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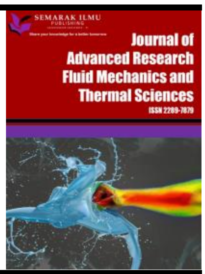

The Phenomenon of Water Fluid Flow Distribution in Hydropower Pico-Hydro Viewed from the Number of Turbine Screw Winding

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ABSTRACT

Water is one of the energy sources that has the potential to contribute to replacing energy from fossil materials. This research focuses on picohydro scale hydropower, namely water-based electricity generation as a turbine driving source. Picohydro-scale hydropower is an important part to implement, because the system is not difficult to implement. The aim of the research is to determine the performance of the pico-hydro renewable power plant in terms of the number of turns of the turbine blade screw. The research method was carried out by direct experimentation from a device that had been made using water fluid which was circulated in a closed cycle in pico-hydro hydropower. In the initial stage of the research, drawing designs were carried out, after validation, the tool manufacturing process was carried out. After completion of the manufacturing process, it continues with the testing and measurement process to obtain the desired data. Measurements start from the water flow produced, turbine shaft rotation, transmission rotation, load and power produced. The test model consists of variations in the number of screw turns, namely 9 turns, 11 turns and 13 turns. The results of this research are from data processing and are contained in the discussion obtained under certain operational conditions and discharges ranging from 2 m^3/h to 30 m^3/h in driving a screw turbine. However, the results obtained are still different, which can be seen in the trend lines in the graphic illustration. The performance in this research can be described in the highest power results reaching 434 Watts with a rotation of 298 rpm at a flow rate of 30 m^3/h on a test model with 11 screw winding. This condition is the best result compared to other test models, which is possible because due to several factors, such as being too heavy for an increasing number of screws, uneven distribution of the water fluid flow that pushes the turbine blades.

1. Introduction

Energy needs as the main driving source in human life need to be provided from various sources that are pollution-friendly and do not have a negative impact on the long-term survival of living things [1]. Environmentally friendly energy sources are an important part of the development of new and

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renewable energy, especially those sourced from nature or the earth currently inhabited. Water is the result of abundant natural resources that need to be given more attention to be used as an energy source in producing pollution-friendly electricity from natural sources [2,3]. Energy sources originating from water will be a substitute for energy originating from fossils, which will increasingly run out in the next 50 years. Currently, electricity plays an imperative role in improving rural or remote community economic growth and quality of life [4-6]. The electricity in rural or remote areas increases lighting time (increasing hours of productivity), triggering regional business development [7-9]. Therefore, the availability of electricity in rural or remote areas is a form of encouragement to increase economic productivity. Rural or remote areas are difficult to access, making the construction of electricity grids to connect and transmit electrical energy to the regions becoming increasingly complex and expensive [10-14]. A wise solution to resolve this problem is to utilize each region's potential energy as an energy source for independent power plants [15]. The problem with implementing pico hydro is not friendly to aquatic biota [16,17]. The fast-rotating runner can kill the fish that passes through it [18,19]. For this reason, Archimedes turbine are considered because aquatic organisms such as fish can still swim through gap in the turbine blade [20,21].

It is common knowledge that countries in various parts of the world are currently busy looking for renewable energy sources as a substitute for energy originating from fossils which will soon become extinct. In reality, this situation is experienced by all countries, so that those who are not active in looking for independent, pollution-friendly energy sources will be left behind in meeting the standard of living for their people [22-24]. From various information received, energy sources applied in all countries in the world still use energy originating from earth fossils such as crude oil, natural gas, coal, which of course will soon run out in the not too distant future [25-27]. Therefore, pico hydro generators that utilize low discharge are one of the appropriate solutions that can be applied in this condition, in order to meet electrical energy needs for household and factory operational activities. This type of picohydro generator can work and produce up to 5 kW of electricity with the main components being flowing water as a driving source, water pipes, spray nozzles, turbines, generators [28]. The advantage that can be achieved with this generator model is that with a small water discharge it can produce electrical power of more than 1 kW which can power the lights and electricity needs of the community, but the maximum only produces less than 5 kW so in this context it is called a small-scale generator or pico [29,30].

