INVESTIGATION ON THE PERFORMANCE OF BLAKE HYDRAULIC RAM PUMP

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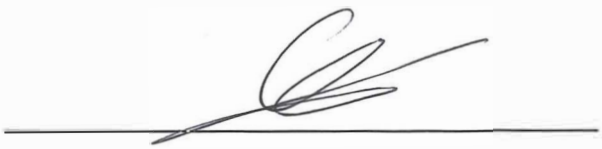
DECLARATION

The work in this report is my own, with the exception of quotations, equations, summaries, and references, which have been properly cited.

1ST JULY 2022



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VERIFICATION

SUPERVISOR **SIGNATURE**

DR NAZREIN ADRIAN BIN AMALUDIN _____

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First and foremost, I would want to convey my gratitude and admiration to my project supervisor, Dr. Nazrein Adrian Bin Amaludin. Throughout the entirety of the project, he has been an incredible support and has provided invaluable guidance. Because he has showed such intrest in my work, I have been inspired to perform to the best of my abilities. He has been my guide, and I will be forever thankful to him for all of the assistance and direction he has given me.

In addition, I would like to extend my gratitude and admiration to my friends for their contributions to the development of the prototype for my project, which accidentally offers support and aid in a variety of forms. Last but not least, I would want to express my gratitude to my parents, Reson Yanga and Jenny Chang, for their unwavering support and unwavering faith in me throughout my life. If they weren't here, I wouldn't have the self-assurance to keep moving on with my idea.

ABSTRACT

This research involves the development of a ram pump that can pump water without the need for external energy sources. It is deemed an important analysis because, once completed, it can be utilised to improve and facilitate various agriculture and health-related activities.

Prior research has been conducted on the ram pump. However, the purpose of this study is to comprehend the prototype built system in order to determine the optimal combination of parameters that will result in changing ther performance of the ram pump system.

The investigation will be conducted by reviewing scientific literature and developing a hydraulic ram pump prototype and testing it using an experimental procedure. In order to decide if it is worthwhile to put a ram pump in specific locations, it is necessary to have a thorough understanding of the advantages and disadvantages of the ram pump, which encompasses both the experimental and literary fields.

As a result of this investigation, the Blake Hydraulic Ram Pump's operating parameters have been determined. Higher mass added to waste valves doesn't increase the system's performance, as it is shown that the hydraulic ram pump reaches its highest peak of performance at a certain mass level, although it must be taken into account that the mass added and the length of the lifting stroke of the waste valve can be controlled in this system, as it affects the working rhythm of the pump. When the waste valve is fully open, the pump performs better, as long as it is running at a high lifting stroke

ABSTRAK

Penyelidikan ini melibatkan pembangunan pam hydraulik yang boleh mengepam air tanpa memerlukan sumber tenaga luaran. Ia disifatkan sebagai analisis penting kerana, apabila siap, ia boleh digunakan untuk menambah baik dan memudahkan pelbagai aktiviti pertanian dan berkaitan kesihatan.

Kajian terdahulu telah dijalankan ke atas pam hydraulik. Walau bagaimanapun, tujuan kajian ini adalah untuk memahami sistem yang dibina prototaip untuk menentukan kombinasi optimum parameter yang akan menyebabkan perubahan prestasi sistem pam ram.

Siasatan akan dijalankan dengan mengkaji literatur saintifik dan membangunkan prototaip pam ram hidraulik dan mengujinya menggunakan prosedur eksperimen. Untuk memutuskan sama ada ia berbaloi untuk meletakkan pam ram di lokasi tertentu, adalah perlu untuk mempunyai pemahaman yang menyeluruh tentang kelebihan dan kekurangan pam ram, yang merangkumi kedua-dua bidang eksperimen dan sastera.

