



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF PICO HYDRO GENERATION SYSTEM
WITH LOW COST WATERWHEEL TYPE TURBINE**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

By

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APPROVAL

This report submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirement for the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours. The member of the supervisory is as follow:

.....

(Ir. Dr Mohd Farriz Bin Basar)

ABSTRAK

Malaysia kini menuju penggunaan tenaga boleh diperbaharui untuk kegunaan harian. Kebanyakan penduduk sekarang menggunakan salah satu tenaga boleh diperbaharui, tenaga solar untuk menghidupkan peralatan elektrik. Pico hydro adalah tenaga boleh diperbaharui yang tidak banyak digunakan di Malaysia. Dalam projek ini, matlamatnya adalah untuk membangunkan turbin jenis airwheel kos rendah untuk sistem hidro pico mudah. Sistem hidro pico ini akan menggunakan jenis turbin roda air menggunakan bahan kitar semula. Projek ini akan menggunakan turbin air kincir air sebagai penggerak utama dan mengalir air untuk menggerakkan penggerak utama atau turbin air kincir air seperti sungai atau air terjun yang menjana elektrik. Oleh itu, projek ini menggunakan penjanaan elektrik rendah dan berskala kecil tetapi dapat menampung penggunaan peralatan elektrik, ia akan menghasilkan kuasa sekurang-kurangnya 30 watt. Projek hydro Pico yang telah dibangunkan dipercayai membantu sesiapa yang memerlukan dan pada masa yang sama membantu untuk mendapatkan banyak pengetahuan tentang tenaga hidro untuk masa depan.

ABSTRACT

Malaysia is now heading for uses of renewable energy for daily use. Most residents now use one of renewable energy, solar energy to turn on electrical appliances. Pico hydro is a renewable energy that is not widely used in Malaysia. In this project, the objective is to develop a low-cost waterwheel type turbine for simple pico hydro system. This pico hydro system will use water wheel turbine type using recycle materials. This project will use the waterwheel water turbine as the prime mover and flowing of water to move the prime mover or waterwheel water turbine like a river or a waterfall in turn generate electricity. Hence, this project uses a low cost and small-scale electricity generation but it can accommodate the use of electrical appliances, it will generate power at least 30 watts. Pico hydro project that has been developed is believed to help anyone in need and at the same time help to get as much knowledge about the hydro energy for the future.

DEDICATION

To my beloved parents Mr. Wan Mohamed Daid bin Wan Muda and Mrs. Rohani binti Mohd Nor for their support and pray. A full appreciation to my supervisor Ir Dr Mohd Farriz Bin Basar for advising and helping through this project.

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TABLE OF CONTENT

Abstrak	i
Abstract	ii
Dedication	iii
Acknowledgement	iv
Table of Content	v
List of Table	ix
List of Figure	x
List of Abbreviations, Symbol and Nomenclatures	xii
CHAPTER 1: INTRODUCTION	1
1.0 Introduction	1
1.1 Pico Hydro	3
1.2 Water Turbine	4
1.3 Research Gap	6
1.4 Objective	7
1.5 Scope of Project	7
CHAPTER 2: LITERATURE REVIEW	9
2.0 Introduction	9
2.1 History of Hydroelectric Power	9
2.1.1 Small-Hydro in Malaysia	10

2.1.2	Introduction of Pico Hydro	11
2.2	Pico Hydro Component System	13
2.2.1	Penstock	13
2.2.2	Turbine	14
2.2.3	Generator	14
2.2.4	Battery	15
2.2.5	Inverter	15
2.2.6	Distribution system	16
2.2.7	Electrical load	16
2.3	Planning for Pico Hydro System	16
2.3.1	Estimation of Power	17
2.3.2	Measurement of Head	18
2.3.3	Flow Rate of Water	18
2.3.4	Selection of generator	18
2.3.5	Turbine Type Selection	20
2.3.6	Inverter	22
2.4	Theoretical	23
2.5	Previous studies	23
2.5.1	Studies 1: Design and development of pico hydro Power system by irrigation water	23
2.5.2	Studies 2: Pico hydro power generation: Renewable Energy technology for rural electrification	25
2.5.3	Point of departures	28

