

# Analysis of Performance of Permanent Magnet Generator Fluks Axial 1 Phasa with Variation Load

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**Abstract**— With the potential of low water head energy and relatively small water discharge then it takes a low round generator to be applied to the potential of existing energy. The development of Permanent Magnet Generator (PMG), being an alternative considering the pole construction of the rotor is relatively simple compared to conventional generators, so it is technically required a more number of rotor poles in the effort to lower the speed The nominal dial generator. The purpose of this research is to analyze the 1-phase axial generator performance with varied resistive loads and inductive loads. This research has 4 stages of research: 1). Study literature. 2). Carried out testing tools. 3). Measurement of data retrieval. 4). Data analysis. From this research obtained results from the tools and measurements of the data retrieval of the performance of axial generator 1 phase with inductive and resistive load Vaiasi. Load mounted 15 watts, voltage 35.10, current 0.80, RPM 2550 when load 75 Waat, Voltage 11.50, current 1.54, RPM 2220. From these results can be concluded axial generator 1 phase currents also get bigger but voltage and rpm decreases.

**Keywords**—PLTMH, PMG, Axial Generator, resistive load, inductive load.

## I. INTRODUCTION

Everyday human life needs can hardly be separated by electrical energy. Electrical energy has become a fundamental human necessity in today's modern era. There are still many areas that are still not accessible by electricity from the state Electricity Company (PLN) such as in Hamlet Sarwan Desa Merbau, District of South Ogan Komering Ulu, because it is constrained by the road to the small hamlet just enough For the intersection of two-wheeled vehicles, also the condition of the bullish road is quite steep that makes the distribution of generating not able to reach this hamlet. With energy resources available today one of which is water from a small stream that forms a waterfall with a low head.

Several previous researchers have conducted research on microhydro turbines. The variable speed of micro hydro power generation: Modeling, loss analysis, and experimental validation were investigated by Guo [1]. Yuhendra and Zaini [2] studied the mapping of potential locations for micro hydro power plants in West Sumatra based on GIS. The frequency and voltage control of the hybrid microgrid using an FLC-based two-way converter equipped with BESS was investigated by Choudhury [3]. Active power management of

renewable microgrid plants isolated from rooftop solar arrays, wastewater and municipal solid waste from smart cities using the Salp swarm algorithm was investigated by Barik and Das [4]. Control Strategy for Power Management of Isolated Micro Hydro-PV Battery Hybrid Energy System was investigated by Das and Akella [5]. The design and implementation of the Micro Hydro Module for Small Falls was investigated by Abdulla Al Mamun [6]. An Effective Microhydro Based Microhydro Scheme for Rural Electricity in South Africa was investigated by Patel and Chowdhury [7]. The prospect of Off Grid Energy Generation via Low Head Screw Turbine in Nepal was investigated by Dhakal [8]. The Study of Technical, Economic and Social Factors Affecting Micro-Hydro Power Plants in Nepal was investigated by Butchers [9]. Application of Distributed Generator-Based DVR to LV Distribution Network was investigated by Mosobi and Gao [10]. From the background of previous research and from the potential in the Hamlet Sarwan Arise initiative to utilize water flow energy into a small capacity water power plant using archimedes screw turbine that will be connected with the axial flux Generator 1 Phasa .

The screw turbine has been widely studied by previous researchers. The prospect of Off Grid Energy Generation via Low Head Screw Turbine in Nepal was investigated by Dhakal [8]. The performance characteristics of the Energy Cat 3EC42 hydrokinetic turbine were investigated by Shahsavarifard [11]. The investigation of Archimedean screw turbines for optimal power output by varying the number of blades was investigated by Khan [12]. The Micro Hydro Power Plant using Wastewater in Hayatabad Peshawar was investigated by Durrani, Mujahid and Uzair [13]. The Archimedes screw generator for sustainable energy development was investigated by Simmons and Lubitz [14]. A micro hydro power plant for distributed generation using municipal wastewater with archimedes screws was investigated by Raza [15]. The predictive control method for wind power regulation via a double screw expander generator and supercapacitor was investigated by Zhu, Lu and Liu [16]. A review of Nepal's low head turbine system for rural electrification was researched by Koirala [17]. Archimedes screw for microhydro induction generator: The effect of applying a frequency converter was studied by Buffa [18].



