations and the power obtained. The test conditions of a slope angle are 30°, 45°, and 60°. Here, the power is the water propulsion power or water power, and the turbine power working on certain normal operating conditions. In Figure 7 with a slope angle of 30°, the red line shows the maximum turbine power reaching 111.4 Watt at a discharge of 15 m^3/h. On the other hand, the black line shows the greater increase in water power, namely 240 Watt at a discharge of 10 m^3/h. This is certainly different from the discharge conditions compared to the turbine power. In general, the power generated from the test results describes the actual measured conditions. Under certain conditions, the water power in Figure 7 first experienced an increase in succession to a peak of 10 Watt. This is because the water impetus that hit the turbine blades continues to move

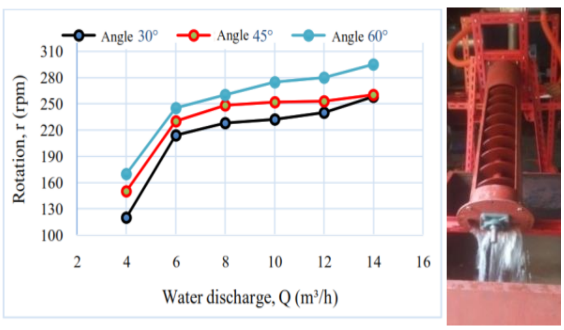


Figure 6. Graph of the relationship between flow rate (Q) and turbine rotation (r) at various variations of the turbine shaft angle

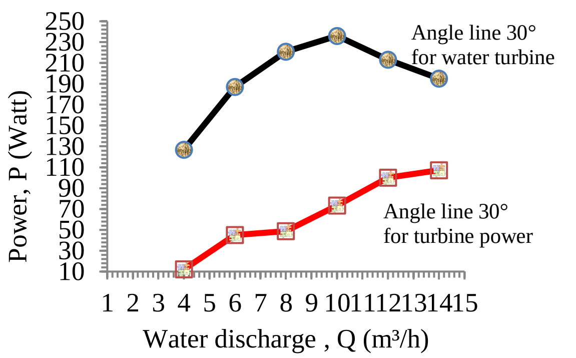


Figure 7. Graph of water power (P_{water}) and turbine power ($P_{turbine}$) influenced by water discharge (Q) at an angle of 30°

normally due to the steady flow of water. However, a decrease is seen in the discharge to 15 m^3/h. This condition is due to the water flow experiencing a decrease in water flow rate.

Tests and measurements are carried out appropriately with the installation of measuring instruments based on planned needs in the research being carried out. Figure 8 is a graph of the results of data processing after measurements have been carried out in the form of the relationship between water discharge and power at the angle of the second test model, namely the shaft angle of 45°. Similar to the previous tests, the given water discharge is carried out in variations so that measurable results are obtained. Figure 8 shows that the two graph lines of water power and turbine power increase regularly. However, an increase in experienced by water power is slightly different, namely, after an increase from the initial flow of 4 m^3/h. After that, it decreases. This condition is probably due to water flow which is very heavy pushing the blade of the screw turbine because the angle opening is larger than previously. In this study, at an angle of 45°, the researchers obtain the maximum power of 141.7 Watt (water power) which occurs at the discharge opening of 10 m^3/h. The results obtained, if observed, are certainly greater than those obtained at a slope angle of 30° with the difference in power as a performance, namely 30.1 Watt. In another discussion which is also still in the schematic of Figure 8, the green line or turbine power shows a trend that continues to increase massively from the start of the first opening water discharge to the discharge point of 8 m^3/h. After that, it decreases to the normal limit. This means that it is not too far from the initial maximum increase in the turbine performance line. In line with that, it can also be clearly seen that another increase continues to move without a decrease after the discharge of 10 m^3/h at the turbine power of 68 Watt. In this study, the nozzle used is designed with one jet hole placed at the end of the inlet to enter the water flow to the screw turbine blades so that the thrust that occurs can maximally provide energy in one direction of the water jet. This makes the turbine blade rotation stable.

The next presented analysis results and their comments are concerning the data presented in Figure 9 in which the phenomena that occur are similar to the 30° and 45° angle models. The difference is seen in the turbine power graph line, namely the position of the water discharge from 6 m^3/h to 8 m^3/h. It reoccurs at the position of the water discharge from 10 m^3/h to 12 m^3/h. However, after that, there is an increase in back to normal. This phenomenon must be of particular concern because it will have an impact on the final results of this study in obtaining optimum performance results.

