DESIGN AND FABRICATION OF MINI WATER POWER GENERATOR

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE TECHNOLOGY) WITH HONOURS

2022

Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this "DESIGN AND FABRICATION MINI WATER POWER GENERATOR" is the result of my own research except as cited in the references. The "DESIGN AND FABRICATION MINI WATER POWER GENERATOR" has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : *Saartish*

Name : SAARTISH A/L GANASH

Date : 11/01/2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

Signature : Sulhan

Supervisor Name : MOHD SULHAN BIN MOKHTAR

Date : 11/01/2023

DEDICATION

I dedicate my dissertation work to my family and all my friends. Enormous gratitude to my father, Ganash a/l Murugan, who believe in me and always encourage me to be self-assured. I also dedicate this report to my entire BMMA classmate, who provided me with numerous ideas and tips throughout the semester to help me improve my report. Not forgetting to all my lecturers who had taught and gave a knowledge directly or indirectly. Last but not least, thousnads of thanks to my PSM supervisor, Encik Mohd Sulhan Bin Mokhtar who always guided me to finish these thesis.

ABSTRACT

Water power generator or hydropower plant is a mechanism that produces electrical energy using water flow. Small hydropower is a sustainable energy source that helps to minimise reliance on fossil fuels while lowering greenhouse gas emissions significantly. Remote locations, on the other hand, are far from any metropolis with a significant water power plant. As a result, power delivery to remote locations is constantly constrained. Furthermore, in order for the massive hydroelectric plant to be functional, it necessitates the construction of a dam, which destroys the ecology and environment in the area. As a result, a small-scale water power generator that is both environmentally benign and capable of supplying electricity to remote places is required. Furthermore, the vast majority of small hydropower plants are run-of-river designs that do not require substantial storage reservoirs. CO2 emissions are zero when electricity is generated by run-of-river facilities. The method used in this research are house of quality to identify user and technical requirements, morphological chart to develop several conceptual design, Pugh method to select the best design and finally failure mode and effect analysis to identify potential failures and ways to overcome the problem. In this research, the fabrication of micro hydropower plant was fabricated and the result shows that the micro hydropower plant is capable of producing 9.12 V of electricity at the water speed of 0.064 m^3/s. As a conclusion, the result has successfully fulfilled the objectives stated in chapter 1. The fabricated hydropower plant can be very useful to be applied in the rural areas.

ABSTRAK

Penjana kuasa air ataupun loji kuasa hidro adalah satu mekanisme yang menghasilkan kuasa elektrik mengunakan aliran air. Loji kuasa hidro menghasilkan sebuah kuasa yang boleh diperbaharui yang membantu mengurangkan pengunaan bahan api fosil dan mengurangkan penyebaran gas rumah hijau. Selain daripada itu, kawasan pendalaman terletak jauh dari kawasan bandar yang mempunyai logi kuasa hidro yang besar. Ini menyebabkan kuasa eletrik yang diberikan kepada kawasan pendalaman terhad. Tambahan pula, loji kuasa hidro yang besar mempunyai empangan, yang menyebabkan kerosakkan alam sekitar. Justeru, sebuah penjana kuasa air yang kecil diperlukan untuk menyalurkan bekalan elektrik kepada kawasan pendalaman dan mesra ekologi. Kaedah-kaedah yang digunapakai adalah "house of quality", untuk mengenalpasti keperluan penguna dan keperluan teknikal, "morphological chart" untuk membangunkan beberapa konsep rekabentuk, kaedah "Pugh" untuk memilih konsep rekabentuk yang paling bagus dan akhir sekali, "failure mode and effect analysis" untuk mengenalpasti potensi kegagalan dan cara untuk mengatasinya. Dalam penyelidikan ini, fabrikasi loji kuasa mikro hidro telah dibuat dan keputusan menunjukkan loji kuasa hidro mikro mampu menghasilkan 9.12 V elektrik pada kelajuan air 0.064 m^3/s. Kesimpulannya, hasilnya telah berjaya memenuhi objektif yang dinyatakan dalam bab 1. Loji janakuasa hidro yang difabrikasi boleh digunakan dan diaplikasikan di kawasan luar bandar.

ACKNOWLEDGEMENTS

First and foremost, I want to express my gratitude and praise to God the Almighty, my Creator and Sustainer, for everything I have been given since the beginning of my life. I'd like to express my gratitude to the University Teknikal Malaysia Melaka (UTEM) for providing the research environment. Thank you also for the financial support from the Malaysian Ministry of Higher Education (MOHE).

