Faculty of Electrical and Electronic Engineering Technology

PROTOTYPE SUBMERSIBLE IN-PIPE PICO GENERATOR FOR LOW STREAM FLUID

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Bachelor of Electronics Engineering Technology with Honours

2021

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI KEJUTERAAN ELEKTRIK DAN ELEKTRONIK

BORANG PENGESAHAN STATUS LAPORAN
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Sesi Pengajian : 2021/2022

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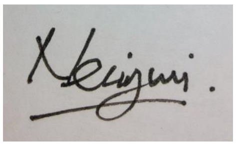

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DEDICATION

This project is dedicated to both my parents.Norizah Binti Jaafar, my mother, who not only raised and nurtured me but also served as a source of motivation and strength through times of despair and disappointment. Her motherly care and support have recently been demonstrated in spectacular ways. Over the years, my father, Abdul Latib Bin Abd Rahman, has sacrificed blood, sweat, and tears to support my education and intellectual growth.

ABSTRACT

The necessity to find alternative energy to replace the electricity supplied by generators is one of the most critical problems of the rural electrification project. The rising cost of fuel, as well as the cost of delivery to the distant location, restricted the availability of power to particular times of day. Because rural settlements are generally located near a water source, hydro-based renewable energy is preferred. The creation of a model system for a low-cost Pico-hydro turbine will be discussed in this study. The low flow and low head of the application will dictate the size of the turbine. In-pipe water to wire power systems is addition to solar and wind systems, are becoming increasingly tempting for incorporating renewable energies at the urban and building scale due to their capacity to capture sustainable energy from surplus head pressure in urban and household water pipes. These Pico-hydro power systems can operate in a wide range of head-to-flow conditions and provide dependable renewable and constant electricity without interfering with wind and solar energy, while also assisting with pipeline management operations. This paper discusses the design and construction of a Pico-hydro generating system that leverages the kinetic energy of water flow to generate electricity for energy storage as well as everyday functions such as charging and lighting. The water pressure and flow within the pipe utilized for routine operations are employed to spin a small scale hydro turbine, which drives a generator to generate electricity.As a result, this research is being carried out to create a small scale hydro generating system that will employ using water or flow and water pressure as an alternative electrical energy source.

ABSTRAK

Keperluan untuk mencari tenaga alternatif untuk menggantikan elektrik yang dibekalkan oleh penjana adalah salah satu masalah paling kritikal dalam projek elektrik elektrik luar bandar. Kenaikan kos bahan bakar, dan juga kos penghantaran ke lokasi yang jauh, menyekat ketersediaan tenaga pada waktu tertentu dalam sehari. Oleh kerana penempatan luar bandar umumnya terletak berhampiran sumber air, tenaga boleh diperbaharui berasaskan hidro lebih disukai. Penciptaan sistem model untuk turbin Pico-hidro kos rendah akan dibincangkan dalam kajian ini. Aliran rendah dan kepala aplikasi yang rendah akan menentukan ukuran turbin. Sistem bekalan air ke kabel elektrik adalah tambahan kepada sistem suria dan angin, menjadi semakin menggoda untuk menggabungkan tenaga yang boleh diperbaharui pada skala bandar dan bangunan kerana keupayaan mereka untuk menangkap tenaga lestari dari lebihan tekanan kepala di paip air bandar dan isi rumah. Sistem tenaga elektrik Pico-hidro ini dapat beroperasi dalam berbagai kondisi head-to-flow dan menyediakan elektrik yang dapat diperbaharui dan berterusan yang boleh dipercayai tanpa mengganggu tenaga angin dan solar, sementara juga membantu operasi pengurusan saluran paip. Makalah ini membincangkan reka bentuk dan pembinaan sistem penjanaan Pico-hidro yang memanfaatkan tenaga kinetik aliran air untuk menghasilkan elektrik untuk penyimpanan tenaga serta fungsi sehari-hari seperti pengisian dan pencahayaan. Tekanan dan aliran air di dalam paip yang digunakan untuk operasi rutin digunakan untuk memutar turbin hidro skala kecil, yang mendorong generator menghasilkan tenaga elektrik. Hasilnya, penelitian ini dilakukan untuk membuat sistem pembangkit hidro skala kecil yang akan menggunakan air atau aliran dan tekanan air sebagai sumber tenaga elektrik alternatif

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to my supervisor, Ts. Dr. Zulkifli Bin Ibrahim and for precious guidance, words of wisdom and patient throughout this project.