Figure 9 provides information on actual conditions based on experimental analysis in which the greater the flow of water used is, the greater the turbine power produced will be. Meanwhile, the actual water power that occurs does not affect the turbine power. This can be seen at the discharge of 12 m^3/h and 15 m^3/h, in which there is a decrease in water power due to the lowest head. In this study, the greatest turbine power is obtained at an angle of 60° with a discharge of 15 m^3/h and the power generated of 186 Watt.

If viewed from all the events that have an impact on the performance of pico-hydro by using various variations of the given shaft angle, the water flow is certainly one of the main determinants of orbiting the size of the performance. The larger the water flow opening is (in this case: the discharge), the higher the impact of the obtained turbine power will be. This condition also occurs if the opposite thing is carried out. The water that flows towards the turbine blades will first pass through the nozzle as the tip of the thrust shot which converts the energy in the water into kinetic energy. The phenomenon occurs due to the reduction of the cross-sectional area of the pipe to the nozzle. Therefore, the impact of the amount of kinetic energy given is the increasing velocity of the jet of water. The next analysis is when the water spray comes out of the nozzle which then definitely hits the center of the screw turbine blade due to the collision between the water spray and the blade so that the turbine rotates continuously following the given water flow. Therefore, the greater the water flow that is inserted to push the turbine blades is, the greater the turbine

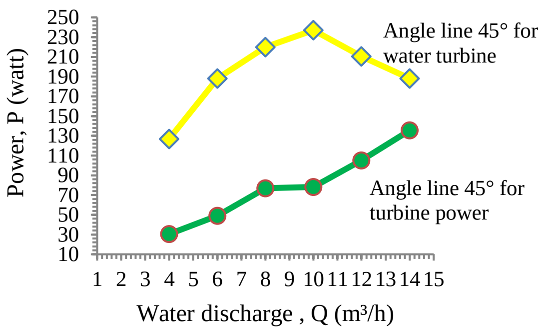


Figure 8. Graph of water power (P_{water}) and turbine power ($P_{turbine}$) influenced by water discharge (Q) at an angle of 45°

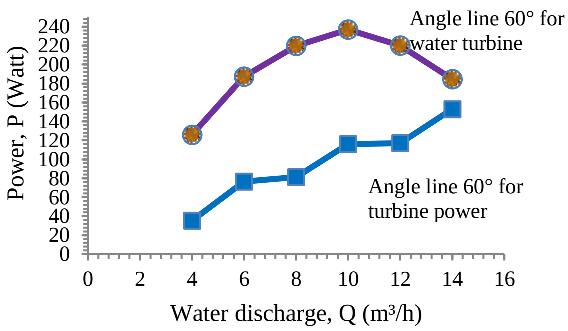


Figure 9. Graph of water power (P_{water}) and turbine power ($P_{turbine}$) influenced by water discharge (Q) at angle of 60°

performance on the pico-hydro will be. This is also in line with what has been conveyed by Aggidis and Židonis [32], that if the water flow is increased, greater rotation will be generated. Therefore, the output of power, electrical energy, and overall performance will also improve on a prototype scale. Likewise, the opposite law applies. It means that the less the given water is, the smaller the turbine rotation, the electrical energy, and the electrical performance will be.

The optimization is carried out using the response surface method with a model comparing three variations of the turbine shaft angle. The results of the optimization of experimental data are processed and calculated numerically to obtain the characteristics of the overall pico-hydro performance. Furthermore, an analysis of each test and operational conditions is carried out on each of the tested shaft angle blade models.

In the analysis of the electrical performance, as shown in Figure 10, it can be seen that the efficiency generated in the pico-hydro made in this study is increased. This condition is generated by an increase in water flow and rotation produced by the turbine. The performance of pico-hydro, which in this case is represented by efficiency, which is presented in Figure 10, in which the greatest efficiency is obtained at an angle of 60° with a rotation of 295 rpm and the yielded efficiency of 87%. Meanwhile, the smallest efficiency is obtained at an angle of 30° with a rotation of 120 rpm and the yielded efficiency of 57%. An increase in efficiency, generally, is obtained in the three variations of the screw turbine shaft angle. It is because the angle of the given opening is getting greater, which increases the height of the falling water, meaning that the angle position is getting straighter and closer to 90°, resulting in increased efficiency. The basic reason for this statement has also been explained from Zhou's reference and Irwansyah's research which states that an angle position that is greater or closer to 90° can reduce the flow resistance and facilitate the flow of water falling where the falling water force, pressure and velocity are free of obstacles. The turbine screw blades that rotate as a result of the impetus of water at an angle position close to straight make it