Furthermore, I would like to express my heartfelt appreciation to several people who helped me throughout my graduate studies. First and foremost, I would like to express my heartfelt gratitude to my supervisor, Encik MOHD SULHAN BIN MOKHTAR, for his enthusiasm, patience, insightful comments, helpful information, practical advice, and never-ending ideas, which have been invaluable throughout my research and writing of this report. I was able to successfully complete this report thanks to his vast knowledge, extensive experience, and professional expertise in Data Quality Control. This project would not have been possible without his help and guidance. In my studies, I could not have asked for a better supervisor.

Last but not least, a heartfelt thank you to my loving parents, Ganash A/l Murugan and Saroja A/P Velu, for their unwavering support and for being pillars of strength in all my endeavours. Finally, I'd like to express my gratitude to everyone who has helped, supported, and inspired me to pursue my studies.

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
PWPG	-	Pico Water Power Generator
W	-	Watts
kW	-	Kilo Watt
PHP	-	Pico hydropower plant
MHPP	-	Micro Hydro Power Plant
SWW	-	Sewage Waste Water
PMSG	-	Permanent Magnet Synchronous Generator
mAh	-	Milliamp Hours
GMA	-	General Morphological Analysis
HOQ	-	House of Quality
MC	-	Morphological Chart
Psi	-	Pressure
PVC	-	Polyvinyl chloride
FMEA	-	Failure Mode and Effect Analysis
OCT	-	Open Circuit Test

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background Study

Electric energy is a need, and its availability plays a significant role in everyday living. The gap between demand and supply of power is constantly widening, and it is becoming impossible to provide it, resulting in grid supply shortages in most rural regions. As a result, there is a significant need for electricity generation in rural regions. Because it is developed near valleys and tiny rivers that are remote from the national grid, the Pico Water Power Generator (PWPG), also known as pico hydropower system, is one of the new alternatives for rural electrification (Mungwe et al., 2016).

Pico water power generators have a power producing capability of 1 to 5 kW. (Haidar et al., 2012). The powerhouse at PWPG lies right on the runway stream, with minimum arrangements for channelling water towards the powerhouse, avoiding the need for a hydro governor. As a result, pico PWPG does not require a reservoir to generate electricity. The water from the runway stream is utilised to generate electricity and then returns to the runway stream via the tailrace. When compared to major hydro power plants, PWPG has a negligible impact on the surrounding ecology (Nasir, 2014).

Due to its remote location from the national grid, PWPG's power plant expects less maintenance. A strong control system is also required for the powerhouse to ensure steady power generation. A good control system will have a consistent transmission, resulting in consistent turbine and generator speeds. The unequal flow of water, in the absence of a hydro governor, will result in varied turbine speed, which will result in variable generator speed. As a result of the absence of technical advancement for maintaining constant generator speed, implementing PWPG is a difficult undertaking. As a result, a novel transmission system design is necessary to maintain constant generator speed when the input turbine speed varies (Bhargav et al., 2018).

This research aims to design and develop an affordable water power generator to generate electricity from 200W to 5kW in range. A water power generator functions as a system that generates electricity with the aid of water flow. The kinetic energy of water flow rotates the turbine which also rotates the gear to converts the kinetic energy to mechanical energy. Then the generator generates electricity from the mechanical energy of the gear. It is hoped that this water power generator could lower the cost of fabrication and reduce the environment impact.

1.2 Problem Statement

Even in nations with considerable grid electrification, tiny and remote settlements are frequently without electricity. Despite the huge demand for electrification, utilities are reluctant to connect tiny villages to the grid because of their low power usage. Other energy sources, such as oil and gas, are also prohibitively expensive.

Furthermore, a domestic energy generator is required to cut costs and create electricity. Hydro power is a potential renewable energy source that may be adopted since isolated places are located near flowing sources of water such as rivers and waterfalls. Dams, unfortunately, are exceedingly expensive to construct and have a negative impact on the environment. As a result, there is a need to develop and build a low-cost, easy-to-use portable power water generator.

