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AN EXPERIMENTAL OF SINGLE PHASE INDUCTION MOTOR AS GENERATOR: MOTOR AND CROSSFLOW TURBINE AS PRIME MOVER

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ABSTRACT

One of the ways to backwardness alleviation is doing with improve all fields, electrical infra structure is important thing to be developed, especially remote community in rural area. To reach the need of electricity, the community on rural area must bring to independent electrical energy. The hope, power generator can be made by people from rural community, and finally "swa-electrification" for remote community will be reached. Hydropower is electricity generated using the energy of moving water, with water as energy, will be need turbine and generator. So in this research will be design picohydro power generation, with water as kinetic energy to rotate the blade of turbine, who made from bamboo, induction motor use as generator so called Induction Motor as Generator (IMAG). How far bamboo can be use and hold the load, and rotate the generator. The experiment has been done have results about power and efficiency; experiment simulation was done with turbine as prime mover to rotate generator, produce voltage and electric current. The results of the IMAG showed that the generator could work up to 360 watt lamp load at 1672 rpm. The actual load generator was 200 Watts at 1580.4 rpm, with total efficiency ηT, 23%.

Keywords: water turbine, bamboo blade, IMAG, picohydro.

INTRODUCTION

One way to alleviate village whose underdevelopment is done by increasing development in all fields, especially to develop infrastructure, particularly developing electricity infrastructure. Until now, existing electric power development could not meet the needs of society, especially in remote villages (Nimje, AA & Dhanjode, G 2015). After 60 years Indonesian Independence about many of village remains to be electrified and also many household in the country still dark at the evening. Most of the unelectrified settlements are located in rural village.

Recognizing the urge for electricity access in remote areas and for replacing conventional by renewable energy sources, the Government of Indonesia recently set the target of 90% electrification by 2020, as a subset of its "Vision 2025: Building New Indonesia strategy" and aims at implementing policies which foster renewable energy technologies. In recent years, a number of promising reforms have taken place designed to invite the participation of local government and the private sector in renewable energy based rural electrification efforts.

In Indonesia there is no agreed general consensus on the small hydropower definition, with the terms small, mini, micro and pico hydropower used interchangeably. Current installed small hydropower capacity is about 100 MW; however, the potential is much higher about 1.267 MW.

Germany has provided long-term support to the development of mini hydropower in Indonesia. A cooperative called Mini Hydro Power Project (MHPP) was carried out by the Directorate General of Electricity and Energy Utilization, Ministry of Energy and Mineral Resources and the German Technical Cooperation (GTZ). The first phase of the MHPP project (1991-1996) had focused on the introduction of technology to local institutions and individual's that were already active in micro hydropower project development. In the second phase (1999-2002), the scope of intervention was broadened to include policy dialogue, scaling-up of technology packages, and improving operation and management. The project has developed a variety of mini hydropower technology packages transferring knowledge and expertise to local manufacturers in Java and Sumatra. Over the past decade, such packages have been applied in more than 100 installations. These schemes presently supply over 20,000 families with clean and sustainable energy.

Small Hidro Power is an excellent option to promote productive uses, economic growth and development for small remote communities in developing countries, because: hydro is usually the least cost of all electrification options for isolated communities, where hydro resources exist; and hydro energy is a mature technology, widely proven and now manufactured in a number of developing countries (Alliance, 2014);

Picohydro is also a small-scale of hydro power, that utilize the flow of river water as the power to drive the turbines, converting the potential energy of water into mechanical work, turning a turbine and generator to produce electrical power small scale, which is about 0-5 kW(picohydro), which did not use the fuel. Picohydro application of a positive effort to reduce the rate of global climate change being an important issue today.

The impacts of Rural Electricity (RE) on indoor air quality, health, and knowledge, and fertility reduction are quantifiable and significant. The health benefits from RE as follows: Improvements to health facilities, better health from cleaner air as households reduce use of polluting fuels for cooking, lighting, and heating, Improved health knowledge through increased access to television, Better nutrition from improved knowledge and storage facilities from refrigeration (Worlbank, 2008)

Development of Picohydro will make people more actively protecting the environment including forests for continued availability of supply streams for water. Most of the small hydro power plants are base on Run of River scheme, implying that they do not have any water storage capability. Run off river plants have many disadvantages as compared to other types plants such as wind, solar power plants. Runoff river plants are non polluting source of energy (Sharma H., Singh J, 2013).