This research focuses on pico-scale generator using screw turbine as the generating technology, while the test model is the number of screws wrapped around the turbine shaft. The screw is the part of this generator which is responsible for pushing parts of the water to flow from upstream to downstream in the turbine. Therefore, the reliability of the screw must be investigated to maximize performance if applied in a river where there is actual water flow. In this research, testing was carried out on threads with varying numbers of threads wrapped around the turbine shaft with the aim of obtaining information on the best performance produced by the system or tool [31,32]. Basically, hydroelectric power plants have been applied in several conditions and circumstances in society, such as those applied by companies and countries that have a lot of water sources to be able to apply this type of hydropower generation. In other conditions, the pico-scale model generator still needs to be developed, because with a low discharge flow it can produce enough electricity for household use. It can be seen that several researches have been carried out on micro-hydro and large-scale hydropower plants with the aim of power above 1 MW, therefore the researchers carried out a measurable study in this research which focused on the number of screw turns which is one of the main components of pico-hydro-scale hydropower [33,34].

In various theories it is said that hydropower is a model of electricity generation that uses small-scale hydropower sources with a maximum capacity of 5 kW which can be applied to rivers, irrigation with low water flows from 2 meters to 10 meter [35]. If this small-scale hydropower plant model is to be installed, the most important thing is to ensure that it has fulfilled several permits from the authorities and of course technically it is related to the main requirements such as the continuous uninterrupted flow of river water and its water source is quite good. and an adequate place for the construction of hydropower in terms of falling water or the height and width of the river where the generating equipment will be placed as a whole [36,37].

The slope in the blade position is the most important part in a water energy conversion system as a tool that interacts directly with flowing water to push fluid. Screw type water turbines are divided into two types, namely the steel strough type and the closed compact installation type. The steel trough type screw turbine is a turbine model that looks like the blades or blades are open to a certain size, this condition causes the water that flows into the turbine blades to only be on the side of the bucket [38]. Meanwhile, the other type, namely the closed compact installation type screw turbine, is a type of turbine with a tightly closed installation system in the hope of maximizing rotation [39,40]. In this type of turbine, it is possible for the water flowing towards the turbine blade to be ensured to fill the part covering the turbine installation until it rotates based on the design applied [41,42]. In terms of the geometry of an Archimedes screw in hydropower, it is determined by several external parameters, namely outer radius, thread length and slope. Other influencing parameters are internal parameters such as inner radius, number of blades, and blade pitch [43,44]. These external parameters are usually determined by the location of the Archimedes screw and how much water will be lifted. Meanwhile, internal parameters are free to be determined independently to optimize the performance of the thread [45]. The background description is the most important part for determining more detailed and focused research objectives. So, researchers have conducted research related to the model of the correct number of screws turns in the application of picohydro technology as an environmentally friendly electricity producing energy source, namely the aim of this research is to determine the best performance for various numbers of screws wound on the hydro-powered picohydro scale turbine shaft [46].

The gap in this research generally lies in the pico-hydro scale hydropower with a maximum output of 5 kW using a water flow with a small discharge, apart from that the turbine design is made in a screw shape which can maximize even water thrust. Meanwhile, currently several studies have been carried out by previous researchers regarding large-scale hydropower with power obtained above 20 MW using large water discharges such as giant dams or water flow dams originating from lakes with lots of water. The contribution of this research can be a reference for researchers in the field of hydropower, especially on a small scale, apart from that, the benefits of this tool can be applied in rural areas that still do not have access to electricity but have a water flow energy source to drive turbines, such as agricultural irrigation, ditches, rivers with small water discharge around residential houses.

2. Methodology

This research is presented openly to make it easier for the general public to read and understand the actual conditions in the test process until the results obtained. In Figure 1 is a series of test equipment that has been designed and used in data collection, where you can see the test model for variations in the number of windings used in this experiment, namely 9 winding, 11 winding and 13 winding of the screw turbine and tested alternately with the aim that the data obtained can be obtained. maximally analyzed.

