PERFORMANCE SIMULATION

OF MICRO HYDROPOWER SYSTEM

Mohammad Hanafi Bin Salam

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Student Name : Mohammad Hanafi bin Salam

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_____ _____

Dr. Al-Khalid Haji Othman Date

(Supervisor)

PERFORMANCE SIMULATION OF MICRO HYDROPOWER SYSTEM

MOHAMMAD HANAFI BIN SALAM

Thesis is submitted to

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Dedicated to my beloved family and friends

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ABSTRACT

This thesis is intended to design and implementation of analysis of micro hydropower system using computer simulation. Micro hydropower is a term used for hydroelectric system that typically produces in the 5kW to 300kW range of power. The concept in generating electricity from a potential of water flow has been around for a long time. There are many hydro electric facilities around the world that have been implemented. What is new is the idea that this concept will work on a smaller scale. For a comparison, system for the other type of renewable energy or natural resources such as wind and solar is being scale up but hydropower system is being scale down to meets community needs. It is possible and very practical to look at performance analysis of micro hydropower system using a computer simulation before implementing it in the actual condition. This thesis will provide a basic understanding of micro hydropower system development and how performance simulation of the system can be done. The information will help to determine the water potential, provide the various components necessary for a micro hydropower system, and explain the basic differences between common micro hydropower components and the best design for a micro hydropower system. This thesis also provides a valuable insight about the technique in designing micro hydropower system simulation. This thesis hopefully will be informative and enlightening.

ABSTRAK

Kajian ini bertujuan untuk merekabentuk dan membina untuk menganalisa sistem mikro hidro menggunakan simulasi komputer. Sistem mikro hidro adalah terma yang digunakan bagi sistem hidroelektrik yang menjanakuasa 5kW hingga 300 kW. Konsep menjanakuasa elektrik daripada tenaga keupayaan air yang mengalir telah lama wujud. Terdapat banyak fasiliti bagi hidroelektrik di seluruh dunia yang telah di bangunkan. Apa yang baru adalah pembinaan pada skala yang lebih kecil menggunakan konsep yang sama. Sebagai perbandingan, sistem menggunakan tenaga yang boleh diperbaharui seperti angin dan solar dibangunkan pada skala semakin besar manakala sistem hydro menjadi semakin kecil bagi memenuhi keperluan manusia. Adalah sangat berguna dan sangat praktikal untuk menganalisa keberkesanan sistem mikro hidro menggunakan simulasi komputer sebelum sistem tersebut dibina di lokasi sebenar. Kajian ini menyediakan asas pemahaman tentang pembangunan sistem mikro hidro dan simulasi komputer. Maklumat tersebut akan membantu bagi menentukan potensi sumber air, pelbagai komponen yang bersesuaian, menerangkan perbezaan antara komponen dan rekabentuk terbaik bagi sistem mikro hidro. Kajian ini juga menyediakan maklumat tentang teknik membangunkan sistem simulasi bagi sistem mikro hidro. Diharapkan kajian ini mengandungi banyak maklumat dan menarik.

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CHAPTER 1

INTRODUCTION

This chapter will be an overview of the micro hydropower system where it consists of the project background and its objectives. Furthermore, the expected outcomes and contribution will be explained, as well as the way of approaching the project.

1.1 Project Overview

Micro hydropower system is a system that converts potential energy when water flow from a higher to a lower level in the form of mechanical power and change it into electrical power. Micro hydropower system was design to converts this energy in the form of mechanical power using a turbine. This energy is turn into electricity using a generator. The power from generator will be control using electrical device before being distribute to the user. The power generates from the system is proportional to the volume of water flowing, the head from it drops and efficiency of overall system.

This project is intended to design a simulation system using simulation software which is able to perform performance analysis for micro hydropower system and reduce the overall error before implementing the system in actual

environment. The purpose of this project is to increase efficiency of the system and implement the best system. Micro hydropower system has output range from 5 kW to 300kW and known as a system that is small, simple, easy to implement and renewable. Micro hydropower system is design to be used on a small scale and it is the most cost effective form of energy. For a comparison, the others renewable energy sources such as wind and solar being implemented are being scaled up to meet the community need and micro hydropower system is being scaled down to residential size. That's why efficiency of micro hydropower system is under consideration.

A micro hydropower system consists of main parts such as a small dam, intake weir, penstock, nozzle, turbine, electrical generator, drive systems and optional equipment for generating electricity. This project is more focusing on increasing and analyzing performance and efficiency of micro hydropower system using a computer simulation system. All part and component are being analyzes and all relevant parameters such as flow rate from the stream, gross head, head losses, intake weir design, type of penstock, size of penstock, friction coefficient for the penstock, thickness for the penstock, nozzle design, size of nozzle, nozzle range from the turbine, nozzle angle, turbine design, turbine diameter, number of buckets, range between buckets, turbine rotation per minute, type of generator, types for drive system, ratio for drive systems, power control system, power output and power distribution are being considered. This project also illustrates the basic technique in designing the simulation system and how the input parameters can be manipulate in the simulation system to analyze the output data. The simulation system is implement using computer software that is available in the market.

