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TAJUK: Development of Portable Water Hammer Accumulator for Domestic Water System

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DEVELOPMENT OF PORTABLE WATER HAMMER ACCUMULATOR FOR DOMESTIC WATER SYSTEM

Thesis submitted in accordance with the partial requirements of the
Universiti Teknikal Malaysia Melaka for the
Bachelor of Manufacturing Engineering (Design Manufacturing)

By

MOHD HELMI BIN ABDULLAH

Faculty of Manufacturing Engineering

June 2015

DECLARATION

I hereby, declared this thesis entitled "Development of Portable Water Hammer Accumulator for Domestic Water System" is the results of my own research except as cited in references.

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APPROVAL

This PSM submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Process Manufacturing) (Hons.). The members of the supervisory committee is as follow:

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ABSTRAK

Sumber air yang bertekanan rendah merupakan masalah yang biasa dihadapi oleh pengguna. Walaubagaimanapun, di sebahagian kawasan mendapat tekanan air yang kuat, yang mana boleh menyebabkan masalah lain. Tekanan air yang kuat ini boleh menyebabkan berlakunya masalah kebocoran pada bahagian yang lemah paip terutama pada bahagian penyambung atau sesiku. kebocoran ini berlaku adalah disebabkan oleh tukul air. Projek ini adalah untuk mengenalpasti konsep dan fungsi akumulator tukul air untuk mengatasi kebocoran pada sesiku dan bahagian penyambung paip, untuk mereka dan membina akumulator mudah alih yang mempunyai nilai tekanan yeng berbeza untuk sistem air domestik dan untuk menganalisis keberkesanan akumulator pada tekanan yang berbeza.. Projek ini dimulakan dengan merangka beberapa konsep akumulator seperti jenis bebola dan jenis spring. Selepas itu, konsep yang terbaik telah dipilih melalui proses saringan konsep, hasilnya akumulator bebola telah dipilih sebagai konsep terbaik. Seterusnya, akumulator yang terpilih telah dilakar dalam lukisan 3D menggunakan perisian solid work sebelum ia dihasilkan. Dalam projek ini, bahagian dalam akumulator mempunyai sebuah bebola yang diisi oleh udara mampat. Bebola ini adalah berfungsi untuk menyerap peningkatan mendadak tekanan tukul air menghasilkan peningkatan tekanan secara berlahan dan stabil didalam sistem paip tanpa meyebabkan kerosakan pada sebarang bahagian. Setelah itu, akumulator telah di uji menggunakan kit ujian yang telah dibina lebih awal. Daripada proses pengujian, fungsi akumulator telah terbukti dalam penyelesaikan masalah tukul air. Akumulator ini berupaya untuk meningkatkan masa lengah untuk tekanan mencapai tahap maksima. Disamping itu, ia juga menunjukkan akumulator ini mampu menurunkan kadar kenaikkan tekanan hampir 100% daripada tekanan tukul air.

ABSTRACT

The low pressure of water supply is the common problem experience by domestic water user. However, in some area experience high water pressure, which can cause another problem. This high water pressure can cause leaking problem on the weakest part of the pipe especially at joining and elbow. This leaking is happening due to the shock pulsation or water hammer. This project is to identify on concept, principles and function of the water hammer accumulator to overcome leaking at elbow and joint part of pipe, design and develop the portable bladder accumulators which have different pressure for domestic water system and to analyze the efficiency of different pressure of portable bladder accumulator. This project is started by designing a few concepts of the accumulators such as bladder type and spring type. After that, a concept screening was constructed to choose the best concept, hence the bladder type with the different pressure were chosen. Next, the chosen accumulators were transformed into the 3D drawing by using the solid work software before it was developed. In this project, the inner mechanism of the accumulator has a bladder which is filled with the compacted air. This bladder is functioning to absorb the shock increases of water hammer pressure resulted the pressure to increase slowly and steadily in the pipeline system without the failure of any part in the system. After that, the accumulator were tested by Testing Rig that was developed early. From the testing stage, the functionality of the accumulator was proven in solving the water hammer problem. The accumulator was able to increase the delay time to the pressure to reach the maximum pressure. Besides, it is also shown the accumulator able to reduce the rate of pressure rise almost 100% of the water hammer pressure.

DEDICATION

This project is dedicated to UTeM, my Main Supervisor, Dr Mohd Shahir Bin Kasim, my family who has supported me and also not forget to FKP Technicians and everyone that helps me directly or indirectly in making of this project until its successfully finish.