Hasil daripada penyiasatan ini, parameter operasi *Blake Hydraulic Ram Pump* telah ditentukan. Jisim yang lebih tinggi ditambah pada injap buangan tidak meningkatkan prestasi sistem, kerana ia ditunjukkan bahawa pam ram hidraulik mencapai kemuncak prestasi tertinggi pada tahap jisim tertentu, walaupun ia mesti diambil kira bahawa jisim ditambah dan panjang strok angkat injap buangan boleh dikawal dalam sistem ini, kerana ia mempengaruhi irama kerja pam. Apabila injap buangan terbuka sepenuhnya, pam berfungsi dengan lebih baik, selagi ia berjalan pada pukulan angkat tinggi.

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FINAL YEAR PROJECT

Overview

The purpose of this study paper is to create and develop a Blake hydraulic ram pum to determine its performance. In general, it is to obtain data analysis and comparison of more than one perimeter that will be investigated of the Blake Ram Pump performance compared to the old Hydraulic Ram Pump (straight hydraulic ram pump). The fundamentals of the main design and conceptualization of the ram pump are based on past research, which is covered in detail in the section on literature review. The Blake HRP is explored in this study to determine the effect of any operational and performance conditions for the research objective on the rate of pumping and wasting in the system. Finally, in order to improve the understanding of this design project, related journals, theses, articles, books, and research papers were reviewed in order to identify the critical factors that should be taken into consideration for the design in order to provide a better understanding of the design development and the performance data analysis phases of the project.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The Hydraulic Ram Pump (HRP) is a device that was designed over 250 years ago and is capable of pumping water uphill using only the force of the water flowing inside the mechanism. HRP was found and is being used in several countries, such as China, India, Greece, and Rome (Ndache et al., 2007).

The Hydraulic Ram Pump (HRP) is a simple and most environmentally friendly device available because it requires no internal power to push the water, in more work, it is only using kinetic energy to push the water from lower to higher level (Inthachot et al., 2015). The HRP is particularly appealing in several places in poor countries and rural areas that lack or are located far distant from a reliable supply of energy, and it is commonly used to generate energy for agricultural and household uses (Manghani, 2017). Farmers and middle-class residents of rural areas rely on this type of pump because it uses a low operating cost (Sheikh et al., 2013). When a stable water source is available, the HRP can be an effective method of pumping water to a higher altitude where it is needed (Bergant et al., 2006). This source could be a river, a stream, a well, or a dammed pond. Theimplementation of HRP pumps can assist in resolving issues such as a shortage of appropriate water for drinking, agriculture, and many others. Ideally, the pump system should be situated below the water source. This scenario is critical for establishing a free flow of water and imparting velocity to the flowing water(Othman et al., 2020).

HRP consists of two moving components, a waste valve (impulse valve) and a delivery valve (check valve) that are coupled to a driving pipe, a delivery pipe, and an air chamber (Figure 1.1) (Mondol, 2017). HRP operates continually because of the waste and delivery valves' opening and shutting cycles. When the waste valve is closed, the pressure in the drive pipe increases. The air chamber is required to maintain a constant flow of water at a sufficient pressure. When designing a HRP, six design factors should be considered (Suarda et al., 2018). These include the height difference between the water source and the HRP, the height difference between the pump site and the storage, the quantity of water flowing, the length of pipe connecting the water source to the pump, the volume of required water, and the length of drain pipe.

