UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN AND SIMULATION OF IN-PIPE GENERATOR

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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I hereby, declared this report entitled “DESIGN AND SIMULATION OF IN-PIPE GENERATOR” is the results of my own research except as cited in references.

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APPROVAL

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

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(MR SYAHRUL HISHAM BIN MOHAMAD@ABD. RAHMAN)

ABSTRACT

Hydroelectric power is a popular method used to generate electricity. The project uses the same concept of "Run-of-river". "Run-of-river" requires a large area because it has a generator outside the pipe, but the generator will be placed in the pipe and it is designed in a small size. Water will flow through a pipe in it and there is a generator will convert's mechanical energy into electrical energy. The objective of this project is to design in-pipe generator using Ansys Maxwell and to run the simulation performance with the aid of FEM software. The generator is designed using the software ANSYS Maxwell. In order to achieve these purposes, the given parameter has to translate into FEM and the obtained result will be analysed. The magnetic flux energized when the high voltage. In addition, the advantages of using an in-pipe generator is a small cost compared to existing generation. At the end of this project, the objective is ensuring to be achieved.

ABSTRAK

Kuasa hidroelektrik ialah salah satu kaedah yang popular untuk menjana elektrik. Projek ini menggunakan konsep “Run of River”. “Run of river” memerlukan satu kawasan yang luas kerana ia mempunyai penjana yang berada di luar bahagian paip, tetapi penjana ini ditempatkan didalam paip dan direka bentuk dengan saiz yang kecil. Air akan mengalir mengalir didalam saluran paip dan penjana didalam akan menukarkan tenaga mekanikal kepada tenaga elektrik. Objektif projek ini adalah untuk mereka penjana di dalam paip menggunakan Ansys maxwell dan menjalankan simulasi dengan bantuan perisian FEM. Penjana direka bentuk menggunakan perisian ANSYS Maxwell. Bagi mencapai tujuan ini, parameter diterjemah ke dalam FEM dan keputusan yang diperolehi akan dianalisis. Flux magnet akan wujud apabila voltan aruhan tinggi. Tambahan pula, kebaikan menggunakan penjana ini mengunakan kos yang rendah berbanding penjana yang sedia ada. Akhirnya, projek ini akan memastikan semua objektif di capai.

DEDICATIONS

To my beloved parents, all my beloved friends and also all my lecturers who had teach me.

ACKNOWLEDGMENTS

First of all, I would like to thank ALLAH SWT because for HIS blessing, finally I able to complete my final year report project. I would like to convey my greatest appreciation to my project supervisor, Mr Zulkifli Bin Ibrahim and Mr Syahrul Hisham Bin Mohamad@Abd Rahman on their guidance and discussion to provide information concerning my process to complete this project. The every view and given suggestion has its own value to me and I take it as a reference for my project foundation and also continuously supporting me in every aspect while writing of this report. Thousands of thank for your support sir. Sincere thanks to all my friends who helped me in terms of services, moral support and view. Last but not least undying thanks to my beloved parents who always pray for my success.

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FEM	=	Finite Element Method
PMSM	=	Permanent Magnet Synchronous Motor
FEA	=	Finite Element Analysis

CHAPTER 1
INTRODUCTION

1.1 Introduction

The renewable energy is one of technology which is use by the world to generate energy whereby the energy comes from naturally refillable which is solar energy, hydropower, wind turbine, steam energy and others. Besides that, biomass also classified as renewable energy such as pallet, oil gas and coal. However, the biomass resources are limited. The steam energy is the generated electric using the hot water. The hot water will be collected in a pool and steam produced by the hot water going through the turbine and generator will generate electricity. Hydroelectric is electricity generated by hydropower, the production through use of the gravitational force of falling or flowing water. Water flowing into the turbine and drive the generator and convert the motion of blade rotates to electrical energy.

This project is use the same principle with the run-of-river but on a smaller scale. In run-of-river principle, the power comes from the potential energy of water driving a water turbine and generator. The energy extracted from the water depends on the volume and on the difference in height between the source and the water's outflow. The difference between run-of-river and traditional hydro power generation is that a run-of-river does not require a large reservoir and it tend to be on smaller scale. It's also need to build on a river with consistent and steady flow. The main structure of a run-of-river is simply to direct water flow from a weir towards the penstock (delivery pipe) which feeds the water used to spin the turbines located in the power station which converts the energy from the water to generate electricity. After this process, the water is redirected back to the natural flow of the river.

1.2 Problem Statement

The problem statements are:

i. Now day's hydroelectric power is not a new technology, this study is use the same principle of run-of-river but on a smaller scale.
ii. This study supplies the water from the river to generate the power energy.