The explanation that can be seen from Figure 2 is a set up design for the test equipment used in this research, where the equipment is equipped with a complete installation of the main pico-hydro scale hydropower components and measuring instruments used in the data collection measurement process. The workings of the prototype of this pico-hydro scale hydropower test equipment starts from when the water pump is turned on to suck water from the reservoir, the water is then flowed into a connecting pipe that has been installed at the output of the water pump towards the nozzle, in this testing process the pressure of the water flowing through the stop pipe will be measured and the incoming water discharge, where this condition is likened to the height that would be had if done in actual conditions. Next, after the water reaches the nozzle, it moves or rotates the screw turbine blades with the number of turns installed according to the test conditions. The next step is to measure all the measuring instruments that have been installed, such as the rotation of the turbine shaft, measure the resulting load and record the electric current. obtained on generators, rotameters, pressure gauges, load cells.

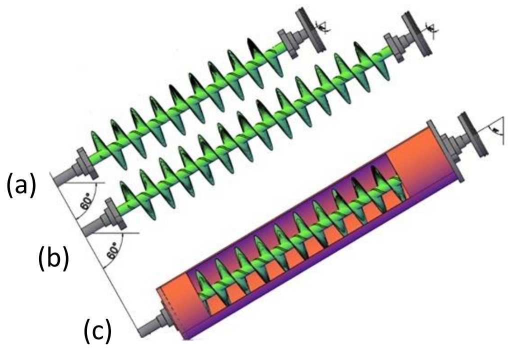


Fig. 1. Test model for the number of thread turns (a) 9 screw winding, (b) 13 screw winding, and (c) 11 screw winding

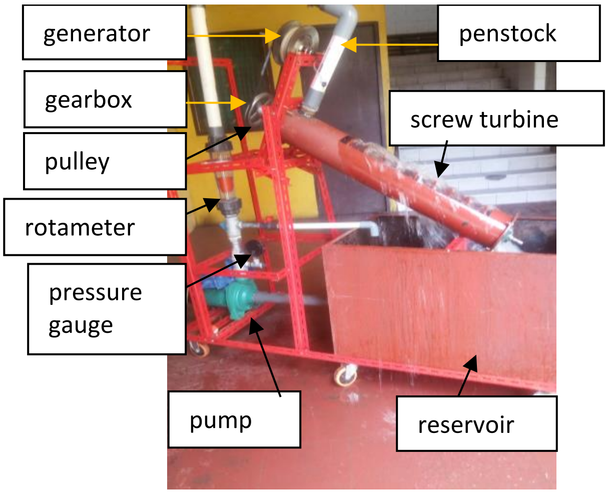


Fig. 2. Experimental set up

In this test, an iterative process is carried out, which means that after the water rotates the turbine blades and falls into the reservoir, the water is not wasted uselessly but the water is directly sucked in by the pump and then circulated back into the stock pipe. Figure 1. is a variation of the test model used in this research process, namely 3 variations in the number of threads as seen in Figure 1. In the process of this research, it has been carried out using an applied experimental method using a prototype scale test model before being tested for industrial feasibility to be applied to actual system conditions. Then, at the end of the research, data processing is carried out as well as making correlations with research results related to this research in particular. which is close to basic theory and its relation to standards suitable for use or suitable for application with optimal performance [47]. The following explains the data collection process which consists of initial preparation, implementation, analysis and completion, namely:

(i) Preliminary preparation

This stage is carried out in accordance with the initial planning process by preparing all the needs related to what will be involved in preparing the next processes, for example what is carried out is the procurement of tools and materials for a prototype scale hydropower installation and equipment to support the smoothness of making experimental test equipment. The component materials used to make this tool are chosen to be standard, meaning they are not too heavy and not too light, for example the material for making turbine blades, a plate with strong and light material is chosen so that it can rotate perfectly and strongly in all operational conditions, besides that Instruments are provided to make it easier to see accurate measurement results, the equipment includes pressure sensors, rotameters, tachometers, manometers, pressure gauges and load cells, while other materials are also prepared, including gearboxes, water pumps, elbows, reservoirs, generators, pipes [48]. PVC, angle iron. Calibration of all measuring instruments is carried out before testing to obtain the desired data based on research needs [49,50]. This is also what has been stated by several researcher such as Suherman *et al.,* [51] and Aggidis and Židonis [52] so that the results are precise and accurate in obtaining test data.