CHAPTER 3: METHODOLOGY	29
3.0 Introduction	29
3.1 Flow Chart	30
3.2 K-Chart	31
3.3 Overview performance analysis technique	32
3.3.1 Frame work	33
3.4 Instrumentation	34
3.4.1 Golden motor	34
3.4.2 Tachometer	35
3.4.3 Water meter	35
3.5 Design and development	36
3.5.1 Design	36
3.5.2 Development	38
3.6 Testing procedure	40
3.7 Testing table	41
CHAPTER 4: RESULTS AND DISCUSSION	42
4.0 Introduction	42
4.1 Expected results	42
4.2 Laboratory testing result	43
4.2.1 Load 10 W	43
4.2.2 Load 20 W	44
4.3 Field testing results	45
4.3.1 Performance of Pico Hydro system using 4 blades	45

4.3.1.1	Calculation performance using 4 blades	48
4.3.2	Performance of Pico Hydro system using 8 blades	50
4.3.2.1	Calculation performance using 8 blades	52
4.4	Discussion	55
CHAPTER 5: CONCLUSION		56
5.0	Introduction	56
5.1	Summary of Research	56
5.2	Achievement of Research Objective	57
5.3	Significance of Research	57
5.4	Future Work	57
REFERENCES		xiii
APPENDICES		

LIST OF TABLES

1.1	Turbine classification	6
2.1	Hydroelectric development in Malaysia	11
2.2	Type of turbine	21
2.3	Classification of hydro plant based on capacity	27
2.4	Classification of hydro plant based on head	27
3.1	Variable parameters	40
3.2	Table1= Mechanical Parameter	41
3.3	Table 2= Electrical Parameter	41
3.4	Table 3= Power and Efficiency	41
4.1	Data using load 10 W	43
4.2	Data using load 20 W	44
4.3	Potential energy using 4 blades	45
4.4	Power mechanical 4 blades	46
4.5	Power electrical 4 blades	46
4.6	Table efficiency 4 blades	46
4.7	Potential energy using 8 blades	50
4.8	Power mechanical 8 blades	50
4.9	Power electrical 8 blades	50
4.10	Table efficiency 8 blades	51

LIST OF FIGURES

1.1	Undershot Water Wheel Design	2
1.2	Overshot Water Wheel Design	2
1.3	Water head and flow rate	4
1.4	Turbine application range chart	7
2.1	Pico hydro power system	14
2.2	Charging and discharging	15
2.3	Pico hydro system research flow	17
2.4	Turbine selection chart based on head and flow rate	22
2.5	ACP Composite sheet	24
2.6	Complete designed waterwheel type model	24
2.7	Turbine outlet using straight shape	25
2.8	Turbine outlet using T-shape reducers	25
2.9	Pico hydro power system application at rural area	26
3.1	The flow chart of the project	30
3.2	K-Chart	31
3.3	Overview performance analysis technique	32
3.4	Frame work of experiment phase and analysis properties	33
3.5	Golden motor 250 W, model 902-24V-24R-902	34
3.6	Digital tachometer	35
3.7	Water meter	35
3.8	Logo of SolidWorks software	36
3.9	Modelling in SolidWorks software	37

3.10	Model of waterwheel turbine	37
3.11	PVC pipe with their fittings and recycled bottles	38
3.12	The hardware of waterwheel	38
3.13	The separated hardware of waterwheel	39
3.14	Field testing	39
4.1	Expected result	42
4.2	Load 10 W	44
4.3	Load 20 W	45
4.4	Voltage between current with fixed head	47
4.5	Power input between power electrical with fixed head	47
4.6	Voltage between current with fixed head	51
4.7	Power input between power electrical with fixed head	52
4.8	Graph analysis blade between 4 blades and 8 blades	55

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

P	-	Power (Watt)
Q	-	flow rate (L/s)
H	-	head (m)
g	-	gravitational (9.81 N/Kg)
η	-	efficiency
AC	-	alternate current
DC	-	direct current
T	-	torque
ACP	-	Aluminium cover plate
R	-	radius
ω	-	speed (rad/s)
N	-	force

CHAPTER 1

INTRODUCTION

1.0 Introduction

Renewable energy is energy generated by the energy of the environment such as water, wind, sun, rain and geothermal. This energy can reduce pollution that would occur when using non-renewable energy. It can also be a solution to global warming worldwide.

