Faculty of Mechanical and Manufacturing Engineering Technology

DESIGN AND FABRICATE AN EFFICIENT ROTATING SYSTEM FOR MINI HYDRO POWER TURBINE

Chieng Jun Yuan

Bachelor of Mechanical Engineering Technology (Maintenance) with Honours.

2019

DESIGN AND FABRICATE AN EFFICIENT ROTATING SYSTEM FOR MINI HYDRO POWER TURBINE

CHIENG JUN YUAN

A report submitted in fulfilment of the requirement for the Bachelor of Manufacturing Engineering Technology (Maintenance) with Honours.

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2019

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: Design and fabricate an efficient rotating system for mini hydro power turbine

SESI PENGAJIAN: 2018/2019 Semester 2

Saya **CHIENG JUN YUAN** mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	TIDAK TERHAD	

Disahkan oleh:

(_____)

(_____)

Alamat Tetap:

32, Jalan NB2 3/1,

Taman Nusa Bestari 2,

81300 Skudai, Johor

Tarikh: 24/5/2019

Cop Rasmi:

Tarikh:

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Design and fabricate an efficient rotating system for mini hydro power turbine” is the results of my own research except as cited in references.

Signature : ……

Author’s Name : ……

Date : ……

APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Maintenance) with Honours. The member of the supervisory is as follow:

Signature : …….

Supervisor's Name : …….

Date : …….

DEDICATION

To my beloved parents, I would like to thanks to them who gave me caring and plenty of love around me. They give their fully support to me throughout the project. When I face the difficulties, they give me advices and I have the perseverance in the face of obstacles.

ABSTRACT

Nowadays, hydropower plays a very vital role in development of human civilization, the power demand increase with the improvement of living standards of the human. The hydropower is known as the most environnmental friendly energy source among the others. The objective of this project is to design and fabricate an efficient rotating system for mini hydro power turbine, there are a lot of problem of hydro turbine found in rugged area, such as low efficiency power output or low availability. Hence, a reliable, convenience and high efficiency mini hydro power turbine is designed and fabricated in this project. The project scopes is select the best material to fabricate an high effiency rotating system for mini hydro power turbine based on their characteristics. Different types of transmission is compared to gather more information on the efficiency of the rotating system. Furthermore, the virtual prototype of the mini hydro power turbine is fabricated by computer-aided design. The spur gear is designed bu using SolidWorks software. The material that used in fabrication of spur gear is Polyamide 12, it can resist high presssure and corrosion. The overall efficiency of mini hydro power turbine is calculated and the factor that affect the efficiency is discussed as well.

ABSTRAK

Pada masa kini, kuasa hidro memainkan peranan yang sangat penting dalam pembangunan tamadun manusia disebabkan peningkatan permintaan tenaga dengan peningkatan taraf hidup manusia. Kuasa hidro ini dikenali sebagai sumber tenaga yang paling mesra alam berbanding tenaga lain. Objektif projek ini ialah untuk merekabentuk dan membina sistem berputar yang lebih efisien untuk turbin kuasa hidro mini. Terdapat banyak masalah turbin hidro yang terdapat di kawasan yang sedang membangun, masalah tersebut termasuklah efisien yang rendah. Oleh itu, efisien turbin mini hidro yang tinggi efisien akan direka dan dibina dalam projek ini. Skop projek merupakan memilih bahan terbaik untuk menghasilkan sistem berputar yang efisien untuk turbin kuasa hidro mini berdasarkan ciri-ciri tersebut. Jenis transmisi yang berbeza dibandingkan untuk mengumpul lebih banyak maklumat mengenai sistem berputar yang lebih efisien. Selain itu, prototaip maya turbin kuasa hidro mini direkabentuk menggunakan rekabentuk terbantu komputer. Gear spur akan direkabentuk menggunakan perisian SolidWorks. Bahan yang digunakan dalam fabrikasi gear memacu adalah Polyamide 12, ia dapat menahan tekanan tinggi dan kakisan. Kecekapan keseluruhan turbin kuasa hidro mini dikira dan faktor yang mempengaruhi kecekapan dibincangkan juga.