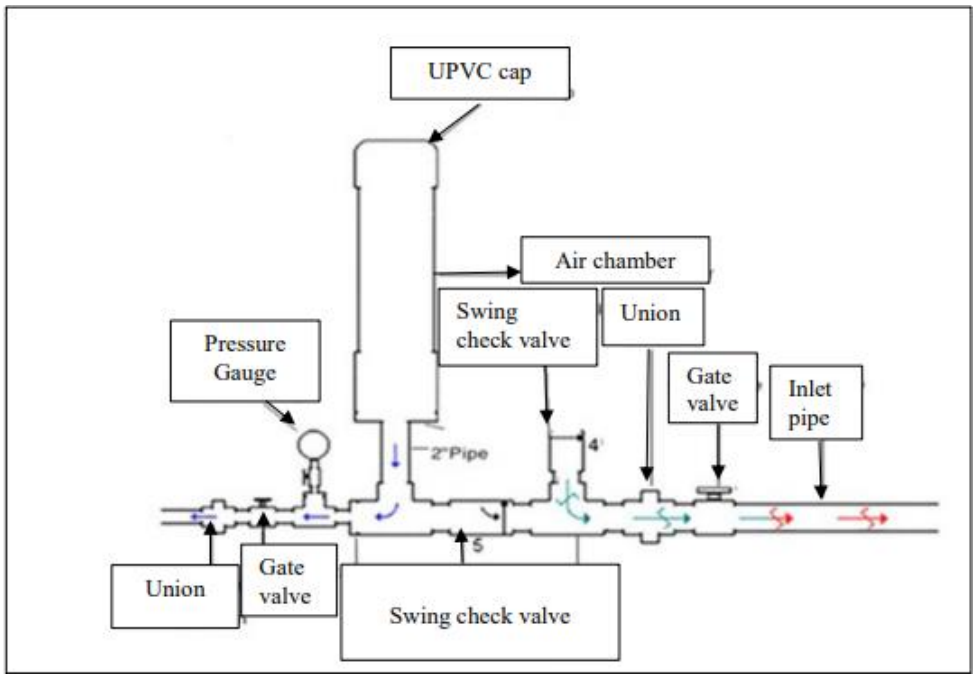

Figure 1.1: Hydraulic water pumping system configuration
Source: (Sampath et al., 2015)

The waste valve (or impulse valve) and the delivery valve (or check valve) are the two types of valves that are important to run the cycles of pumping water. As the wastewater travels through the waste valve, the waste valve is hefty and has a lengthy stroke, allowing for large flow rates. This will increase the hammer pulse's impact, which is suggested for higher heads, while a small mass and short stroke is

advised for lower heads to get more 'beat' and swiftly deliver larger volumes. The delivery valve has a large opening to allow the pumped water to flow more freely into the air chamber. With a one-way directional valve, a basic valve such as a clap check valve or clack valve can be employed (Asvapoositkul et al., 2019).

1.2 Problem Statement

One of the most pressing challenges in human resource management is the performance and efficiency of the organisation. Because the hydraulic ram pump does not rely on external forces to operate, the output flow rate is determined by the design specifications of the pump. After an alternate cycle occurs, the HRP of the total input discharge of the supply source utilising water hammer energy is calculated. In each cycle, the ram pumps generate the water hammer phenomenon and regulate the energy required to pump the water.

The problem statement of the research is to investigate the output performance of the Blake HRP toward the modification, which is to manipulate the mass of the waste valve. Continuingly with the second problem statement, does the change in the length of stroke of the waste valve affect the output performance of the Blake HRP. The modification was made by customising the whole body of the three-quarter inch foot valve, so that the foot valve mass can be changed to add more mass while at the same time the length of stroke of the waste valve also changes in various lengths. In general, when the mass is added to the waste valve, the performance of the HRP will change and the efficiency will also change. The same goes for the change in the length of stroke of the waste valve

The main concept of HRP depends on the supply source using the water hammer energy concept after the alternative cycle. During each cycle, the water hammer phenomena are generated, and the ram pumps handle their energy for water pumping. The problem with these phenomena is that it is impossible to identify the maximum and minimum water hammer functioning while witnessing the HRP system. By comparing the mass added and the change in length of stroke of the waste valve in HRP, both can be compared to identify the effect of the two perimeters

on its performance and efficiency. In the meantime, it will also affect the water hammer in the delivery pipe.

1.3 Research Objectives

This article presents the design and development of the Blake Hydraulic Ram Pump (BHRP) as well as an analysis of its performance. To do so, it makes use of design process techniques, conceptual designs, prototype parameters, prototype experiment procedures, and mathematical relationships that were utilised during the design effort. The literature review served as the primary inspiration for the design and conceptualization of the ram pump. The purpose of this research article is to obtain analysis data of modification toward the waste valve in terms of the changing of the mass and the rising of the length of stroke.