Calibration is part of the research process that is carried out to obtain data accuracy, especially on measuring instruments that are installed on each part of the object being observed. The flowmeter is calibrated one to two times by means of the experimental device in the on position, then measurements are made by observing the pendulum printed on the flowmeter, if the pendulum works normally, the measuring instrument is in good condition, but if it is the other way around, the flowmeter will be opened, then readjusted. pendulum position in the lower and upper positions. Calibration was also applied to all measuring instrument used in this experiment prior to actual data collection.

(ii) Implementation of research

In principle, the process of collecting experimental data is carried out after the preparation stage is complete and it is truly suitable for testing. This implementation involves taking test data, with operational conditions that have been set according to the desired ones, for example data on variations in the number of turbine screw turns, determining the tilt angle of the turbine screw, torque section, voltage and visualization of flow rate on the flow meter, so that from the data This provides the best performance information from the test model.

(iii) Data analysis and solution

Data analysis is carried out to obtain information according to the test model design created, then a structured discussion is carried out and focuses on the objectives to be obtained.

In actual conditions to complete and facilitate the specifics of this research work, it is presented in the detailed specifications of the research tools in Table 1. and the test parameters are in the form of Table 2. The operational conditions are tested to obtain data that is in accordance with research standards. Before testing the research equipment, calibration is carried out based on the applicable measurement rules.

Table 1
Specifications of measuring instruments used in this research

Measuring tools and equipment	Units	Specifications
Frame material (steel box)	mm	20 x 40 x 6
Nozzle Thickness	mm	2
Service pump	HP	Induction motor 2.0
Storage tank	m	1.2 x 1.2 x 0.75
Laser digital tachometer	rpm	Measuring range 2.5-99.999
Generator low	Watt	Magnet neyodimium N52
Pressure gauge	kg/cm^2	1 until 6 maks
Rotameter	gpm	0 until 30 maks

Table 2
The test parameters used in this study

Test parameters	Units	Research Range
Head maks (h)	meter	8
Water discharge (Q)	m^3/h	2 until 30
Screw winding	Blade winding	9, 11 and 13
Nozzle angle (α)	Degree	60
Load (m)	kg	0.2-1.2

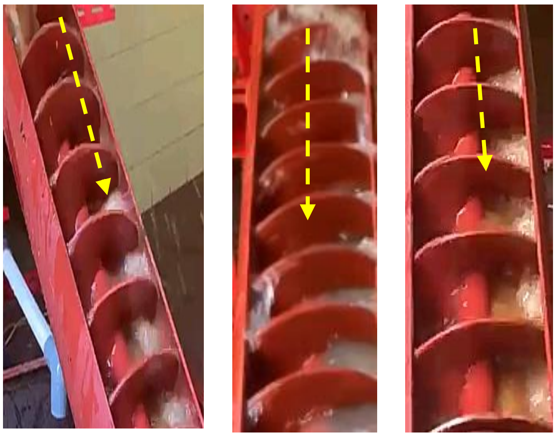
3. Results

3.1 Overview of Fluid Flow Distribution

The distribution of water fluid flow in this explanation is reviewed from visual photos that have been obtained when collecting data on experimental equipment based on each number of screw winding models surrounding the turbine shaft and tested alternately. In this research, the fluid flow distribution process that occurs in all test models needs to know the characteristics or phenomena that actually occur in the distribution of water thrust across the parts of each screw blade. Therefore, it is necessary to carry out visual observations and discussions in accordance with the actual situation, so that this phenomenon can provide extensive information in the aspect of distribution of water fluid flow in screw windings. If you look carefully at Figure 3, the flow distribution phenomenon occurs normally, where each screw winding is exposed to fluid flow falling from upstream to downstream, but the distribution of water in the parts of the screw is different and does not seem to follow the normal line, as shown in Figure 3. seen in photo Figure 3(a), namely when the test was carried out using the test model, the number of screw turns was 9 or in this case the smallest number of threads. In Figure 3(a) the distribution of water pushing the screw blades shows that at first the water coming from the first screw did not appear to fill the space from one screw to the thread in front of it, the phenomenon of water starting to fill the space of the screw was visible on the second blade. Three, however, it still looks not optimal because the water is only visible on the side and starts to fill the thread space in the fourth section and so on which looks normally distributed.