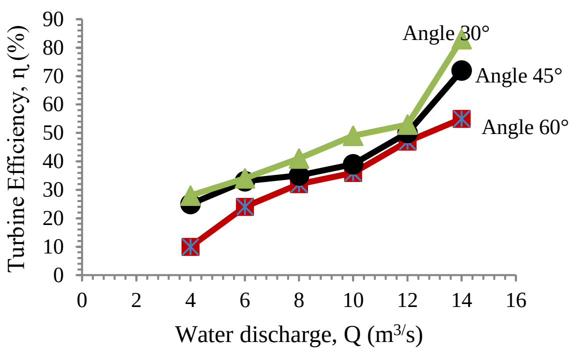


Figure 10. Effect of water discharge on efficiency

easier to move one blade to the blade in front of it, so that performance in the form of efficiency increases along with system operations that run smoothly, this condition will certainly be more efficient difficult to rotate if the blade angle is smaller or below 30°. When compared with the three variations of the shaft angle used, the best performance is obtained at the largest angle. Meanwhile, the decrease in thrust due to the size of the water flow discharge opening gives different responses in each test model. These results of the analysis are also close to what has been reported by Zhou et al. [33] and Irwansyah et al. [34] regarding the optimization of the screw turbine. However, their studies are carried out numerically. Their studies revealed that the water discharge opening on the flowmeter will have a very large impact on changes in all components of the generator, especially the final performance that will be obtained. Therefore, determining the initial design is very important in produced optimal performance.

4. CONCLUSION

From the results and discussion, there is a correlation between the initial planning and the results obtained. In this study, the measurements are carried out on the amount of water discharge produced, the rotation of the turbine blades, the rotation of the transmission, the rotation of the alternator, and the power generated. Furthermore, the variations in the angle of the screw shaft used in this study are 30°, 45°, and 60° on the screw turbine part which is traversed by the flow of water. The obtained data are processed in the performance analysis on each test model. The results of the measurement indicate that the magnitude of the turbine shaft angle and the flow rate used will affect the performance of pico-hydro verbally. Observations at the discharge of 15 m^3/h with an angle of 30° provide information that the obtained screw turbine power is 111.4 Watt with an efficiency of 60%. For an angle of 45°, the produced power is 141.7 Watt and an efficiency of 77%. Meanwhile, at an angle of 60°, the produced power is 165.5 Watt and an efficiency of 87%. The results of this analysis proved that the pico-hydro model with a screw turbine by adjusting the angle variation on the turbine shaft gives the conclusion that the greater the given angle is greater the obtained performance will be, in terms of power and efficiency.

5. ACKNOWLEDGMENT

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Persian Abstract

چکیده

استفاده از انرژی، به ویژه برای نیازهای روزانه، مهم است .پیکو هیدرو یک مدل نیروگاه سازگار با محیط زیست است که می تواند از نرخ جریان پایین بهره برده و برق کمتر از 1 کیلو وات تولید کند .هدف از این تحقیق به دست آوردن بهترین عملکرد پیکو هیدرو با مدل توربین پیچی شکل یا آنچه که توربین پیچی ارشمیدس نامیده می شود می باشد .روش تحقیق به صورت تجربی با تنظیم زاویه محور توربین پیچی ارشمیدس یعنی 30 درجه، 45 درجه و 60 درجه انجام شد .مشاهدات در دبی 15 متر مکعب در ساعت با زاویه 30 درجه اطلاعاتی را ارائه می دهد که توان توربین پیچی به دست آمده 111.4 وات با بازده 57 درصد است .برای زاویه 45 درجه قدرت 165.7 وات و بازده 77 درصد است در حالی که در زاویه 60 درجه 186 وات توان با بازده 87 درصد تولید می کند .نتایج این تحلیل ثابت می کند که مدل پیکو هیدرو با توربین پیچی با تنظیم تغییرات زاویه روی شفت توربین به این نتیجه می رسد که هر چه زاویه داده شده بیشتر باشد، عملکرد به دست آمده از نظر قدرت و بازده بیشتر خواهد بود.