The small-hydropower system is presented as a way to reduce environmental effect. Dams built primarily for hydropower plants have disastrous environmental consequences. Because of the rapid rate of evaporation and the growth of aquatic plants within the reservoir, dams disrupt aquatic life. Water flowing downstream from a dam often has a greater saline content and lower oxygen concentration than normal. As a result, a smaller scale hydroelectric system must be built, as it does not require dams and is thus more ecologically benign.

1.3 Research Objective

There are three main objectives of this research which are:

i. To design and develop an affordable portable waterpower generator.
ii. To analyze the performance of the portable waterpower generator.

1.4 Scope of Research

The focus of the research is on what needs to be focused on in order for the project to operate smoothly. The following is a list of the research that was conducted in order to create this project:

i. Pico hydropower system, with outputs ranging from 200W to 5kW, is a renewable energy source.
ii. Selection and manufacture of a suitable power generation system for use with the modified water turbine.
iii. Hydropower system installation.
iv. Transmission and electronic component.
v. demonstrating that this modified water turbine may be employed in real-world power generation (full scale).

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The Pico Water Power Generator (PWPG) is a system that generates electricity by transferring kinetic energy from running water to mechanical energy from rotating gear, and then to electrical energy through the use of a generator. There are a few different sorts of water power generators, and pico is one of the smallest.

2.2 Water Power Generator/Hydropower Generator

Reservoir-based and run-of-river hydropower plants are the two types of hydropower facilities. The run-of-river project can be advantageous since it does not require people to be rehabilitated and has a low environmental effect because it uses the constant flow of water to spin the turbines (V. K. Singh & Singal, 2016). Hydropower schemes are classified as large or small depending on the plant's capacity. This concept is defined differently in different nations. The categorization of hydropower systems is shown in Figure 2.1 based on the produced power output.

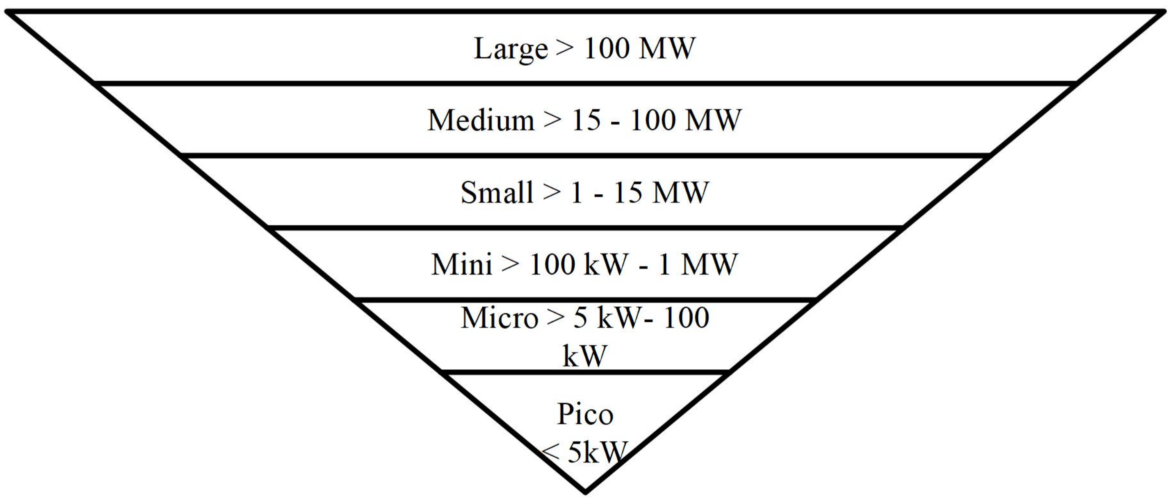

Figure 2.1 Classification of hydropower plant based on the generated power output.

Large hydropower plants have a reputation for producing massive amounts of energy, up to 100MW. With the aid of a dam, a huge hydropower plant might provide such energy. Dams are used to manage water by impounding it, raising the level of it, or redirecting it. Water from the dam/reservoir flows through the penstock, which drives the turbine and generates energy. Figure 2.2 shows the large hydropower plant system.