I am also indebted to Universiti Teknikal Malaysia Melaka (UTeM) which enables me to accomplish the project. Not forgetting my fellow colleague, for the willingness of sharing his thoughts and ideas regarding the project.

My highest appreciation goes to my parents, and family members for their love and prayer during the period of my study.

Finally, I would like to thank all the staffs at the Faculty of Electric & Electronic Engineering Technology, fellow colleagues and classmates, fellow colleagues and classmates, the faculty members, as well as other individuals who are not listed here for being co-operative and helpful.

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LIST OF SYMBOLS

ρ	-	Density of water
g	-	Gravitational due to the gravity
$\dot{\eta}$	-	Turbine efficiency

LIST OF ABBREVIATIONS

V	-	Velocity of water
P	-	Average residential water pressure
Q	-	Volume flow rate
t	-	Time taken
H	-	Hydraulic head
P	-	Hydraulic power
Pout	-	Output power
Cv	-	Coefficient of discharge
Vr	-	Velocity ratio
Pg	-	Power generated
V	-	Voltage
W	-	Wattage

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CHAPTER 1

INTRODUCTION

1.1 Background

Pico is a term used to represent a small property, particularly in relation to the size of the mechanism. Pico-hydro is a hydropower generation system with a maximum production capacity of five kilowatts (5 kW). The smallest hydropower generators are the most suitable systems for rural areas. Electrification, and it's still the most profitable way to generate electricity. The high cost of living in today's lifestyle, especially the high electricity bills, has led people to think about ways to reduce energy consumption at home, it is usually triggered by everyday tasks such as lighting, ironing, washing the washing machine, and so on.

This technology is now widely used as an alternative way to generate electricity in the form of stored energy from regulating the flow of water in pipes domestically. for modern residential areas. The prototype of the Pico-Hydro system was intentionally designed for installation in a domestic water pipe. However, the potential to be used as an alternative energy source for electrification is very limited. Also, potential performance may differ between areas. This is because the water supply pressure and flow rate are different between residential areas. Therefore, both parameters, the pressure of the water supply (waterfall) representing the height of fall and the water flow, must be determined at an early stage in order to estimate the potential performance. Because hydropower is one of the oldest known renewable energies. Sources in history and was the first source to generate electrical energy, this factor has positioned the pico-hydro turbine as a developed technology. In addition to being used to generate electricity.

Pico-Hydro turbines can also help reduce CO2 emissions by replacing fuel and firewood, which contributes to the exploitation of local resources, reducing dependence on imported fossil fuels, saving forests from destruction and soil erosion, reduces the number of house fires and provides energy to charge laptops such as cell phones, are classified as watercourse systems where the operating process does not require a dam, but pipes divert part of the river, reduce the gradient and then dismantle it. Indeed, dams can negatively impact the environment in terms of greenhouse gas emissions, which can also negatively impact wildlife habitats, fish migrations, water flows, water quality and interest-based recreational crimes.

1.2 Problem Statement

According to the Malaysian scenario, solar is the most commonly used alternative energy. Solar maintenance is high and the start-up costs are higher than pico-hydro generators. The Pico-hydro project is based mostly on the river and waterfall. For example, different parts of the river will have different flows, resulting in a varying voltage value. As a result, the optimal voltage will be at the top of the priority list. The value of the voltage created is significant since it determines the power generated by the turbine or Pico-hydrop. At the same time the value of the flow rate that generates the optimum voltage determines the power produced by the Pico hydropower also should be determined. The use of the Pico-hydro turbine as an alternative way to replace the solar is therefore a compatible decision for the daily needs and activities. In addition, there is fewer installations in Pico-hydro turbines with no dam or tank. It also has the advantage of lower maintenance and substitution costs and is environmentally friendly for long-term use.

