UNIVERSITI TEKNIKAL MALAYSIA MELAKA

SIMULATION OF DRAG-TYPE-SPHERICAL IN-PIPE TURBINE AT VARIOUS VELOCITIES AND PRESSURES CONDITIONS.

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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 with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this thesis entitled “Simulation Of Drag-Type-Spherical In-Pipe Turbine At Various Velocities And Pressures Conditions.” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : *Nazaem*

Name : Mohamad Nazaem Bin Zabidi

Date : 11 January 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 with Honours.

Signature	:	Nurul Amira
Supervisor Name	:	Dr Nurul Amira Binti Zainal
Date	:	11.1.2023

DEDICATION

This dissertation is dedicated to Allah The Almighty, my creator, pillar of strength, and source of wisdom, knowledge, and comprehension. He has been the source of my strength throughout this journey, and I have only flown on His wings. Allah bless His final prophet Muhammad (peace be upon him), his family, and his associates. This work is also dedicated to my parents, Zabidi bin Ishak and Fadzilah binti Hussein, who have always loved me unconditionally and whose example has inspired me to work hard for everything I want.

ABSTRACT

Hydropower is a low-cost, well-developed renewable energy source. Instead of replacing pressure-reducing valves, the in-pipe turbine might be employed to generate power. By adjusting the number of blades, blade design, aspect ratio, and angle of deflector, the flow can be analysed to maintain the performance of an in-pipe turbine. To examine the flow in a water distribution pipe, a basic system of computational fluid dynamic simulation is used, and a 3D simplified pipe model was used in this study. The purpose of this project is to perform the optimize computational fluid dynamic simulation on output velocity and pressure and to understand the effect of each parameter on output characteristics. New appropriate parameters for model enlargement were established using ANSYS Workbench 2022 R1 software, as validated by prior study papers. To run simulations, six distinct configuration sets based on fixed turbine design and pipe diameter were used.

ABSTRAK

Tenaga hidro ialah sumber tenaga boleh diperbaharui yang kos rendah dan dibangunkan dengan baik. Daripada menggantikan injap pengurangan tekanan, turbin dalam paip mungkin digunakan untuk menjana kuasa. Dengan melaraskan bilangan bilah, reka bentuk bilah, nisbah bidang dan sudut pemesong, aliran boleh dianalisis untuk mengekalkan prestasi turbin dalam paip. Untuk mengkaji aliran dalam paip pengagihan air, sistem asas simulasi dinamik bendalir pengiraan digunakan, dan model paip mudah 3D digunakan dalam kajian ini. Tujuan projek ini adalah untuk melaksanakan simulasi dinamik bendalir pengiraan terbaik pada halaju dan tekanan keluaran dan untuk memahami kesan setiap parameter pada ciri keluaran. Parameter baharu yang sesuai untuk pembesaran model telah diwujudkan menggunakan perisian ANSYS Workbench 2022 R1, seperti yang disahkan oleh kertas kajian terdahulu. Untuk menjalankan simulasi, enam set konfigurasi berbeza berdasarkan reka bentuk turbin tetap dan diameter paip telah digunakan.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I want to thank Allah, the Almighty, for showering me with blessings during my research endeavour, which allowed me to effectively carry out this research. Allah bless His final prophet Muhammad (peace be upon him), his family, and his associates. I would like to express my gratitude to Universiti Teknikal Malaysia Melaka (UTeM) for offering the learning platform.

My heartfelt thanks go to my research supervisor, Dr Nurul Amira Binti Zainal and Ts. Mohd Arizam bin Abdul Wahap and Dr Nurul Amira Binti Zainal, for giving me the chance to do research and for offering vital guidance during this process. He showed me how to do research and convey the findings as clearly as possible. Studying and researching under his direction was an honour and privilege.

I am eternally grateful to my parents for their love, prayers, care, and sacrifices in raising and educating me. In addition, I want to thank my brothers for their help and prayers. I do want to thank my colleagues for their consistent encouragement and genuine support during this research effort.

Finally, I would like to thank everyone and anyone who helped me finish the research, whether actively or passively.

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
π	-	Pi
v	-	Velocity
ρ	-	Pressure
A	-	Area
P	-	Power
D	-	Diameter
χ	-	Blockage coefficient

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

In-pipe turbine power has been considered a potential alternative energy source for decades. It is not only a cheap way to generate electricity, but it is also a renewable source of energy. The in-pipe turbines may operate in a variety of flow patterns, volumes, and velocities. It generates energy by eliminating excessive head pressure from huge diameter pipes (24" - 96"). (Calderone, 2016). Energy created within the pipeline, on the other hand, can be used to develop in-pipe turbines. (Muhsen et al., 2019). Designers in the renewable energy industry must recognise the relevance of shape in all aspects in order to grow or change their existing designs, particularly when in-pipe turbines are involved. The key problem with in-pipe turbines is determining the appropriate design to maximise efficiency.

The best type of water turbine design for a particular situation is frequently influenced by the amount of head and flow rate available at a certain area, as well as whether the location is on the bank of the river or stream, or whether the water will have to be channelled or transported directly to the spot.