The main research of Blake Hydraulic Ram Pump (BHRP) perimeter will be divided into two parts, which will investigate the relationship between the effect of adding mass on the waste valve and modifying the length of stroke lifting the waste valve toward its output perfromance and efficiency. The aim of this study is to investigate the performance and effectiveness of the ramp pump if we change the mass of the waste valve and the length of stroke of the waste valve lift. To figure out the problem, the research will conduct an experiment on the real prototype to investigate the performance of the HRP. This study looks into how different operating and performance conditions affect the rate of pumping and wasting in BHRPs.

In addition, the Blake Hydraulic Ram Pump (BHRP) will undergo an examination of the increase or decrease in two factors, which are: the first is the flowrate of the output ram pump, and the second is the pressure output from the output pump. The last objective is to see the difference between the straight hydraulic ramp pump and the Blake design of hydraulic ram pump. It was discovered that the design parameters and their impact on BHRP performance had not been thoroughly investigated. This study looks into how different operating and performance conditions affect the rate of pumping and wasting in BHRPs.

1.4 Scope of Works

The first scope work for this research is to design and develop Blake Hydraulic Ram Pump (BHRP). The first step is to design by using 3D modeling (Figure 1.2) and after that will come out with development with an experimental prototype.

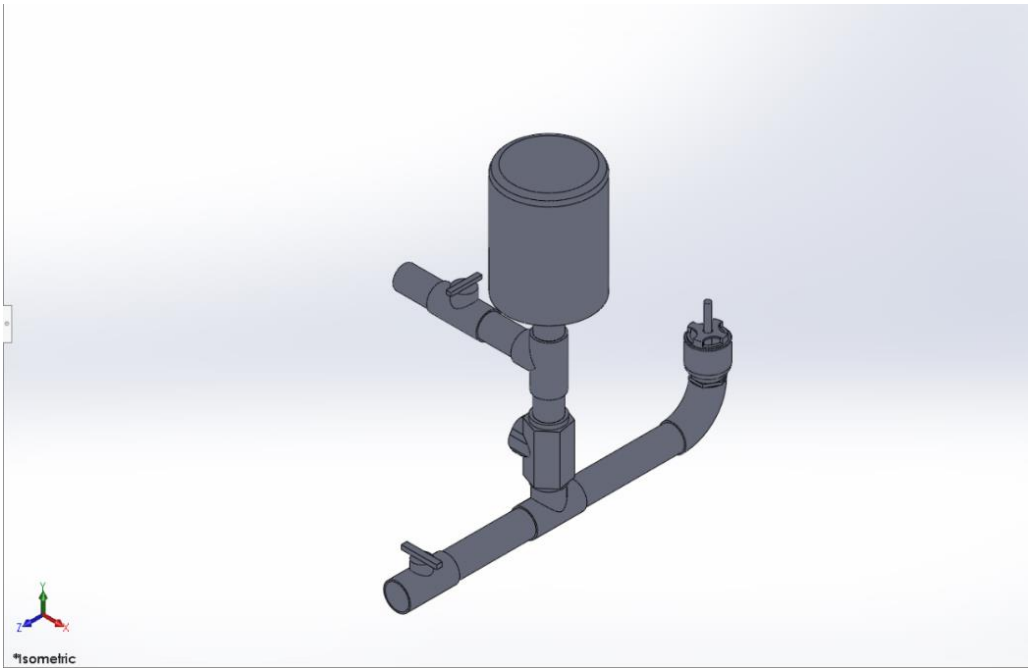

Figure 1.2: 3D Design of Blake Hydraulic Ram Pump

The purpose of this research is to investigate the relationship between the effect of increasing mass on the waste valve and modifying the length of stroke elevating the waste valve toward its output perfromance and efficiency. The 3D modelling of the waste valve modification(Figure 1.3) was produced to allows the mass and length of stroke of the waste valve can be altered.