1.3 Project Objective

Based on the problem statement described in the previous section, therefore the objective of this research are:

a) To develop a set of generator that can produce electricity by using low stream fluid model.

b) To design a generator by using Ansoft Maxwell RMxprt design.

c) To produce result simulation by using different flow speed of water.

1.4 Scope of Project

In order to achieve the above objectives, the following scopes have been drawn::

a) Renewable energy – Pico hydro electric.
b) Selection and fabrication of suitable component for model motor in simulation.
c) Succesful simulation to show maximum output for certain flow and when certain output is achieved the flow still increased.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The fundamentals of the Pico-hydro turbine will be described in this chapter. The first method is to conduct a utility study on the basics of the Pico-hydro system, which includes the application and generation system. In addition, conduct a thorough investigation into the feasibility of a Pico-hydro system, with a focus on the motor.

2.2 Pico Hydropower

Pico hydro is a tiny hydroelectric power plant that may produce up to 5kW of power. The word "pico" was invented by Nigel Smith (2005) to distinguish it from micro, mini, and bigger hydro power. (2013) (Thomas, Brian; Jordan, Bill; McGhee, Ryan). The most cheap form of generating energy is pico hydro, which is extensively utilized in rural communities. The intake from a stream or river, the pipe, the water turbine, the electrical generator, the electronic controller, and the electrical distribution system are the key components of the system. (Howey, D. A., 2009). Figure 1 is an example of a pico hydro system use in a steep site. This system will make use of an upper water reservoir located a few meters above ground. The reservoir's water flows downwards through the pipe system. This downhill distance is known as the "head," and it allows the water to accelerate in preparation for the primary moving mechanism. As a result, the turbine will create electricity by turning the alternator. (A. Williams,. 2007)

Many nations have already employed this technology to generate small-scale power for home consumption, including Vietnam, Indonesia, and Kenya. The Intermediate Technology Development Group's Eastern Africa office (ITDG-Ed) constructed a very tiny "pico-hydro" power plant in Central Province, Kenya, to serve two isolated settlements on Mount Kenya's slopes. Over 200 houses received light and power as a result of this initiative. This initiative received the Ashden Awards for Sustainable Energy. (Toklu, E. 2013)

Figure 1 Picture about Pico-generator being used at rural area

Hydropower operates on the energy conversion concept, transforming kinetic energy available in water flow from higher elevation to lower elevation to mechanical energy, which is then utilized to drive the generator in the power plant and create electricity. Head is the difference between higher and lower levels, which can occur naturally in rivers and streams. The hydropower potential is determined by the availability of head (H) and flowing discharge (Q), as defined in the language used to estimate hydropower potential. The hydro potential of a turbine shaft may be calculated using the equation below.

$P = \eta \rho g Q H$

Where, P = mechanical power produced (kW),

η= turbine hydraulic efficiency,

ρ = the density of water (kg/m3),

g = the acceleration due to gravity (m/s2),

Q = the quantity of water flowing through hydraulic turbine (m3/s),

H =Net available head in meters (m).

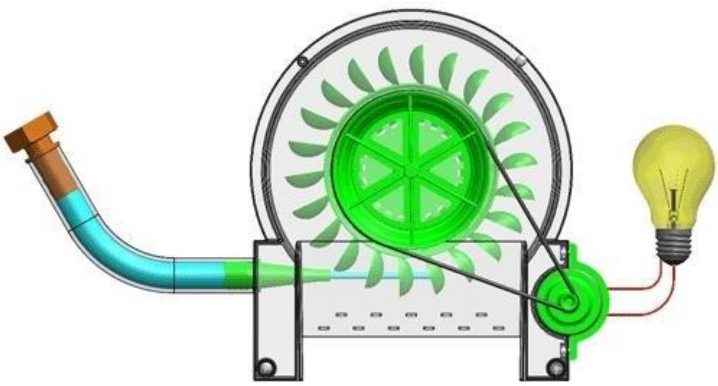

Figure 2 Illustration about how Pico-generator work.