The energy sector is one sector that is a top priority policy of the Indonesian government after reforms. It is seen one of them in the National Research Agenda (ARN) which states that renewable energy is one of the priorities in the development of national research, in addition to the field of food security, information and communication technology, transportation and defense. Technological breakthrough is needed to encourage the use of new energy sources/renewable, the intensification of the search and development of energy resources (oil, geothermal, wind, biomass, ocean energy, solar, water), and energy conservation. To support the increasing national electrification, the research, development and application of science and technology focused on the development of geothermal energy, wind energy, solar energy, fuel cells, nuclear energy, and ocean current energy.

Micro hydro power plant is one of the renewable energy sources that are still not widely used in parts of Indonesia. Based on data from the Ministry of Energy and Mineral Resources, Indonesia has a hydropower potential of 75,000 MW and currently only 13.5% of this potential utilized (EMR, 2003). Therefore, it needs to be improved picohydro use in areas that have the potential to be built picohydro, so that the electric energy needs are no longer so dependent on the PLN(State Electricity Company).On the other hand, one of the components picohidro is a generator as a tool to transform mechanical energy into energy turbine shaft listrik. Generator are widely used inpicohydro is asynchronous generator(power generating >10kW) and asynchronous generator or induction(for generating power<10 kW).There are several reasons why an induction generator used to power generating MHP<10 kW, among others: the synchronous generator power<10 kW are very difficult to find in the market, easy to maintain, and cheaper. One way to get the induction generator is changing the induction motor becomes a generator induction, by providing reactive power supply into the induction motor (Effendy, M., 2009). Reactive power supply could come from a capacitor or of PLN. In this study, we will use a capacitor as a source of reactive power.

The advantage of picohidro are as follows:

a) Sustainable and renewable, picohidroa power plant the most environmentally friendly also does not pollute and destroy nature, because it uses water as the energy source instead of fuel. Picohidro also does not pollute streams.
b) The technology is reliable; The technology use dis reliable and sturdy so it can operate morethan15years.
c) Low operational costs
d) Simple maintenance.
e) Easy operation
f) Not consumptive of water usage.
g) The energy produced can betaken into account as a potential source that is widely available in Indonesia.

A simulation have done by Ho-Yan, a Matlab program was devised to extend the theory of Tesla turbine, analytical investigation into Tesla turbines. Employing this, a preliminary design of a Tesla turbine has been conceived to generate 300W under conditions of 20 m head and 2.5 L/s flow (Ho-Yan, 2011). Ho-Yan find that efficiency of the preliminary turbine design was near 80% but it is believed that efficiency losses will be found in inlet and exhaust flows, which were not considered in this analysis. Challenges still remain for the application of Tesla turbines to pico hydro generation and were highlighted throughout this preliminary design process

Crossflow (Banki-Michell) turbines are cylindrical in shape with two end plate connected by a circular array of blade. A rectangular nozzle directs the flow to contact the entire length of the cylindrical runner. The flow contacts the blade array at different location on entrance and on exit. Crossflow turbine yield relatively high part flow efficiency which can be achieved by channelling the flow over a portion of the runner (Sangal S. *et al*, 2013). The water strikes the blade on the rim of the wheel flows over the blade, leaving it, passing through the empty space between the inner rims, enters a blade in the inner side of the rim, and discharge at outer rim. The wheel is therefore on inward jet wheel and because the flow is essentially radial the diameter of the wheel is practically independent of the amount of water impact, and the desired wheel breadth can be given independent of the quantity of water (Mockmore, C A, Merryfield F, 1949).

Cross flow turbine blade shape in the form of a radius, enabling the turbine blades made of bamboo, so in this experiment blade of turbine made from bamboo. Bamboo is used to simplify the manufacturing process of crossflow turbine, on the other hand the bamboo also easily found in rural areas. The diameter of the bamboo may have been adapted to the design of turbine blade

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diameter, whereas the strength of bamboo adapted to load received by the blade, and overcome by selecting the thickness of the bamboo.