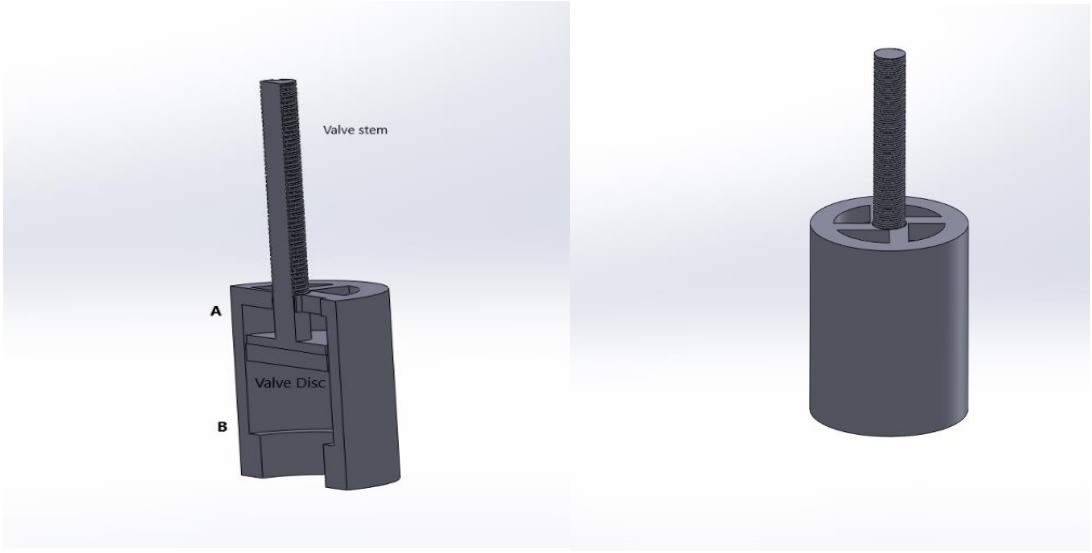

Figure 1.3 Draf design of modification waste valve

A draft design of waste valve designed(Figure 1.3) such that the mass and its stroke can be varied depending on the design system. As part of the first phase of the examination, the BHRP will be subjected to an increment of a predetermined mass toward the waste valve. We will investigate the maximum flowrate and output pressure achievable at a given height. The valve that controls the flow of water to both ram pumps is opened so that water can flow freely to both pumps. Both the output flowrate and the output pressure at a given height will have their data recorded. The data for the highest rising level will be recorded first. The experiment will continue with three different mass s to compare the results.

The next step in the assessment process is to conduct experimental research to determine the optimal max output pressure and flowrate of the BHRP based on the different lengths of stroke that the waste valve can have. The valve that controls the flow of water to both ram pumps is opened so that water can flow freely to both pumps. The information on the output pressure for the highest increasing level and the output flowrate at a particular length of stroke for the waste valve. The data from the experiment will continue to be collected using three distinct lengths of stroke for the waste valve lifting.

1.5 Research Expected Outcomes

The first goal of this research is to develop the Blake Hydraulic Ram Pump (DHRP) design with adjustable mass and lifting level of the waste valve, and a combination of copper valve and PVC pipes. This will be the first step to achieve the first expectation of this research.

The first thing that will be looked at is how the different mass s of the waste valve affect the overall performance of the BHRP. The first thing we think will happen is that the amount of water that comes out of the waste valve will go up if its mass goes up. The second test that will be done as part of this research will look at how a change in the length of the waste valve lift affects how well it works overall. With an increase in the length of stroke of the lifting waste valve, this system is expected to work better. Because of this change, the maximum output pressure will not change either. In addition, the efficiency of the ram pump will also be determined by using the ram pump efficiency formula. The expectation of the efficiency targeting is around 50 to 70 percent as the delivery height is just twice of the supply head height.