This phenomenon is clearly different from what has occurred in the flow distribution in the number of screw winding of 11, (Figure 3(b)) where it can be seen that the water flowing to push each screw has been visible from the beginning of entry, which means that the water distribution has started to be full from upstream despite the conditions. not yet stable for all phenomena in each thread section. The water flow distribution has filled the first thread and is slightly reduced in the third and fourth threads, however the water distribution occurs normally following a straight line of the turbine shaft. The screw chambers are full when they reach the fifth section and so on, this indicates that with the 11 screw test models, the water fluid flow distribution phenomenon looks stable and can fill the screw chamber with full water until the downstream side.

The next discussion seen in photo Figure 3(c) is that when the number of threads is given as 13 turns, in this model it is the one with the most turns. The flow of water can actually be seen starting by filling the second screw chamber and becoming increasingly full of water when it enters the third chamber and so on. This condition is different from what occurs in the phenomenon in Figure 3(a) and Figure 3(b), but in terms of water pressure it is the same. together forming a normal line following the direction of the turbine shaft axis. The phenomenon of fluid flow distribution that occurs with each different number of turns of thread causes different conditions for the resulting performance, where from the tool during testing it can be seen that the rotation is getting faster at 11 turns of thread but it decreases when the number of threads is given as high as 11 turns. 13 coils. In this phenomenon, if seen visually in the field during testing, the possibility of decreasing rotation occurs as a result of the influence of the number of thread turns and the weight of the material used. Under the same operational conditions it appears that the more turns the thread has, the heavier the power and the longer the travel time, however. If the number of screw coils is smaller, it is less than optimal in pushing water downstream and under different conditions, a test model of 11 screw coils is displayed which visually looks more perfect when compared to other test models. This explanation is possible because with the current operational conditions the 11 screw winding test model is the most ideal to apply and of course still needs to be developed.



(a) 9 screw winding (b) 11 screw winding (c) 13 screw winding

Fig. 3. Photo of fluid flow distribution based on the number of screw winding

3.2 Research Results and Explanation

The state of the research and the following illustration of the results tell in Figure 4, namely a graph of the relationship between the water discharge given or injected and the torque results for various variations in the number of turns of the screw blade as a place for water distribution in passing it to the exit side of the turbine housing. Based on the experimental results and data processing carried out which is then outlined or illustrated in a graph as in Figure 4, it can be seen that with a total of 9 turns of the screw blade, to be precise, the black and red lines when given a flow rate of 2 m3/h produce a torque of 0.18 kg.m and there continues to be an increase along with the increase in the water flow injection which is added to the conductor pipe leading to the input of the turbine house. If you take a quick look at the discharge position from 18 m3/h to 20 m^3/h, there is a quite significant trend increase compared to the other lines where the figure reaches 0.45 kg.m, rising to 0.67 kg.m with a gap of 0.22 kg.m and after that there was a constant increase without significant change.

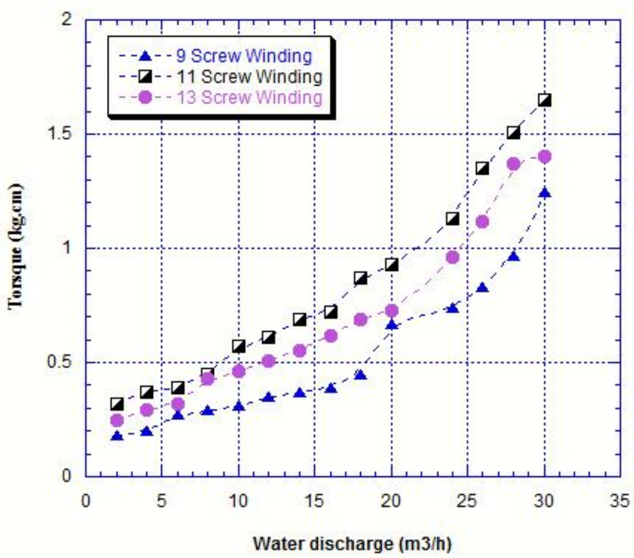


Fig. 4. Graph of the relationship between discharge with torque at variations screw winding