LITERATURE REVIEW

Induction Generator

Induction generator is one type of AC generator which apply the principle of induction motors to generate power. Induction generator is operated by rotating the rotor, rotor rotation is faster than synchronous speed so as to produce a negative slip. Induction motors can generally be used as a generator without any internal modification. Induction generators are very useful in applications such as micro hydro power plants, wind turbines, or to lower the high pressure gas flow to low pressure, because it can take advantage of the energy with relatively simple control. In operation, the induction generator to be excited first uses leading voltage. Such excitation is done by connecting the generator to the existing power system.

At the induction generator that operates stand alone, the capacitor bank must be used for supplying reactive power. Reactive power supplied must be equal or greater than the reactive power drawn when the machine operates as a motor. Generator terminal voltage increases with increasing capacitance adjusted for changes in the existing load (Irianto, C.G, 2004)

Torque-speed characteristics of an induction machine like the curve in Figure-1, shows that if the induction motor is rotated at a speed higher than synchronous speed by an external prime mover, the induced torque will reverse direction and the motor will act as a generator. With increasing torque given prime movers to the axis, of the power generated by the induction generator participate bertambah. Seperti shown, there is an induction torque value of the maximum possible in this operating mode generator. Torka called pushover torque generator. If the torque supplied by the prime over the shaft torque exceeds pushover, the generator will overspeeding. There are some limitations when the induction machine operates as a generator, since the absence of a separate field circuit, induction generator can not generate reactive power. In operation, the induction generator actually consume reactive power so that the external reactive power source must be connected to the generator at all times to keep the stator magnetic field.

This external reactive power source must also control the voltage generator terminal. Without afield current, induction generator can not control the output voltage itself. Normally, the voltage generator is guarded by the power system in which the generator is connected.

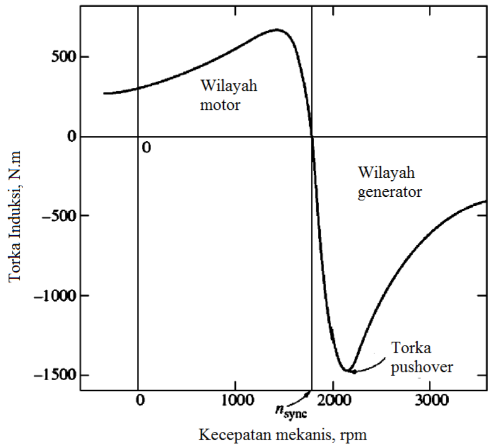

Figure-1. Torque-speed characteristics of an induction motor, shows the generator operating region.

Flow rate, mass flow rate and power

Measurement of river flow is usually done by using a buoy and a stop watch, measuring the flow velocity is done by measuring the travel time of the current float through a predetermined distance. And the flow rate can be calculated using the following formula:

$$Q = V.A \tag{1}$$

$$\dot{m} = \rho.Q \tag{2}$$

Description

Q = flow rate
V = Velocity
A = Cross sectional Area
$\dot{m}$= mass flow rate
ρ = mass density

Waterpower, which is generated by the flow and height of the water flow, can be formulated as follows:

$$Pw = \rho.Q.g.h \tag{3}$$

Pw= Water power (Watt)
Q = flow rate (m^3/s)
g = gravitation (m/s^3)
h = head of water (m)

The formula of water on the installation testing with simulations using a water pump,

$$Pw = P\ A\ v + ½\ \dot{m}v^2 \tag{4}$$

P = Measure pressure
A = Pipe cross sectional area
v= water velocity

Power comes from the kinetic energy of water and the pump pressure, will be used to drive a turbine, as explained earlier in this planning will be used cross-flow turbine, where the planning adapted to the selection criteria of the turbine. Crossflow turbine is widely used because of advantages in its use of ease of manufacture and installation.