The factors that were going to be predicted include the increment of the head effects toward the output water lift level of the BHRP, which is better at a specific mass, as well as the lifting level of the waste valve. These factors are going to be expected. Other considerations are the volumetric flowrate and water pressure at the BHRP's discharge point. Both investigations are anticipated to have a growth spurt, and as a result, the good feedback from this research will result in the accomplishment of the goal that this research set out to find.

1.6 Research Contributions

The proposed project's contribution will be to introduce an improved design of HRP by creating a new design of Blake Hydraulic Ram Pump (BHRP). The performance and efficiency of the BHRP will be better than the old design HRP. Apart from these features, the new design of the BHRP will be introduced to the rural area, and it will be more beneficial and efficient than the previous design of the pump. Finally, the

design of the new HRP will be more durable because it will use both potential and kinetic energy to operate the ram pump system, allowing it to last longer.

1.7 Research Commercialization

The goal is to provide profitable business outcomes that have a positive impact on society as a whole. In most cases, this is accomplished through the commercial licencing of intellectual property to an existing commercial organisation or the development of a new spin-out firm dedicated to bringing the new products or services to market. Water is one of the most vital resources required in everyday life, not only for human survival but also for agriculture and cattle production. Novel research on a new modification design for a ram pump could have a significant impact on the utility of the ram pump. Because there are still many areas in Sabah where people do not have enough water to sustain their daily lives, the commercialization of the ram pump is still viable. The free energy concepts of this HRP to pump water from one place to another place will provide worldwide usage, mostly in rural areas or areas that do not have an electric supply.

1.8 Report Gantt Chart

Table 1: Gantt Chart FYP

No.	Item	week													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
SEMESTER 1 (2021/2022)															
1	Topic Suggested by Supervisor														
2	Proposal Preparation														
3	Proposal Moderation														
4	Literature Review														
5	Design and 3D Modelling														
6	Methodology Progression														
7	Progress Report														
8	Submission Of Progress Report														
9	Presentation 1														
SEMESTER 2 (2021/2022)															
1	Material Collection														
2	Prototype Fabrication														
3	Prototype Testing and Optimization														
4	Product analysis and data Collection														
5	Thesis														
6	Thesis draft and technical paper														
7	Presentation 2														

1.9 Report Outline

This project focuses on Performance of Blake Hydraulic Ram Pump (BHRP). The output flow rate of this device depends on the pressure inside of the pump. Enhancing the performance of hydraulic ram pump and prolonging the lifetime of this device will require great knowledge from previous research.

Chapter 1 discusses the overview of the whole project to give readers a vision of what this project is intended for. This chapter will provide the background of the hydraulic ram pump and its architecture. The problem statement and challenges faced are also presented. Other than that, this chapter also contains the aim and objectives of this project, including the scope of work to visualize the overall project.

Chapter 2 of this report reviews the HRP design and previous research done by researchers. The history and available design of HRP are also reviewed in this chapter. The working principle and the main topic for this report which is the water hammer phenomenon is also reviewed.

Chapter 3 describes the methodology used in this project. Starting with the outline of the overall flowchart that took place in the making of this project. Next, the conceptual design in rough 3D modelling drawing is presented before the experimental setup is explained in detail in this chapter

Chapter 4 is the result and discussion section, in which the hydraulic ram pump is examined by experimental procedure. The performance, such as the delivery flowrate, number of valves per minute, and efficiency, will be determined at two different perimeters which the first is the mass contribution, and the second is the length of lifting stroke toward the waste valve, which will be determined.

Chapter 5 is representing the study of centred on the development of a blake hydraulic ram pump that would conveniently alleviate the problem of water supply to the mass populace. Ideally, the different combinations of mass toward the waste valve and length of lift will affect the performance of the hydraulic ram pump system.

Chapter 6 talks about the future studies that can be conducted to improve and find the best solution to the improvement. There will be a few improvements, such as finding the best mass for the best efficiency of the hydraulic ram pump system. From the study, there will be a point that represents the best performance that the ram pump can achieve. More than that, the effectiveness of the delivery flow rate can be used to develop a power generator to supply electricity to the rural area.