Utilization of potential energy of water with low head and or relatively small discharge into electrical energy requires the affordance of low round generator technology. The development of Permanent Magnet Generator (PMG) became an alternative considering the polar construction of the rotor is relatively simple compared to conventional generators, so it is technically easier if a larger number of rotor poles are required in the effort. The nominal turndown speed of the generator. One important aspect in the design of a permanent magnet generator is the flux meeting that surrounds the stator coil (anchor coil). The quantity of the flux meeting on the stator coil would affect the voltage and power output of the Permanent magnet generator.

Research on permanent magnet generators has been investigated by previous researchers. Characteristics Analysis and Experimental Verification for Double-Sided Permanent Magnet Linear Synchronous Generator according to Magnetization Array was investigated by Seo [19]. A New Control Strategy for Wave Energy Converters Using a Linear Permanent Magnet Synchronous Generator was investigated by Oh [20]. The design of a 100 W mini permanent magnet linear generator for a wave energy converter system was investigated by Wahyudie, Susilo and Jehangir [21]. Small wind turbines on a smart grid. The transformation of an electric machine into a permanent magnet synchronous generator was investigated by [22]. The experimental analysis of dSPACE for permanent magnet synchronous generators used in voltage control was investigated by (Akhrif, Abbou and Ferfra [23]. Design, Control, and Dynamic Performance of an Interior Permanent Magnet Synchronous Generator for Wind Power Systems was investigated by Solomon [24]. Comparison of Finite Element Between Permanent Magnet Synchronous Generator and Asynchronous Generator Used in Wind Turbines was investigated by Noun, Mrad and Arnaout [25]. Direct Torque Control Without Speed Sensor of Direct Drive Permanent Magnet Wind Generator was investigated by Cai, Li and Huang [26]. Torque Estimation of Interior Permanent Magnet Wind Generator Considering Low Pass Filter Phase Shift Compensation was investigated by Pravica [27].

On a axial flux type generator used permanent magnets. The use of permanent magnets in this generator can produce magnetic fields in an air gap without the need for excitation, and without dissipation of power. For a permanent magnet generator used its own reinforcement system. This reinforcement system is used in brushless alternator generators. As well as a relatively easy maintenance system that could potentially be applied to micro-hydro power plant low head. The type of permanent magnet used is neodymium Ferrite Boron (NdFeb).

## II. LITERATURE REVIEW

### A. Hydrohydro Power Plant

The working principle of hydrohydro power plant is the difference between the high and the amount of water per second in the water flow [28]. Will spin the turbine shaft resulting in mechanical energy [29]. The turbine will rotate the generator and generate electrical energy [30]. The parts of the microhydro system are shown in Figure 1. From this figure, it can be seen that the main components of microhydro

are the tapping building, the carrier channel, the calming tub, the rapid pipe, the power house, the exhaust channel and the overflow channel.

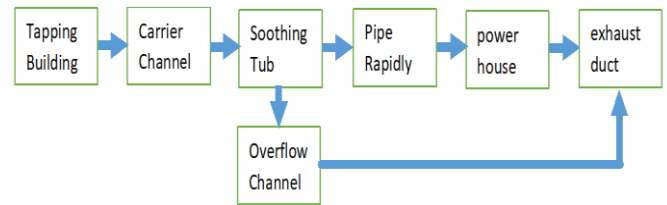


Fig. 1. PLTMH System Parts

### B. Potential of water as energy

Water is an abundant and relatively easy source of energy, water-owned energy is a potential energy and kinetic energy can be used and exploited in the form of mechanical energy that will be utilized to turn the waterwheel or water turbine.