Other factors to consider are whether the planned electrical generator is an insulated "reaction turbine design" like the Francis turbine or an uncovered "impulse turbine design" like the Pelton turbine, and also the proposed electrical generator's speed of rotation.

Each hydroelectric power plant's beating heart is the water turbine. It consists of many metal or plastic blades connected to the main rotating shaft or plate. Due to the velocity and pressure of the water, water flowing through the enclosed turbine casing contacts the turbine's blade, generating torque and forcing the shaft to rotate. Water's velocity and pressure diminish as it pressures against the turbine blades (energy is lost), forcing the turbine shaft to spin. (Prem Baboo, 2016).

1.2 Problem Statement

Hydropower is a mature and cost-effective renewable energy source in which energy and water are inextricably linked. (Muhsen et al., 2019). The design features of the turbine can be studied in order to maintain the performance of an in-pipe turbine. According to research on turbine design for fluid flow, the number of blades, deflector system, aspect ratio, and blade shape all influence the pressure and velocity reaching the in-pipe turbine. This is because a bad design will result in low output velocity and pressure. As a result, the water distribution channel will be slower and less efficient to utilise. A fundamental system of computational fluid dynamic simulation is utilised to analyse the flow in a water pipe, and a 3D simplified pipe model was used in this research. The output velocity and pressure can be generated using the optimal number of blades, angle of deflector, and aspect ratio of the turbine. The information can also be used to calculate the turbine's efficiency. The goal of this research is to simulate the output velocity and pressure for the best design of an in-pipe drag-type turbine.

1.3 Objective

The objectives of this project are:

a) To construct a turbine design using 3D modelling software based on parameters that have been considered.

b) To perform a computational fluid dynamic simulation on output velocity and pressure of an in-pipe drag-type turbine.

c) To compare the output velocity and pressure between the turbine final design and the existing turbine design.

1.4 Scope of Research

The scopes of study of this project narrowed down to:

a) this study is carried out to prove that changing input velocity will affect the output pressure and velocity using ANSYS software.

b) Focus on the turbine design for in-pipe drag-type turbine piping system using ANSYS software.

c) Produce 3D drawing and simulate with well-set parameters given.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, the relevant literature and research on topics relevant to this project, such as general concepts of turbine, drag-type turbine, in-pipe turbine, drag-type turbine parameter, common angle employed, formulas and general information on how to validate the data, are presented.

2.2 Definition of Water Turbine

A water turbine with a rotor that may be rotated around an axis is revealed. Water flows over the at least three blades that generate rotational motion for the rotor. At least one of the blades is contained within one of the rotor's triangulated elements.

A water turbine uses the potential energy that arises from the height difference between an upstream water supply and the generator level of water (the tailrace). Basic watermills have been in operation for roughly 2,000 years, and water turbines are their modern descendants. Nowadays, water turbines are the most common method of generating electricity.

In contrast, the majority electricity is generated by steam turbines connected to electric generators. A fossil fuel or nuclear-powered generator generates steam, which powers the turbines. The change in enthalpy across the turbine is a simple way to express the amount of energy extracted from steam. As the sum of internal heat energy and flow system pressure times volume, enthalpy represents all mechanical and thermal forms of energy. Increases in steam generator temperature and pressure, as well as turbine-exit pressure, enhance the potential enthalpy shift.

Water turbines are often classified as either impulse (for use with big water heads and lower flow velocity) or reaction (for usage with higher flow velocity) (used for low water heads and moderate to high flow rates). The Pelton impulse generator and the Francis, propellers, Kaplan, and Deriaz reaction generators fall into these two categories. A horizontal or a vertical shaft can be used to construct a turbine. Individual hydraulic conditions can be accommodated by wide-ranging design changes within each type. Hydroelectric turbines are now the primary use for most hydraulic turbines. As of this writing, (Fred Landis, 2017)

2.2.1 Impulse Turbines

A well constructed nozzle releases water to transform potential energy (or even the flow heads) into kinetic energy before being used in an impulse turbine. In order to turn the water energy into productive labour, the jet is directed to curved buckets affixed to the runner's edge.

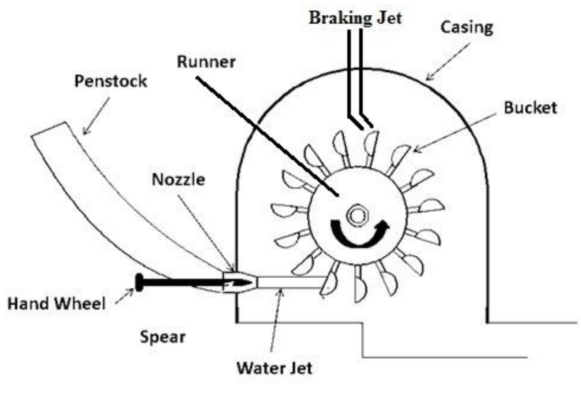

Figure 2.1 Impulse turbine