1.3 Objectives

The objectives are:

i. To design an In-Pipe-generator using Anysy Maxwell.
ii. To conduct a performance simulation by the aid of FEM software.

1.4 Work Scope

The work scopes are:

i. This project will focus on simulation.
ii. The ANSYS Maxwell software is used to design the generator.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In the developing world and the growing demand for clean living environment, renewable energy has generated high interest. Hydropower is the source of renewable energy. According to the pie chart show in figure 2.1, hydropower is the most popular type to generate electricity. 65% hydroelectric, 16% for wind, 9% wood, and biomass waste 4%. While for geothermal is 4% and solar 2%. Electric energy generation is a process where the energy source is converted to electrical energy. This project use run-of-river type generator concept generally known as mini-hydro technology. Basically, run of river use the generator outside from the pipe to generate the electric, but in this project is use the generator inside the pipe to generate the electric energy.

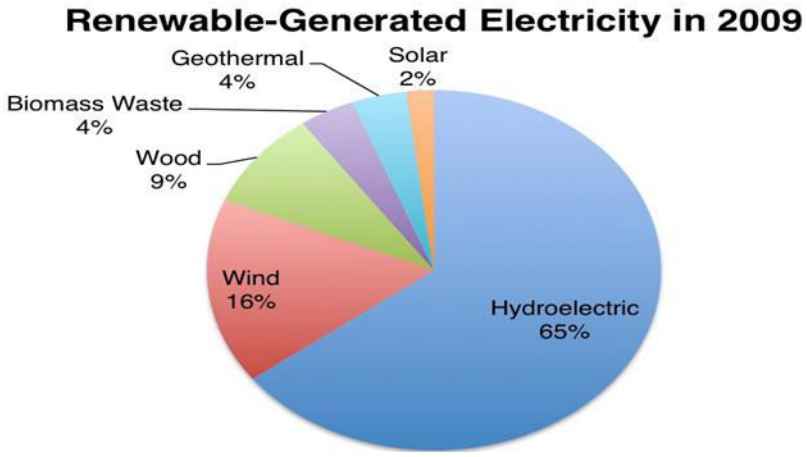

Figure 2.1: The percentage of renewable generated electricity in 2009

2.2 The potential Hydropower in Malaysia

Malaysia has a large population and a insufficient of energy. There are states with 3.8% of electricity coverage. Furthermore, Malaysia has states with rural areas such as Sabah and Sarawak. To reduce the problem of weak electricity in rural areas, renewable energy sources is the best solution. Malaysia potential use of renewable energy sources such as small hydro because this country has a lot of places that are suitable for generating electricity and it can also have benefited the population (Borhanazad et al. 2013). In Malaysia, there are 189 names of rivers and streams along the 57,300km, these rivers have potential to be used to produce hydropower for Malaysia. However, the use of hydropower can cause people to lost ground for agriculture because it requires a large area to be used as water reservoirs (Department of Energy Management and Industry Development, 2010). The impact of small hydro is much lower than a large hydro. This is because the small hydro produce nearly no greenhouse gas emissions but no type of energy development is without impacts.

2.3 Hydropower

2.3.1 Types of Hydropower

There are type of hydropower which is impoundment, diversion and pumped storage. Impoundment is most common type of hydroelectric power plant. An impoundment normally a large hydropower uses a dam to store river water in a reservoir. Figure 2.2 shows the part of impoundment.

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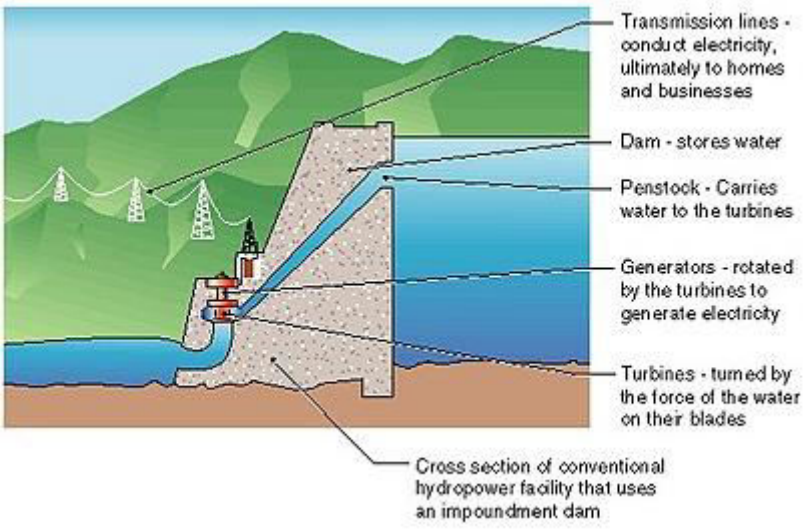

Figure 2.2: The impoundment type

Next, figure 2 shows a diversion is one type of hydropower sometimes call run of river, facility channels a portion of a river trough a canal or penstock. It doesn't need use any storage. The water supplied from the water stream that contain generator (Tunde 2005).