ACKNOWLEDGEMENTS

I would like to thank my supervisor, TS. Azrin bin Ahmad who always offer guidance for the project. I am so grateful to become student under my supervisor due to his patient and enthusiastic. Last but not least, I would like to thanks to all my friends who lend me their helping hands throughout the project, I appreciate their effort and the time to help me out in this project.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS, SYMBOLS AND NOMENCLATURE

A_T	-	Total cross-sectional area of the magnet
A	-	Ampere
AC	-	Alternating Current
B	-	Magnetic flux density
c/s	-	Chord-to-pitch cascade ratio
D	-	Diameter
DH	-	Hydraulic diameter
E	-	Output voltage
η	-	Overall efficiency
F	-	Frequency of generation
FEM	-	Finite Elements
FMECA	-	Failure Modes, Effects and Critical Analysis
G	-	Gravitational force
H	-	Net Head
I	-	Current
m	-	Meter
N	-	Total sum of the coil turns
N_s	-	Rotational speed of the rotor
P	-	Power generated in the turbine shaft
P_n	-	Number of poles
PHPP	-	Pico Hydropower Plant
Q	-	Flow rate of water
QFD	-	Quality Function Deployment
RMS	-	Root mean square
RPM	-	Revolution Per Minute
s	-	Second
SI	-	International System of Units
T	-	Instantaneous time

V	-	Voltage
W	-	Angular velocity
ϵ	-	Strain
τ	-	Torque
>	-	More than

CHAPTER 1

INTRODUCTION

1.1 Introduction

Power demand increases with the improvement of living standards as well as the economy. Following this trend, the capacity of power supply has been increased continuously. The worldwide focus on renewable electricity production triggers the increasing demand on hydro power. It makes additional exploitation of river flow more valuable than it was decades ago. This guides plant owners and investors to feasibility studies and projects of capacity increase in existing power plants, for example, by upgrading of existing units, addition of units in operating power plants and leading to complete new projects and plants.

The mini hydro power turbine is a simple machine that converts water pressure energy into mechanical energy. The mini hydro power turbine is the system that placed in a river with sufficient water running through, if the proper volume or pressure feed the mini hydro power turbine that connected to the generator, it will eventually supply the power to the residence. The mini hydro power turbine is very flexible as well as can be installed in number of various environments.

1.2 Background

In 1827, French engineer Benoit Fourneyron developed a Fourneyron reaction turbine, which could produce about 6 horsepower. British–American designer James Francis built the first modern water turbine' the Francis turbine' in 1849, which remains today the world's most popular water turbine. American innovator Lester Allan Pelton built the Pelton wheel, a water turbine for motivation that he licensed in 1880. The Kaplan turbine, a propeller-type turbine with flexible sharp edges, was developed by Austrian professor Viktor Kaplan in 1913. Innovation of mini hydro power turbine technology bring a lot of benefits to some isolated and poor backward area; the mini hydro power turbine satisfies the resident's daily electrical power needs by producing AC electricity. The electric appliances such as radio, lightbulb and rice cooker can by powered by the AC electricity.

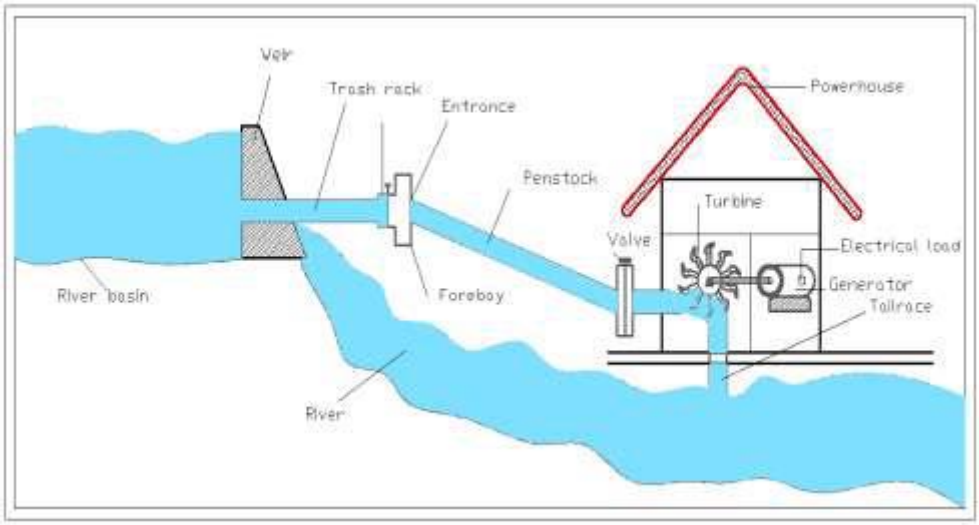

Figure 1.1: Example of Mini hydro power system

(Xhevat Berisha, 2017)

1.3 Problem Statement

Many villages have no electricity supply in some isolated rural areas such as northern Laos. The lack of electricity supply has a negative impact on the daily activities of the human being. According to the research, there are 1.2 billion people with no electricity supply live in South Asia (*World Bank.*, 2013). Hence, the development of mini hydro power production is the good strategic to solve the electricity problem in rugged area which are unfeasible to consider enlarge the national electricity network. The mini hydro power turbine such as river horizontal pico hydro turbines which placed in the watercourse provide at least 0.3 to 0.6kVA to villagers. Thus, the issue of developing an efficiently mini hydro power turbine has been brought to public attention. In Malaysia, although the country had successfully used large and small-scale hydropower in order to generate electricity, unfortunately in some rural urea in Sarawak or Sabah, there are no effort was made to utilize hydropower in the mini or pico hydropower systems.