2.2.1 Turbines

The selection of turbine is critical in the design and development of a hydropower system. The groups of impulse and reaction turbines available are shown in Table 1. In most cases, the reaction turbine is completely immersed in water and contained in a pressure casing. The runner or spinning element and shell are carefully designed to have as little space between them as possible. In contrast, an impulse turbine may function in air and uses a high-speed water jet. Impulse turbines are typically less expensive than reaction turbines since they do not require specialized pressure casing or precisely engineered clearance. Water turbines are categorised according to the kind of generator utilized or the availability of water resources in the installation area. A water-head turbine is the most prevalent type of system. The turbine operates by transforming the potential energy of water into kinetic energy. Head and flow are two words that will be utilized in the design of hydro turbines. The head pressure is determined by the vertical distance the water falls. Hydro turbines are classified into four types based on the direction of flow:

.

2.2.1.1 Radial flow

If the flow in the runner is radial, the turbine is radial flow. Turbines are classified into two types: inward radial flow and outward radial flow. Francis turbines may be radial flow turbines as well. (Linquip Team.,2011)

Inward radial flow: Water enters the turbine casing to the penstock, flows to the rotor to the fixed guiding vanes, and finally exits. As a result, the exit and inlet are represented by the inner and outer diameters, respectively. The flow direction of water in an inward radial flow turbine is seen in the diagram below.

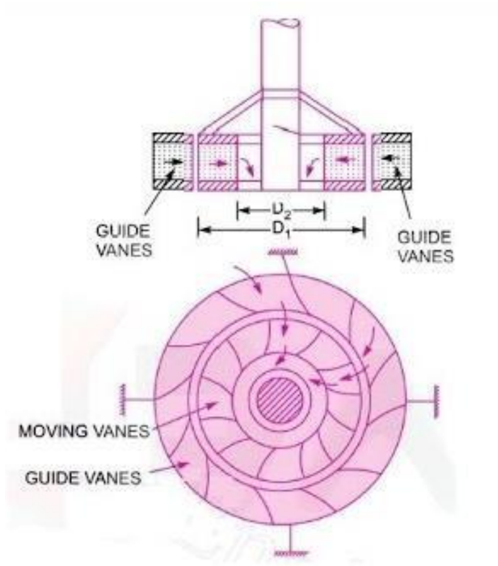

Figure 3 Flow direction in an inward radial flow turbine

Outward radial flow: Water can enter through the casing in the middle of the fixed guiding vanes. Water is directed into the rotor by spinning it around a stationary guide wheel. Water is released from the outer diameter of the runner. As a result, the intake is the runner's inner diameter, and the output is the runner's outer diameter.

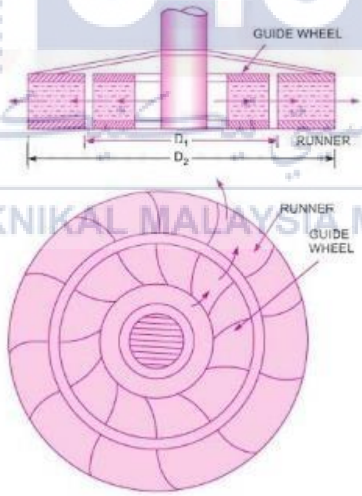

Figure 4 Flow direction in an outward radial flow turbine

2.2.1.2 Tangential or peripheral flow

Water flows tangentially to the runner in these turbines. Pelton is a turbine in this category.