Water is one of the medium to drive the next prime mover generate electricity. This is because water is flexible, it can flow at a rate according to the water flow. The water is clean, cheap and does not affect the environment. Hydro power generated by water. It can be classified with a capacity such as pico, micro, mini and small. Hydro power generation is dominated 83% of renewable energy sources. Pico hydro power is one that can generate maximum output of five kilowatts.(Basar & Othman, 2013)

Hydro energy is a technology that converts water flowing into mechanical energy or electricity. The first equipment is introduced to convert energy into electricity is a water mill because water turbines are only available in the 19th century. Watermill or waterwheel are constructed of wood because of the difference between potential and kinetic energy before. With the growth of hydraulic engineering and with the innovative material and the form and output power, precision upgraded waterwheel.

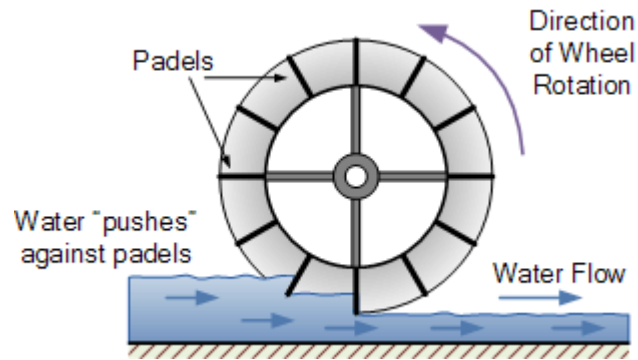


Figure 1.1: Undershot Water Wheel Design

There are two types of waterwheel design is "undershot waterwheel" and "overshoot waterwheel in Figure 1.1 and 1.2. (Alternative Energy Tutorials 2010), (source:<http://www.alternative-energy-tutorials.com/hydro-energy/waterwheel-design.html>)

The undershot waterwheel or recognized as "stream wheel" type water wheel is commonly used and it is a simple water wheel, the cheapest and easiest way to build it. In this type of wheel design, the wheels are only placed directly into the flow that flows quickly and is supported from the top. The movement of water below produces oppressive action against a submerged reel under the wheel which allows it to rotate in one direction only as a water flow direction.

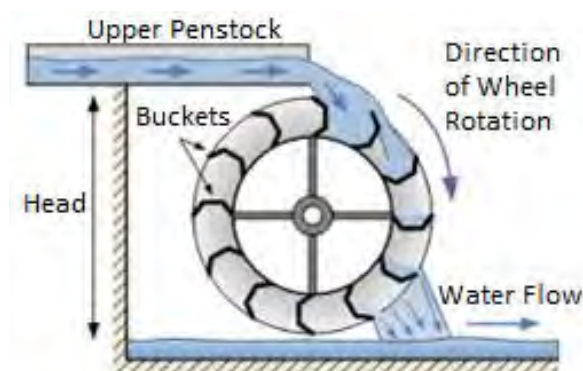


Figure 1.2: Overshot-Waterwheel Design

The Overshoot Water Wheel Design is the most well-known sort of water wheel outline. It is more entangled in its development and plan than undershoot water wheel. It utilizes pails or small compartment to both hold the water.

This bucket or basin contains loads with water flow at the highest point of the wheel. The impact of the water in the full basin makes the wheels turn the hub in the centre of the wheel.

1.1 Pico hydro

Pico hydro advantage as far as cost and effortlessness compared with bigger hydropower (micro or mini hydro). Pico hydropower is the main type of little energy production which capable to work continuously without battery storage. To get real power supply for important need very suitable for small community up to 30 houses hold example, lighting, tv's, media transmission, refrigerator, and so on. Remote community, private houses (villa), rural facility, media transmission station, Campsite without grid supply is an important focus in this innovation.(Basar & Othman, 2013)

The Pico hydropower frame depends on the basic idea of hydropower. The moving water will make the prime mover that will drive the generator and the power will be generated. There are fundamental two principle parameters in pico hydro, head and flow in figure 1.3 below.