Table 1.1: Electricity supply in urban and rural areas in Malaysia

State	Urban	Rural	State	Urban	Rural
Johor	99.53	98.22	**Perlis**	99.63	99.17
Kedah	99.84	98.58	**P.Pinang**	99.84	99.16
Kelantan	99.52	97.5	**Sabah**	89.65	67.05
Melaka	99.9	99.28	**Sarawak**	93.96	66.91
N.Sembilan	99.61	98.6	**Selangor**	99.39	97.92
Pahang	99.63	93.96	**Terengganu**	99.65	98.24
Perak	99.64	96.11	**W.P. Kuala Lumpur**	99.76	-

(Borhanazad, Mekhilef, Saidur, & Boroumandjazi, 2013)

1.4 Objectives

The purpose of the project is to design and fabricate an efficient rotating system for mini hydro power turbine. Compare the efficiency of power turbine with different rotating system.

i. To fabricate an efficient hydro power turbine that produce stable power output
ii. To solve the inefficient rotating system of mini hydro power turbine
iii. To design the rotating system for mini hydro power turbine and maximize the efficiency by using CATIA software

1.5 Project Scope

To make sure the objectives are accomplished, there are a few vital elements must be considered. The objectives include:

i. The 3D modelling of high efficiency rotating system for mini hydro power turbine will be designed and fabricated by SolidWorks.
ii. The analysis of the rotating system for mini hydro power turbine will be analyse by SolidWorks.
iii. Selecting the best material to fabricate the high efficiency rotating system for mini hydro power turbine based on their characteristics.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presents the review of literature based on previous literatures of research. This chapter presents the design consideration for hydro power turbine including the definition, types of turbines application as well as its relevant mathematical expressions of operating parameters for hydro power turbine.

2.2 Hydropower

In the age of rapid development of information technology, energy plays a very crucial role in civilization development. Hydropower is the vital source of renewable electricity supply as well as the unleashed potential in many fields is still considerable. Hydropower exploration and exploitation can bring many benefits to the human being. (Dorji & Ghomashchi, 2014) The Kyoto Protocol, one of the environmental laws, puts more pressure on all governments to produce energy from the sustainable sources. In fact, energy demand is increasing significantly over the years in industrial or agricultural activities to satisfy human needs. Water is a source of clean, cost-effective, renewable energy. Hydropower from rivers, lakes and oceans is considered a resource for water energy (Yah, Oumer, & Idris, 2017). Hydropower can be defined as converting energy into electricity from water movement. The water cycle, also known as the hydrological cycle, this conversion can be considered as a renewable energy source, since the cycle involving repeated water circulation in the Earth's atmosphere.

The hydroelectric turbine is a rotational machine that converts water's potential energy and kinetic energy into mechanical work. In the nineteenth century, water turbines were created and generally used before electrical grids for mechanical power. They are currently widely used to generate electricity. By building the dams, hydro power turbine generates mostly electrical power from the kinetic energy of water flow.

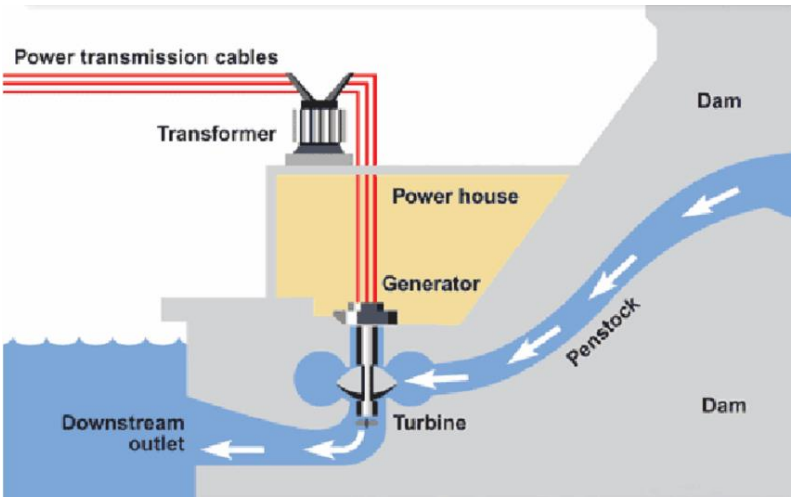

Figure 2.1: Hydro Power Plant

(Bodger, 2014)