The results and discussion related to torque data processing show that the increase in torque with each additional discharge is not very significant as seen in the graph, where the average difference is no more than 0.8 kg.m, in this phenomenon the possible influence of the distribution of water entering the side screws irregularly, apart from that the number of threads attached to the turbine shaft also causes the resulting torque to tend to vary. In Figure 4 it can be seen that the maximum torque with 9 coils is 1.25 kg.m at a water flow rate of 30 m^3/h. The results of this data are certainly the smallest when compared to those obtained in the 13 coils model which produces a maximum torque of 1.4 kg.m as seen in the blue and purple lines on the graph. If we look at the overall increase in torque produced, it is generally not far from that obtained with 9 winding, where the average is 0.519. In Figure 4, it is very clear that the test model with the number of windings 11 provides the highest torque information compared to the other. The black line show that the minimum torque at a water flow rate of 2 m^3/h is 0.32 kg.m and the maximum torque is at a flow rate of 30 m^3/h is 1.65 kg.m, which mean that the optimization of research carried out by creating test models on variations in the number of turbine screw winding can be a reference that the increase in torque produced must be supported by standard infrastructure to produce optimal data.

Figure 5 is the result of measurements in experiments that have been carried out which have been plotted on a graph to facilitate understanding analysis related to the results that have been obtained including data on water flow discharge, rotation of the screw turbine shaft for variations in the number of turns of 9, 11 and 13 blade surround the turbine shaft. The graph in Figure 5. is the relationship between what if given various variations in water flow rate from lowest to largest, whether there is an influence on the results of the shaft rotation, if so, to what extent the condition is for each position for each number of windings that is best.

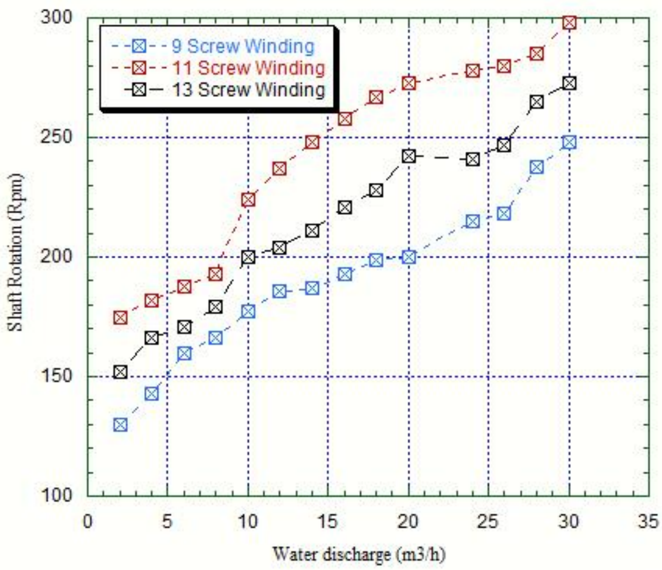


Fig. 5. Graph of the relationship between water flow and turbine shaft rotation

Next, we discuss the condition where the number of screw turns is 11, which is the second highest number of turns in this research. If you look at Figure 5, the red graphic line (11 turns of the screw blade) shows the greatest rotation compared to other test models, namely the maximum rotation at a discharge of 30 m^3/h is 298 rpm while the lowest shaft rotation is obtained at a discharge of 2 m^3/h of 175 rpm, while the increase in rotation with each additional input of water flow rate varies but remains the highest compared to the conditions of the 13 and 9 winding models, this is likely caused by the pushing force of water towards the turbine screw blades due to the distribution of water entering each blade. The turbine is uneven as a result of the collision between the water that has just entered and that is moving towards the tip of the screw leaf until it enters the water outlet side. Apart from that, there is a reverse force so that the thrust may not be linear with each rotation of the shaft. As with the position of the number of coils 11 and 13, it also happens that at the number of coils 9, the resulting increase in revolutions is not linear, however, what can be seen in Figure 5 is that the black line is actually higher than the dark green line, which in fact is the number of coils. as many as 13 and which is the most in this research. with a number of 9 windings, the lowest rotation is 152 rpm at a flow rate of 2 m^3/h, while the maximum rotation is 273 rpm with an input flow of 30 m^3/h. This maximum rotation result is 22 points higher than the number of windings of 13 or 23 points lower. from the highest, namely the number of coils of 11. Analysis of the influence of the water flow rate given for each number of coils illustrates that further optimization still needs to be carried out regarding the resulting numbers, which can also be seen in the graph with the order of the forging positions of the number of coils. 11 is actually the highest compared to other test models.