Total efficiency

In this experiment, the total efficiency is obtained by multiplying the efficiency of the transmission x efficiency of the turbine x efficiency generator, as well as the total efficiency also is the ratio between the electrical power output to power input water entering the turbine.

$$\eta_T = \frac{\text{electric power output}}{\text{water power input}} \quad (5)$$

MATERIAL AND METHOD

In the tests performed, there are 2 kinds of testing, first, testing induction generator driven by an electric motor and generator testing is driven by water turbines. In the first experiment, the equipment used include: electrical motor functioning rotating generator, belt-pulley transmission system, Induction Motor as Generator (IMAG) which function generates electricity. While the second experiment, the equipment used include: water pump which serves to raise the pressure of the water flow, which serves as across flow turbine driving an induction generator, crossflow turbine converts the kinetic energy of water into rotary motion, Induction Motor as Generator (IMAG) which function generates electricity

Through the mechanism of transmission system pulley belt with a specific rotation ratio, the generator will be driven by electric motors. Tests conducted to determine the appropriate rotation for IMAG, so we get the output voltage and the desired power. Setup testing as shown in Figure-2.

Figure-2. Test of Generator MISG.

In the test with the motor prime movers, used two comparison pulley. The first testing with a pulley ratio of1: 3, while the second test used pulley ratio of 1:2.5. This is done to determine the effect of the variations in the performance of the generator IMAG pulley ratio.

Specification of the generator MISG,
Power: ½ hp
Voltage: 110/220 V
Rotation : 1495 rpm
Capacitor: 50 mF
Phase: 1 phase

In Figure-2 is seen that, 3 phase electric motor drives a generator MISG, electric voltage generated is used to power the lighting load. Mounted lamp power, the terminal voltage and load current is recorded for each load change. Given the induction motor which functioned as a generator needs to rotation higher than the synchronous rotation, it will be investigated also influence pulley ratio corresponding to the rotation generator.

The next research methodology includes the use IMAG generator is to be combined with crossflow turbine (as the prime movers), so that the resulting electrical voltage. In the crossflow turbine utilization as prime movers are two variations of the change, namely the transmission pulley ratio variation and variation of the valve opening (valve guide) on the turbine.

Figure-3. Pengujian turbine drive Generator.

Turbine specification

Type : crossflow
Runner Diameter : 180 mm
Blade : made from bamboo, 18 sudu
Runner Width : 105 mm

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Pump specification
Power : 1500 Watt
Max Capacity : 1000 liter/min
Voltage : 220 Volt

Water flow condition before entrance to turbine:
Flow rate : 7 - 9, 8 liter per detik
Pressure : 0, 26 - 0, 47 kg/cm^2

Related research cross-flow turbine blade made of bamboo to find out how far the performance of the turbine can drive a generator and produce electrical voltage. Had previously been investigated by (Kamal, 2013) pelt on water turbine blades of bamboo with a maximum yield of 28% total efficiency. This research will be investigated as well, related to water crossflow turbine blade bamboo as a mover generator IMAG.

The number of blades of bamboo used in this study18blade, where according to Winardi (2004), the number of blades affect the power output produced, the greater number of blade will be greater power to generated. Some experiment was done use number of blade up to 35 piece of blade.

RESULT AND DISCUSSIONS

Results of motor prime over

Table-1. Experiment result ratio pulley 1.

No.	Bulb load (watt)	Current (Ampere)	Voltage (Volt)	Rotation (rpm)
1.	0	0	310	1726
2.	10	0.1	295	1637
3.	35	0.22	278	1674
4.	60	0.33	263	1650
5.	85	0.44	249	1625
6.	110	0.54	236	1608
7.	135	0.63	226	1590
8.	210	0.88	193	1579
9.	285	1.15	162	1615
10.	310	1.29	150	1653
11.	335	1.34	144	1652
12.	360	1.35	142	1672

Table-2. Experiment result ratio pulley 2.