### C. Archimedes Turbine

An economical and efficient way to generate electricity from small streams is shown in Figure 2. From this figure, the screw rotates and generates electricity due to the hydrostatic pressure of water on the screw surface. When the water fills the screw from the inlet line at the top of the slope, the pressure on the screw helical field allows for screw rotation.

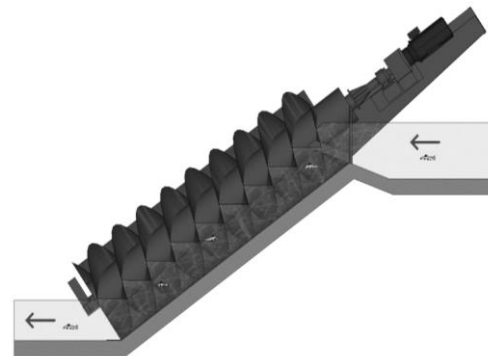


Fig. 2. Archimedes Screw Turbine

### D. Generator

Generator is one electric machine that converts motion or mechanical energy into electrical energy. Generators consist of two main parts namely rotor and stator. The rotor is a rotating piece consisting of a permanent magnet and a silent stator part consisting of several conductor wire coils.

#### 1. Permanent Magnet Generator

The permanent magnet Generator does not have a booster coil and does not produce electrical power desipation. A permanent neodymium magnet is a hard-material magnet that means a ferromagnetic material that has a wide loop know. A wide hysteresis loop shows at least an induction of outside influence on the magnet.

#### 2. Permanent Magnet axial flux Generator

The best alternative aside from the radial flux cylinder machine is the axial flux machine. This type of machine has a compact construction, with a dif entuk and large power density. In this generator used a permanent magnet with the

aim to produce a magnetic field in the air gap without requiring an excitation system and without the insistence of electrical power.

In this type of axial flux generator occurs magnetic flux only if a permanent magnet located on the rotor moves or rotates so that the potential voltage will be generated. Changes in rotor speed will affect the large potential of the resurrected voltage.

3. Electrical load characteristics

In the electrical system of alternating current (AC) electrical load characteristics can be classified into three kinds, namely:

a). Resistive load

Resistive load, which is a load consisting of Ohm only prisoner components (resistance), such as heating element and incandescent lamp. This type of load only consumes active load only and has a power factor equal to one.

b). Inductive expenses

Inductive load, which is a burden consisting of a wire coil wrapped in a core, such as: (Coil), transformer, and Solenoida. This burden can result in phase shift in the current so that it is left to the voltage (lagging). This is due to the energy stored in the form of a magnetic field that will cause the current phase to shift to be left over voltage. This type of load absorbs active power and reactive power.

c). Capacitive load

The capacitive load, which is a burden that has capacitance capability or the ability to store energy derived from electrical discharge on a circuit. This component can cause a previous current against the leading voltage. This type of load absorbs active power and emits reactive power. (Jumadi & Champion, 2015).

III. RESEARCH METHODS

A. FISHBONE DIAGRAM

The fishbone diagram of the performance analysis of the 1-phase axial flux permanent magnet generator with load variations is shown in Figure 3. From this figure, it can be seen that there are two parameters, namely mechanical and electrical parameters. Several mechanical parameters that affect the performance of a single-phase generator are the number of turns, rotational speed, number of magnets, number of coils, flux velocity and air gap. Several electric parameters that affect the performance of the generator are voltage, current, frequency, and cos phi.

B. Data retrieval methods

This research began with the collection of literature from books, journals and resources necessary for research in accordance with the discussion. Water flow speed data retrieval and power calculations are available to know the potential used to spin the Archimedes turbine and the turbine will rotate the axial generator and release the electric energy The generator output can be Tiggikan Its tension with the step-up transformer for the use of LAMGSUMG voltage 220

volts. The block diagram design of the micro hydro system is shown in Figure 4. From this figure, it can be seen that the components in the microhydro consist of a source of water, Archimedes turbine, axial generator, step up transformer, voltage regulator, and load.