Figure 2.3: A diversion type

Besides, there is another type called a pumped storage hydropower as figure 2.3 shows from it serves to store electricity generated by others sources of energy for later use. Pumped storage energy will pump water from a lower reservoir to the

upper reservoir when electricity demand is low. For the period of high electricity demand, water will released back into the tank and turn a turbine and generate the electricity.

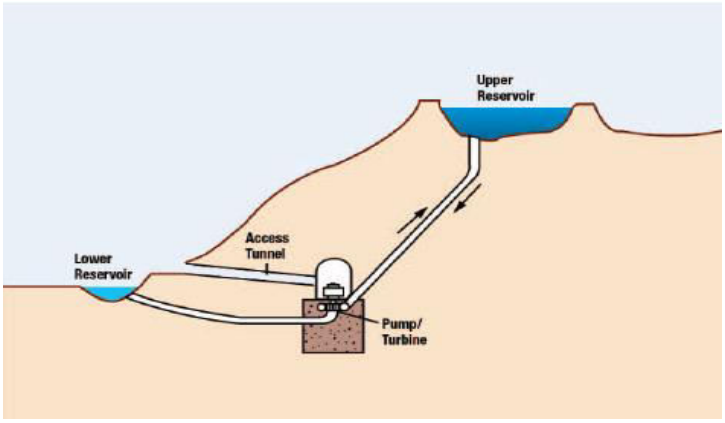

Figure 2.4: The pumped storage type

2.3.2 Classification According To Capacity

Hydropower has been classification according to capacity. For large hydro capacity is less than 100MW, medium hydro capacity is around 15MW to 100MW. While, for small hydro the capacity from 1MW to 25MW and mini hydro have capacity greater than 100KW but less than 1MW). The micro hydro have capacity from 5KW to 100KW and the capacity of Pico hydro is less than 5KW (Sharma & Singh, 2013).

2.4 Small Hydro

Small hydro is environmentally friendly and renewable energy sources, thus making them cheaper and easier to operate maintain and manage (Tunde, 2005). There is no specific word to provide a definition of small hydropower. Each country has different power value (European Small Hydropower Association (ESHA), 2004). In addition, small hydro can maintain the natural environment and preserve the

environment and also create job opportunities to the community (Schwartz & Power ,1979). Small hydro can produce electric for home, farm or ranch. It will stop generating when the river to dry because it produces electricity generated by the flow of river water (Tunde, 2005). There are many advantages of small hydro because it is the technology used to generate electricity in areas that difficult to get electricity and don't has fuel cost and low cost of maintenance (Khan, 2014). The advantages of small hydro are no pollution either the air or the environment and also save the costs for maintenance. Other than that, we do not need to spend a lot of capital because it does not require fuel to generate electricity. Furthermore small hydro is a technology that can survive for long periods of time.

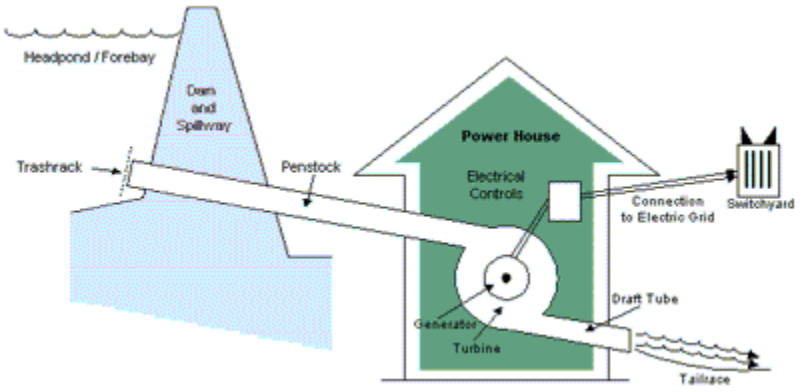

Figure 2.5: The small hydro process

2.5 Run of River plant

Run of river is a type of hydroelectric generation whereby the natural flow and elevation drop of a river are used to generate electricity. Moreover, the run of river power generated changes according to the flow of river water (Khalilzadeh et al. 2014). The run of river has two types which are run of river plant without pondage and run of river plant with pondage. A run of river plant without pondage does not store water and use water flow. The water will flow continuously without any control because naturally the water flow either high floods or low loads water. While, for the pondage is actually collection of water in a dam and increase the capacity for a short time. Storage means collection of water in stream reservoirs and