If this condition is explored further, it can logically be justified because the highest number of coils can create a pushing force on the water, the time until the water gets from input to output is longer, the collision between water causes the rotation of the shaft to slow down, this also applies to the fewest number of coils. namely 9 windings which can be analyzed that the fewer (which is a review of these 3 test models) the number of windings on the turbine blade, the lighter the rotation of the shaft, but this is inversely proportional to the rotation results obtained, this is possible because of the energy produced due to the push of water onto the turbine blades. low and in fact the best performance was in the condition of the test model for the number of turbine blade windings of 11.

The water pressure data produced in this research is very necessary to provide real information apart from the other properties discussed previously. The graph in Figure 6 shows the water pressure which can be seen in general, where it can be said that there is a decrease in water pressure along with the increase in flow rate which is entered into the turbine housing through the pipe to be channeled as a working fluid which will push the screw blades. The higher discharge has an impact on water pressure, namely decreasing pressure, as can be clearly seen in the line trend for each variation in the number of screw turns. In the graph it can be seen that in the test model with the number of windings 9, a pressure of 3.7 kg.cm is obtained at a flow rate of 2 m^3/h and the maximum pressure drop is obtained at a water flow rate of 30 m^3/h, namely 0.73 kg.cm. This condition is most visible. high compared to other graphic lines. Another result is in the test model for the number of coils 11, where the highest pressure drop at a discharge of 30 m3/h was obtained at 0.34 kg.cm which appears to be a significant difference in numbers which is almost half of the results of the test model for the number of coils 9. The next discussion is for the position of the model test for the number of coils 13 which is the smallest pressure drop data compared to the two previous test models, namely the minimum pressure obtained is 2.57 kg.cm and the maximum pressure is 0.25 kg.cm which is the smallest condition obtained compared to the second condition previous trend line. If you look at the decreasing trend line in the graph in Figure 6, it can actually be confirmed that the greater the number of screw windings, the more impact it will have on the pressure drop in every operational condition, because theoretically it can be understood that the more the number of screw windings and the water flow the same. causes the turbine rotation to become heavy and consequently affects the overall performance of the turbine.

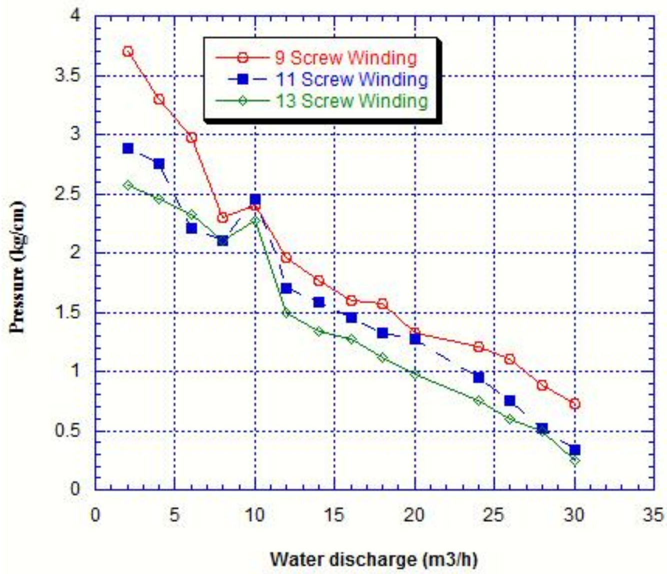


Fig. 6. Graph relationship between discharge with pressure at variations in the number of thread turns