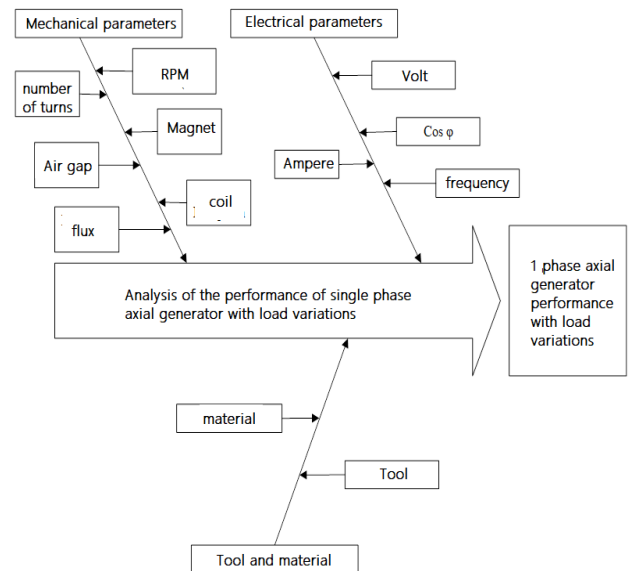


Fig. 3. Fishbone Diagram

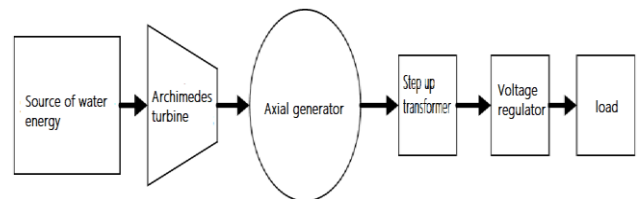


Fig. 4. The Block Diagram

1. Series 1 Phase Series

The circuit in Figure 5 is a series of 1 Phase Series 9 coils of floating or Delta series. From the figure, it can be seen that the 1-phase generator has 9 turns. The wire is wound as much as 9 turns to produce a large electric current in the 1-phase generator.

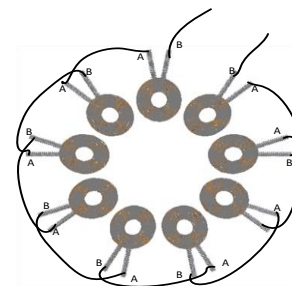


Fig. 5. Series 1 Phase Series

2. The range of axial generator measurements is 1-phase with varying loads

The 1-phase circuit with varying loads is shown in Figure 6. From this figure, it can be seen that there is a voltage measuring device to measure the input voltage to the transformer and the output of the transformer and current measuring instrument.

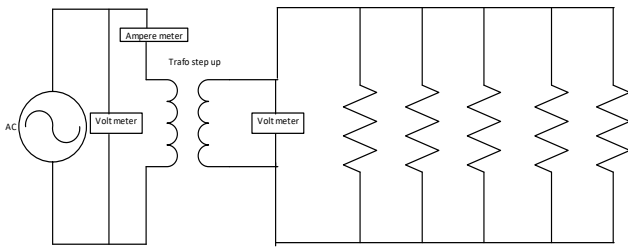


Fig. 6. The measurement range of resistive load-resistant variations

IV. RESULTS AND DISCUSSION

The rotary speed of the generators in the process is influenced by the magnitude of the water flow and the discharge of water that strikes the transmission turbine also greatly affects the rapid rotation of the turbine rotates the generator by using a certain ratio. The power available on the water rotates the turbine to get an RPM of 190-200 to accelerate its RPE by using a transmission with a ratio of 1:10 pulley that is 2 inches: 20 inches will be increased 2000 rpm to rotate the axial generator 1 phase so that Outputs shown in table 1. From the table, it can be seen that the load is best proportional to the stress and speed. The higher the load, the lower the generator rotational speed and the voltage drop occurs. The ratio of the load to the current is proportional. The higher the load causes the current to increase.