this increase the capacity of the stream in time for several months (Sharma & Singh, 2013). Run of the river is when the turbine and generator are located either in dam or found alongside it (Tunde, 2005). Water Canal is permanent component. The generator will not generate the energy if there is no water stream. Water pipeline needed to bring the water to the machine whether it's short or move away. A few characteristics that should be considered for a pipe is the pipe length depend on the distance from the supply to generator. In addition to the pressure inside of the pipe should also be taken to determine how much power used and most the type of pipe use the form of polyethylene or PVC (Gatte et al. 2010).The function of turbine is when water flows through it at a rate of speed. The turbine will rotate in the water speed. The power generated depends on the velocity of the water. There are different types of turbine such as Kaplan, pelton and others. The Figure 2.6 is shows an overview of the run-of-river.

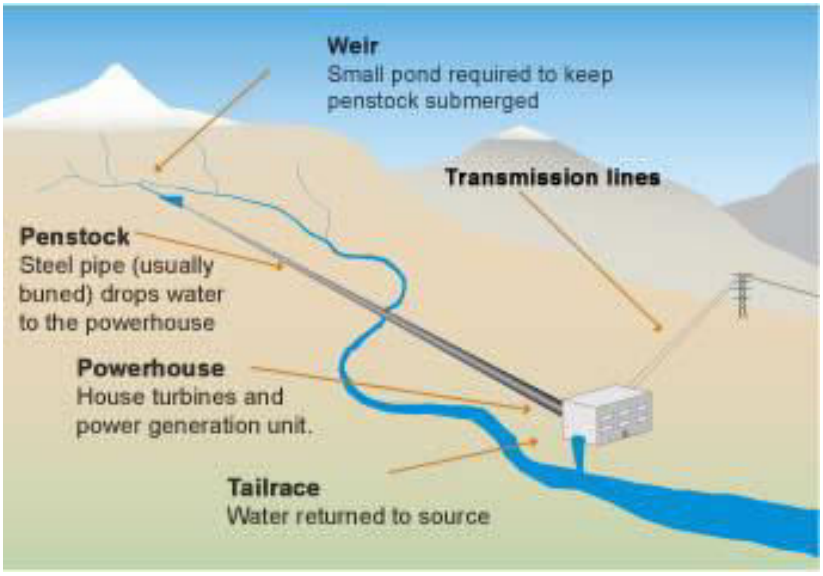

Figure 2.6: The run of river type

2.6 Synchronous Motor

Synchronous motor is a rotating machine. Synchronous motor can function as a generator and as a motor. Generator supplies current to the load resistance connected to the output of the engine is driven at a speed which is given by a prime mover which may be a turbine or engine. Motor, it is a mechanical load driving at a certain speed when input terminal is supplied by a dc voltage. The generator converts mechanical energy into electrical energy. motor while also converting electrical energy into mechanical energy (K.dutta 2012). They are synchronous, AC, permanent magnet motors, which are very flexible and efficient. They do require complicated control electronics. The rotor contains great permanent magnets. There are no coils of wire in the rotor and no electrical connections to it. This increases reliability over DC motors which have windings in the rotors. All windings are in the stator. The control electronics passes an alternating current through these windings to turn the rotor. This current must be "synchronous" with the rotor's movement. This synchronous motor operated only at synchronous speed. The principle operated for synchronous motor as locking method. When the magnet that has south and north face each other they have attracted between two poles. If magnet 1 is rotated the magnet 2 also rotates in same direction with same speed because there has attraction as shown in figure 5. For this condition called magnetic locking.

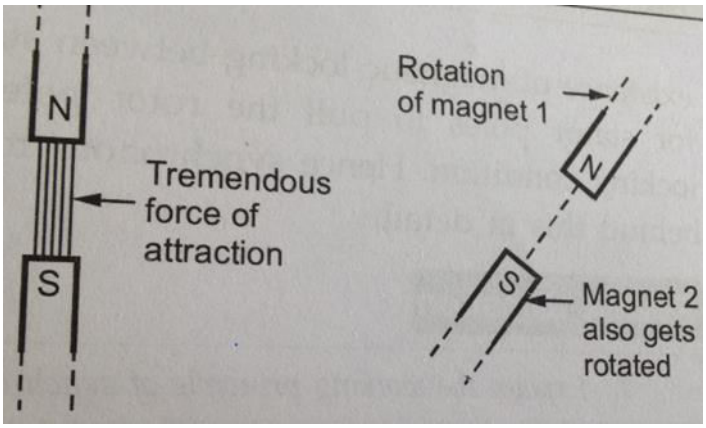

Figure 2.7: The locking method