No.	Bulb load (watt)	Current (Ampere)	Voltage (Volt)	Rotation (rpm)
1.	0	0	255	1606
2.	10	0.09	240	1583
3.	35	0.20	230	1559
4.	60	0.30	216	1547
5.	85	0.39	202	1535
6.	110	0.48	190	1529
7.	135	0.56	180	1522
8.	210	0.77	150	1438
9.	285	0.92	122	1592
10.	310	0.90	105	1610

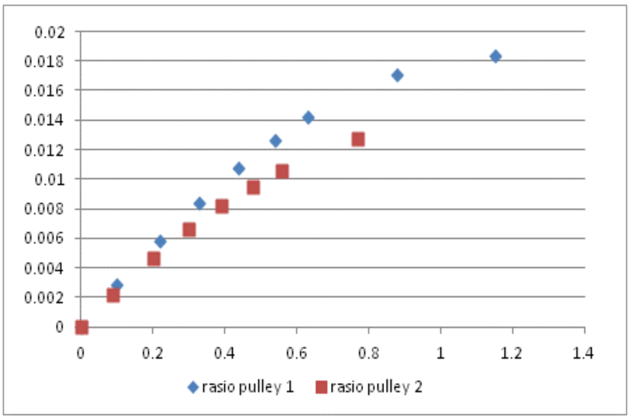

Figure 4. Load Current vs. Torque.

On the testing, the electrical generator MISG with electric motor prime movers in comparison pulley 1, the maximum voltage produced higher at 310V, while the second pulley ratio is only 255V, while the generator rotation respectively 1726 rpm and 1606 rpm. In the comparison pulley 1 is capable of receiving a total load of 360 watt incandescent bulb on the current and voltage of each 1,35A and 142V. In the second pulley ratio capable of receiving a total load of 310 watt incandescent bulb on the current and voltage of each 0,9A and 105V. A decrease in the voltage gradient to increase the load on the pulley ratio 1 and 2 respectively by 2,143 and 2,066, it indicates that the ratio of pulley 2, the rate of voltage drop is slightly smaller and is theoretically better, because smaller voltage changes when given additional load. Grafic trend rom Figure-4 about load current vs. torque same with experiment research done by Devabhaktuni, S., Kumar, SVJ, (2011).

IMAG Generator with Turbine prime over

Results are displayed on testing IMAG generator with turbine prime movers, showing changes in loading as well as some other measurable variables such as voltage, current, and rotation. Data shown are not grouped to variations in changes in the turbine.

Table-3. Result of turbine prime over.

No.	**Load**	**Volt**	**Arus**	**Putaran** (Rpm)	**Daya** (Watt)	η_T
1	45	148	0,3	1449	44,4	-
2	150	84	0,39	1431	32,76	-
3	165	104	0,62	1534,5	64,48	28,5 %
4	190	96	0,66	1568,35	63,36	29 %
5	200	112	0,67	1580.4	74,04	23,3 %

In the turbine generator with the prime movers in general to the various conditions of the variation in the turbine, large loads are given identical incandescent lamps with large voltage occurs and associated with large round of the generator. Added incandescent lamp load with increasing load current, while the addition of an incandescent lamp load does not seem directly related to a decrease in terminal voltage, when it should increase the load will reduce the voltage.

Experiment result of Wolf-Engelke, R. *et al*, (2006).

System A: World bank system	**System B: Francis**	**System C: Modified propeller**	
Power output (electrical)	3 kW	0.5 kW	0.2 - 2kW
Number of houses connected	45	1	20
Penstock	30 m	6 m	None
Type of turbine	Pelton	Francis	Propeller
Type of generator	Induction (4 pole)	Induction (4 pole)	Induction (4 pole)
Head (net)	27 m	2.5 m	None
Flow (design)	42 l/s	20 l/s	None
Efficiency (turbine + generator)	50 %	48%	20-30%
Distance of furthest house	200 m	50 m	20 m

That is because the experiments were done, still associated with changes in the variable turbine that includes a variable pulley ratio and variable valve guide openings. So that the turbine side still needs to be optimized related to comparison pulley and guide the design of the valve, because according to Witdarko 2004, opening the blade steering effect on the performance of the turbine. On the output voltage is still not achieved a nominal voltage of 220 volts, is expected to re-plan your future with the valve and the transmission ratio, nominal voltage can be achieved.