TABLE 1. Variation Load Measurement Results

Load variations	Voltage (Volt)	Current (Ampere)	Rotation (rpm)
Load 0	54.70	0.00	2720
Load Transformer	57.00	0.30	2500
Load 15 watt	35.10	0.80	2550
Load 30 watt	25.00	1.13	2550
Load 45 watt	19.10	1.34	2270
Load 60 watt	14.80	1.45	2260
Load 75 watt	11.50	1.54	2220

The graph of the load against the generator voltage is shown in Figure 7. From this figure, it can be seen that the graph of the voltage to load is inversely proportional. The greater the load, the lower the voltage generated by the generator.

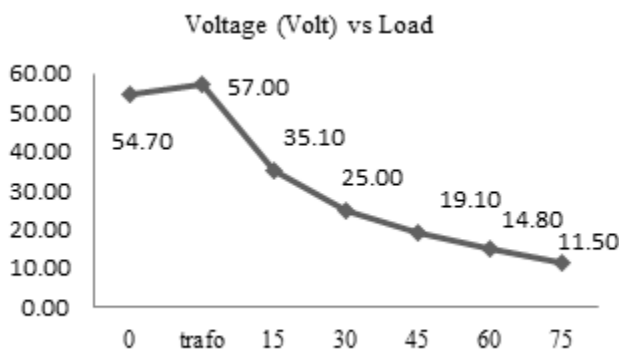


Fig. 7. Graph load against generator voltage

The graph of the load against the generator rotation is shown in Figure 8. From this figure, it can be seen that an increase in load can reduce the rotational speed performance of the generator.

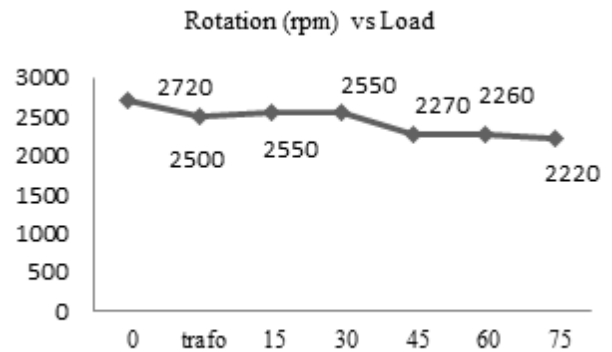


Fig. 8. Graph of load against generator rounds

The graph of the load on the current generator is shown in Figure 9. From this figure, it can be seen that an increase in load can reduce the current performance of the generator

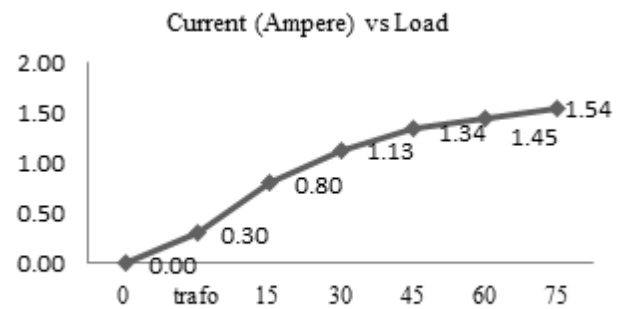


Fig. 9. Load graph against current generator

V. CONCLUSION AND SUGGESTION

The conclusion that can be withdrawn from this study is from the results of Pungujian tools and measurements of the data retrieval of the axial generator 1 phase performance with inductive and resistive load vaiation. Axial Generator 1 Phase out the current at the time the load in the plug against the generator the larger the current load is also increasingly larger but the voltage and rpm decreases.

Suggestions for subsequent research to test variations of load type capacitive loads.

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