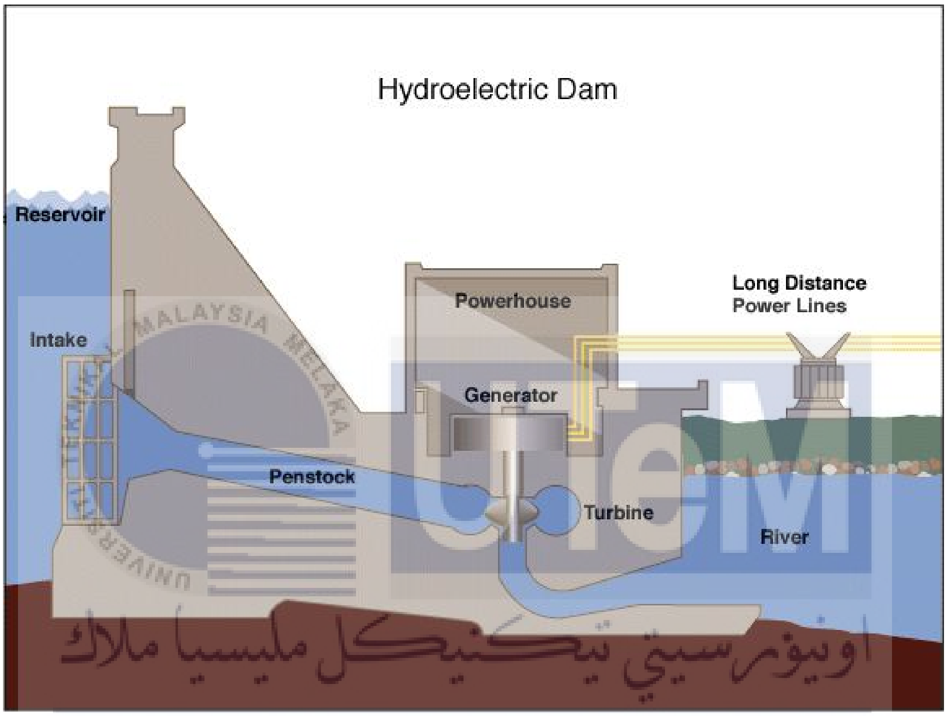

Figure 2.2 The large hydropower plant system.

The pico hydropower plant (PHP) is the smallest hydropower plant that may generate up to 5 kW of electrical output. PHP programmes have gotten a lot of attention as the finest option for generating power in distant and rural locations (Kadier et al., 2018). PHP units may be readily converted to the environment without causing any problems, such as big water storage and population re-establishment. PHP is typically installed in a hilly location or along a river that is suited for rural communities, obviating the need for reservoirs or dams. The PHP system is depicted in Figure 2.3.

Figure 2.3 The example of PHP in rural areas.

Furthermore, hydropower plants are considered an environmentally beneficial renewable energy source since they may be built and designed to minimise interference with river and canal flow (Singh & Singal, 2017). Although pico hydropower technology is not new, its widespread application to small waterfalls and other viable locations. MHPP utilising sewage waste water (SWW) does not necessitate the construction of a huge dam, nor does it result in land flooding. To create power, only waste water from various sections of the city is collected, resulting in little environmental effect.

2.3 Gear Transmission

A gear is a mechanical power transmission system that transmits mechanical power from one place to another. It's a machine-mounted wheel that allows various sections to move at different speeds or in different directions. Gear is used to transform kinetic energy into mechanical power in a water power generator (Pan et al., 2021). Direct transmission and indirect transmission are the two types of gear.

2.3.1 Direct Transmission

The turbine shaft is directly connected to the generator shaft in direct transmission, resulting in extremely high efficiency. However, both the turbine and the generator must be developed to meet the requirements, which is not cost-effective. As a result, it is unsuitable for PHP.

2.3.2 Indirect Transmission

The indirect transmission method is used to match the turbine and generator speeds. Because the turbine speed in PHP is between 100 and 500 rpm, and the normal generator rotates at a considerably greater rate per minute, a speed multiplier is employed. According to the literature, PHPP can use a variety of indirect transmission systems such as chain, belt, and gear drive. Because chain and belt drives have limited efficiency and load sharing capacity, they are only employed in applications with low transmission ratios for power generators under 3 kW.

2.3.3 Types of Gear

In hydro systems that allow for higher speed, links between the generator and the turbine include belts, chains, and gears. They are used with standardised turbines in the small hydropower range when gearing is required but other drives can't handle the power, and their cost becomes a minor portion of the plant's overall cost. Every sort has its own set of advantages and disadvantages:

i. Spur gears are mostly utilised in low-power applications and are distinguished by their narrow transmission ratio, which is enforced by their overall size. Figure 2.4 shows the spur gear.