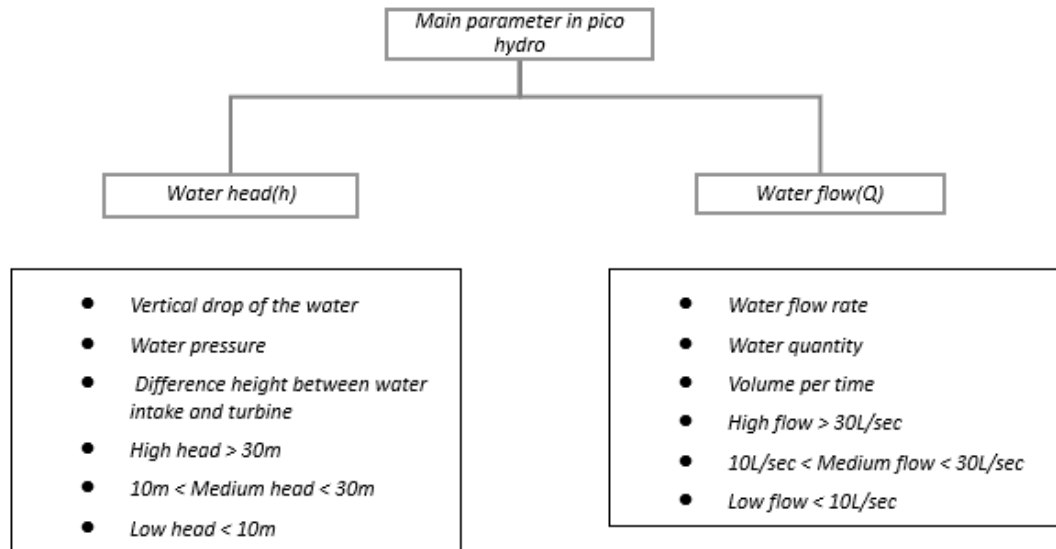


Figure 1.3: Water head and flow rate(Basar & Othman, 2013)

The water head refers to the pressure in which it can determine the vertical water drop. Water heads are formed when there is a difference in height between water intake and turbine. Meanwhile, the flow of water refers to the amount of water per unit of time, or otherwise summarizes the amount of water that passes the turbine at any time and it can be delivered as the amount each time.

Pico Power Plant is small, utilizes prepared available parts and which is comparably low-priced. Transport, installations and maintenances cost are low and the advances utilized straightforward.

1.2 Water Turbine

The water turbine is a rotating machine that converts the potential energy and kinetic energy of water into mechanical work. The water turbine was created in the nineteenth century and is commonly used for mechanical power before the electric frame. Currently, it is largely used for the age of electricity. Water turbines are usually found in dams to generate electricity from the kinetic energy of the water.

The water flow is aligned to the turbine runner, generating energy on the

blades. As the spinner rotates, it acts rotating the generator. In this way, the energy is transferred from the water stream to the turbine.

The water turbine is the most important thing any hydropower plant. It contains of several steel or plastic blade mounted on rotating shaft in the middle or platter. Water flowing through a closed case turbine, the turbine blade will produce torque attacks and create a rotating shaft due to the velocity and pressure of water. Such as turbine blades are pushed by the water, which reduces the velocity and pressure (energy loss) as it rotates a turbine shaft.

There are many differences in the design of water turbines used today. Each type has its own advantages and disadvantages depending on their operational needs. Selection of a water turbine design is very important for any scale hydropower systems successful. The effectiveness of the mechanical power output of the turbine shaft rotates depending on the combination of the height of head, the amount of flow and pressure of water entering the turbine blades, which can only be achieved by selecting the right type of water turbine and fit the requirements for a given installation. Then, based on the change in pressure as it waters used by the turbine wheel, a modern water turbine design can be categorized as shown in Table 1.1:

1. An impulse turbine: Driven by high velocity flow or double water flow.
2. A reaction turbine: The turbine blades of reaction are fully immersed in water and surrounded in a pressure sheath.
3. A gravity turbine: It is driven only by the weight of the water entering the upper part of the turbine and drops to the bottom, where it can be released.