The hydraulic power of the turbine increases as the flow of water increases and the power decreases at the number of screws 13 due to the increasing number of screws, the weight of the water pushing against the blades, in addition to the uneven distribution of flow to the screw blades. In Figure 7, which is a graph of the relationship between flow rate and power, power is measured to obtain output results from this experiment as an inseparable part of the process of producing accurate data, as a recommendation for further research development. In Figure 7, you can see the red line, namely the position of the test model for the number of screw turns of 9 towards the screw blade, where there continues to be an increase in the power produced by 179 W for a water flow rate of 2 m^3/h while at a flow rate of 30 m3/h the power produced is 341 m^3/h, if you look at the trend line graph you can see an increase with each additional water discharge, the average is below 350 W and you can see an increase in each water discharge starting from 26 m^3/h to 30 m3/h. This can be understood because in these conditions the discharge maximum water rise. Analyzing the number of screw turns of 11 based on data results and graphic illustrations, it appears that this condition produces the highest power. If you sort it on the graph line, you can see that when you enter a water flow rate of 2 m^3/h you get a power of 197 W, this situation will continue to increase as the flow rate increases, such as a flow rate of 4 m^3/h you get a power of 50 W, 6 m^3h you get 65 W and so on until you get the maximum discharge condition of 30 m^3/h produces 434 W of power, which is the highest power in this research. In the condition that the number of screw windings is 13, which is the largest number of screw windings, a minimum power of 155 W at a water flow rate of 2 m3/h is obtained, this result continues to increase but is not too significant compared to other distances. The maximum power seen is 289 W at a discharge of 30 m^3/h which is a less than ideal condition, this indicates that the more the number of screw turns and the discharge that can only be given 30 m^3/h the resulting power also varies and does not guarantee that the number of threads will increase. higher power. The data obtained and analyzed has become an important part as initial information on the operational conditions of the equipment being studied, hydropower by selecting the pico scale that can be applied and the impact of technological progress in villages that lack electrical energy. Hydroelectric technology based on hydropower is the right answer to the problem of electrical energy, because by utilizing water flows with low discharge it can produce electricity which is needed in certain conditions as a source of movement for sustainable human life.

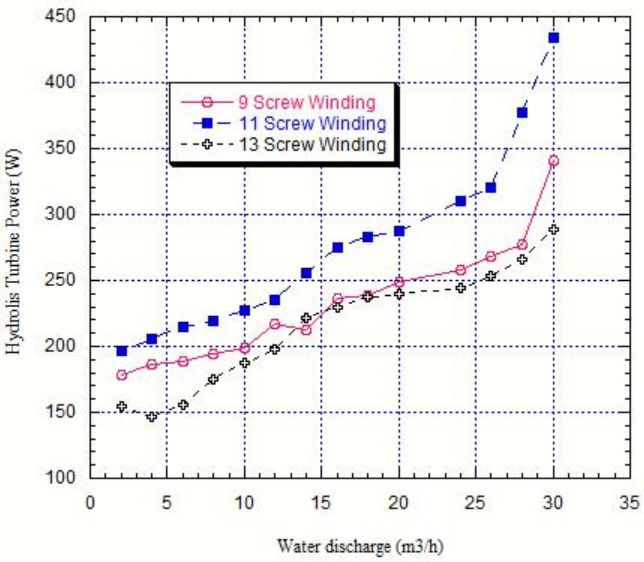


Fig. 7. Graph relationship between discharge and turbine power with variations in the number of screw turns

4. Conclusions

The results of the data that have been collected experimentally using a prototype tool and to facilitate data analysis are made in graphical form, from the temporary results of data processing and contained in the discussion obtained under certain operational conditions and discharges ranging from 2 m^3/h to 30 m^3/h can drive a turbine thread, however the results obtained are still different which can be seen in the trend lines in the graphic illustration so that development research is needed to perfect it. The performance in this research can be described in the highest power results reaching

434 Watts with a rotation of 298 rpm at a flow rate of 30 m^3/h on a test model with a number of screw turns of 11. This condition is the best result compared to other test models. Test data has provided information that, in fact, increasing the number of windings of the turbine blade does not guarantee that its performance will be more optimal because of several influencing factors that can hinder it, such as flow rate, water distribution to the turbine blades and water pressure that drives the screw turbine blade.

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