Total efficiency of this experiment (turbine + generator) almost same with the experiment that done by Wolf-Engelke, R. *et al* (2006). On this experiment have range about 23%-29%, and Wolf experiment about 20-30% (System C).

CONCLUSIONS

a) In the first experiment, the ratio ofpulley1, with a higher rotation generator capable of producing a larger voltage and able to with stand larger loads also, that the burden of incandescent bulbs of 360watts at1.35Acurrentandvoltage of142volts.

b) In the second experiment, the light bulb maximum load power of 200wattswith23.3% efficiency, whereas the maximum efficiency of 29%occurred in the load190wattlight bulb.
c) Crossflow turbine blades of bamboo as a turbine driving an electric generator capable of producing a maximum total efficiency of 29%, if the assumedgeneratorMISGhaveefficiency50%, then the bamboo blade turbine is expected to generate efficiency by 58%, so in this initial study bamboo blade turbines worth used as a turbine driving a generator picohidro.

ACKNOWLEDGEMENT

This research is one part of a research grant competes with related titles funded by the Higher Education in 2014, and we express deep gratitude for the assistance fund such research. Hopefully this research can continue in the year to 2, so that the aspiration to realize self-electrification in remote areas can be realized.

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MANET. To reduce delay at different levels such as routing delay which is time required to search a path from source to destination, a processing delay that occurs when a node executes the processing for the packet for next transmission, a compression and decompression delay which is associated with audio files many innovative proposals have been developed by networking experts but still it lies as a major challenging issue. Again the proper power management of nodes in MANET plays a vital role in efficient routing. In this paper a systematic study has been carried out about different challenging issues associated with delay and power during routing in MANET and analysis has been done about important protocols of MANET dealing with delay and power.

Full Text

Title: Numerical analysis on the cooling passages optimization of turbo blowers

Author (s): H. C. Lee and Y. L. Lee

Abstract: Turbo blowers are used for various industrial facilities and equipment such as agricultural machines, gas supply machines, etc. Recently, with the growing capacity and reduced size of turbo blowers, the thermal management of various packaged electric components has emerged as a challenging issue. Based on this recognition, this study aimed to estimate the required cooling flow and temperature distribution in the initial design phase of 200 HP turbo blowers. The results of this study show that it is possible to achieve cooling performance for the 200 HP turbo blowers by using an adequate partition wall, fan, and filter.

Full Text

Title: An experiment of single phase induction motor as generator: Motor and crossflow turbine as prime mover

Author (s): Efrita Arfah Zuliari and Ali Khomsah

Abstract: One of the ways to backwardness alleviation is doing with improve all fields, electrical infra structure is important thing to be developed, especially remote community in rural area. To reach the need of electricity, the community on rural area must bring to independent electrical energy. The hope, power generator can be made by people from rural community, and finally "swa-electrification" for remote community will be reached. Hydropower is electricity generated using the energy of moving water, with water as energy, will be need turbine and generator. So in this research will be design picohydro power generation, with water as kinetic energy to rotate the blade of turbine, who made from bamboo, induction motor use as generator so called Induction Motor as Generator (IMAG). How far bamboo can be use and hold the load, and rotate the generator. The experiment has been done have results about power and efficiency; experiment simulation was done with turbine as prime mover to rotate generator, produce voltage and electric current. The results of the IMAG showed that the generator could work up to 360 watt lamp load at 1672 rpm. The actual load generator was 200 Watts at 1580.4 rpm, with total efficiency ?T, 23%.

Full Text

Title: Characteristics of lime-stabilized Depok residual soil

Author (s): Damrizal Damoerin, Sigit P. Hadiwardoyo and Teodore I. Minaroy

Abstract: Depok residual soil has generally been used as sub grade layer for road pavement. By applying lime stabilization, the California Bearing Ratio (CBR) of sub grade Depok residual soil is expected to improve. In the present work, the lime stabilization was applied by adding 10 percent of dry weight of soil and furthermore the soil lime samples were compacted by Modified Standard Proctor around the optimum water content of 31.10 %. The soil lime samples were prepared in two conditions. The first condition, the soil lime samples were cured for 0, 6, 24, 72 and 168 hours and

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