Table 1.1: Classification of turbine

Turbine Head Type of Classification	Impulse	Reaction	Gravity
High (>50m)	<ul style="list-style-type: none"> • Pelton • Turgo 		
Medium (10-50m)	<ul style="list-style-type: none"> • Crossflow • Turgo • Multi-jet Pelton 	<ul style="list-style-type: none"> • Francis (spiral case) 	
Low (<10m)	<ul style="list-style-type: none"> • Crossflow • Undershoot waterwheel 	<ul style="list-style-type: none"> • Propeller • Kaplan • Francis (Open-flume) 	<ul style="list-style-type: none"> • Overshoot Waterwheel • Archimedes Screw

1.3 Research Gap

The project is directed to indicate the potential energy potential of the waterways, waterfalls, waterways can be used as an alternative option for sustainable energy sources. Flowing of water have the possible of dynamic energy to convert small turbines to power generation. This power can also be produced without interrupting normal activities, for example, bathing, clothing, and being managed without additional charge for use of water as it is used from environmental sources. From this project development, consumers can spare some cash on their power utilization charge.

Most of the projects or research focused on high and medium head of turbine such as Pelton, Turgo, Francis, Propeller and Crossflow that we can see in the chart turbine application range which is Figure 1.4 below. It is costly to build and it is also difficult in terms of design and requirement. Waterwheel type hydro power is very simple in design and inexpensive to install. The objective of the project wanted to make the installation in villages in need. therefore, to reduce the cost of the project using recycled goods.

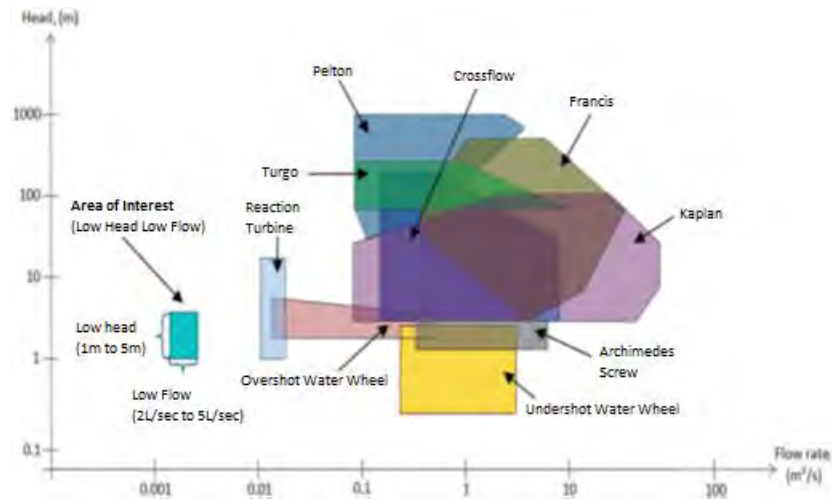


Figure 1.4: Turbine application range chart(Sangal, Garg, & Kumar, 2013)

1.4 Objective

The project objective:

1. To design and fabricate a low-cost waterwheel type turbine for simple pico hydro system.
2. To investigate the performance of the system under small stream nature resource
3. To evaluate and compare the theoretical with experimental performance of pico hydro system.

1.5 Scope of project

The scope of this project is about the design and develop of pico hydro generation system with low cost waterwheel type turbine. This task is to use water turbine that convert the water energy into electrical energy. This project is focusing on developing a waterwheel water turbine as renewable energy source to generate electricity. The research of the proposal energy conservation system for water turbine as backup source and kinetic energy of flowing water to converted electrical energy have been presented in this project.

The material chosen for this project is a recycle goods such as water bottle as a blade of water turbine. It because this is a low-cost waterwheel turbine. Low torque DC electrical generator which easily obtain from local stores. DC generator function as convert energy from mechanical energy to electrical energy. The process of convert energy need waterwheel blade to rotate the shaft of DC generator.

The type was used for this project is under-shot waterwheel turbine and the main parameter for pico hydro is head and flow. The area interest is on low head and low flow. The low head is less than 5 meter and low flow is less than 10 litre/s. The electrical parameter involved in this project is voltage, current and power. The rotational speed and mechanical power is mechanical parameter in this project. At last this project will investigate the overall efficiency.