1.2 Statements of Problems

There are several major problems in implementing micro hydropower system. Important problem that occur in implementing micro hydropower system such as time to develop the system, best design to implement the system, overall cost to design the system and efficiency of overall system. There are a few design for micro hydropower system that have been implemented in the actual situation does not meet the requirement such as the electrical output from the system below the expected output, system failure or damage after certain period of time and a lot of time is needed to rebuild and redesign the system.

Problem also occurs when choosing parts or components for implementing the best micro hydropower system including the intake weir, penstock, nozzle, turbine, generator, and power distribution. There are a lot of equipments and component from different manufacturer to implement the system that is available in the market. All the different equipments and components have a different specifications and performance rates. Actual behavior for the equipments and components needs to be investigated at the real time before knowing the overall efficiency factor to analyze the system.

A simulation system can be the best solution for the problem. Simulation system can provide users an easiest way to come out the problems in implementing the best system and reduce implementing down time and design errors.

1.3 Significant of Study

Aim and purpose of this project is to perform performance analysis of micro hydropower system using a simulation software and gain knowledge and skills to implement the system. This project also gives a better understanding of the actual system and how to use computer simulation to perform the analysis. This project also identifies the best and suitable design for implementing micro hydropower system.

The outcome of this project is a simulation system for performance analysis of micro hydropower system, provides guidance to implement the system and easier understanding in designing the system. This simulation will provides performance comparison for different specifications of equipments and components in implementing micro hydropower system.

This project was significant because performance analysis of micro hydropower system can be done inside the computer before implementing in the real situations. Performance analysis of a micro hydropower system can be done by pointing or clicking the component and equipment parameters inside the simulation software. Different system can easily be compare by changing the parameters inside the simulation software.

1.4 Objectives

The main objective of this project is to develop simulation system that can be used for performance analysis for micro hydropower system. In order to achieve this, several objectives must be reached:

- To study and investigates micro hydropower system that has been implemented.
- To gain knowledge about basic micro hydropower system.
- To investigate the equipments and components characteristics in developing micro hydropower system.
- To learn the technology in developing micro hydropower system.
- Design and develop micro hydropower simulation system for performance analysis purpose.
- Develop software Graphical User Interface (GUI) for simulation.
- To introduce the best system that can be implemented from the performance analysis.

1.5 Benefits of Project Implementation

This project is contribute for designing a more efficient micro hydropower system by applying simulation data from analysis of the micro hydropower system. This project will decrease overall implementing procedure downtime and maximizing service availability for micro hydropower system. This project will contribute for more efficient utilization of hardware and management resources for micro hydropower system design.

The simulation software will provide an easy approach and useful tools for the users for performance analysis of micro hydropower system. The simulation system components will continue to operate in a long term sustainable and safe manner. The system will minimally impact the environment because the simulation system provide data performance and analysis by reducing the error and increase the efficiency before implementing the system in the actual environment. Rather than reduce the overall cost in implementing the actual system, it also can reduce the time needed for implementing the whole system. The simulation system will meet community needs and apply knowledge gained from the data analysis to all future micro hydropower energy projects.

1.6 Expected Outcomes

The expected outcome from this project is a good simulation system for implementing micro hydropower system and increase efficiency for the system. The simulation system also expected to provide performance analysis for the best equipments and components that can be used to implement the system such as the intake weir design, penstock types and sizes, nozzle design, and turbine design to implement the best micro hydropower system to reach the requirement. The simulation system also expected to produce a good data and results to determine the best system for power generation potential from water resources available for any sites. This project also expected to provides guidance, reduce the expected error and reduce the overall cost in implementing micro hydropower system in actual environment.

1.7 Limitations and Assumptions

Limitations and assumption for this project that is under consideration is difficult to obtain all the information or data that actually include in the actual system or actual environment for the system such as the friction coefficient, power loss and the efficiency coefficient for the equipment and component. The simulations software will avoid all the small parameters or data in actual condition of a micro hydropower system if the data being avoid by simulation system designer. All parameters that include in the actual system need to be considered for implementing the best simulation software.

1.8 Thesis Overview

Chapter 1 provides overview of this project and describes the significant of implementing simulation system to do the performance analysis of micro hydropower system. The problems in implementing micro hydropower system are discussed and its solutions are explained. The benefits of the project implementation are also discussed in this section.

Chapter 2 will explain the literature review and discuss more of the system details and how the basic system is operating. It also explains the components and equipments available in the market and technology that being used at this moment. Components and equipments characteristic in developing micro hydropower system is briefly explain in this chapter. This chapter also discusses the best components and equipments to implement the micro hydropower system depend on the resources energy available. This chapter investigates the components and equipments, parts and their relations in making up the whole system that meet the functional and performance. Parameters include in designing the simulation system such as flow rate, flow velocity, intake weir, penstock, nozzle, turbine, generator and power distribution also discusses in this chapter.

Chapter 3 explains the design methodology in order to complete this project. Technique to design the simulation software is well defined in this chapter. This chapter also explains the basic operation of the simulation system and the software development for performance analysis of micro hydropower system.