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CHAPTER 1

INTRODUCTION

1.1 Background

Water is the most important element for the human being to survive. In domestic application, water used as the drink, wash the car, watering the plant and many other uses. Domestic water provides are one of the central requirements for individual life. Without water, human cannot be continual beyond a few days and the lack of access to reasonable water provides results in the spread of disease. In the past, human only consume water from the river, well and rain. Nowadays, the systematic water distribution through piping system. Wijk-Sijbesma (2008) state that, normally, domestic water user experience low pressure of water. A normal house that have 1 until 2 floor will use the gravity to create the water pressure by water, forcing its way to bring water to the home. Water storage tank or reservoir usually located higher than the outlet tap so that the water can flow by gravity. However, some user installed the water pump in order to get the higher pressure so that the water flow rate is higher. The pump usually used in the area that experience the low pressure of water because of the reservoir is located far from the house area. By installing the water pump, the low pressure of water can be prevented. However, the high pressure of water can cause another problem. In some cases, the domestic piping system will be fail because of the high pressure of water can break the pipe especially at the junction (James P, 1973).

With their direction manual arranged for the Department for International Development, (Ian Smout & Sarah Parry Jones, 1998) showed that a negligible model for water supply should be 20 liters for every capita every day, whilst watching the significance of decreasing the separation and empowering household unit association. A comparative figure has been recommended by different specialists (Carter R C, Tyrrel S F, & Howsam, 1997). Gleick (1996) proposed that the global group receive a figure of 50 liters for each capita every day as a fundamental water prerequisite for residential water supply.

Domestic water supply is between 340 kPa to 690 kPa, but most household appliances are designed to work with water pressure between 100 kPa to 830 kPa. Most home appliances can have water hammer or shock pulsation when a water flow turns off suddenly, example a dishwasher, a clothes washer, a stool or even coming together a hand faucet. Closing away the flow suddenly sends a pressure or shock wave down the water line through the water shocking the pipes and producing the 'hammer' noise (Hock, 2008). According to Nor & Maz Enterprise, water hammer waves in typical water pipes can exert tremendous instantaneous pressures, sometimes reaching over 110 kPa.

According to Santrali Sdn Bhd, the pipe that installed in household usually using PVC or ABS pipe with a diameter of 40mm, from the ASTM schedule, the mention pipe can work at maximum working pressure of 110 kPa for the selected size. In other words, the water hammer pressure is extending the work pressure they can be handle by the pipe, so over time, water hammer can eventually weaken pipe joints, damage valves, pipes, and can cause pipe leaking which cause serious damage and high cost repairing.

Pressure surge or water hammer, as it is known, is the arrangement of pressure wave as a result of sudden change in fluid speed in a piping system. The water hammer phenomena typically clarified by considering by perfect supply pipe-valve plan in which the relentless stream with speed V_o is stopped by a momentary valve closure. In other say, it happens when the liquid stream begin or complete rapidly or is compelled to build a quick change in control, for instance speedy shutting the valves and square of a pump can make water hammer (Bergant et al., 2001).

To prevent water hammer and shock pulsation, an accumulator for domestic water system will be designed. Hence, this water hammer able to reduce the percentage of pipe leaking to occur. In this research, two types of accumulator will be designed which is spring type and bladder type. (Choon, Aik, Aik, & Hin, 2012)

According to Hooke's law the magnitude of the power wielded by a spring is linearly proportional to its reference. Therefore, as the spring compresses, the force it exerts on the fluid is increased. This accumulator can reduce shock effects in piping, resulting from inertia or external mechanical forces, maintain system pressure by compensating for pressure loss due to leak, it's compensates for such pressure changes by presenting or taking in a low amount of water. (A. R. Lohrasbi & Attarnejad, 2008)

1.2 Problem statement

Water hammer effect is normally happening in daily life and only that people not realize it. A usual model of a water hammer occurs in most homes everyday: Simply turning off a shower quickly will send a loud thud through the mansion. Water hammer can cause pipeline to fail if the pressure is high enough. Likewise, when a valve in a pipe is shut down, the water downstream of the valve will attempt to keep falling, producing a vacancy that may cause the tube to break up or go off. This phenomena cannot be prevent manually. Water hammer phenomena can weaken pipe joints and one of the factors that can cause pipe leaking if it's not prevented, repairing a pipe leaking need a lot of money and not only can damage the surrounding but it also dangerous that can cause lost life. The issue of water hammer must be studied by analysing the situation where the water hammer effect occurs and propose a prevention of water hammer event (Born, 2010).

1.3 Objective

1) To identify on concept, principles and function of the water hammer accumulator to overcome leaking at elbow and joint part of the pipe.
2) To design and develop the portable bladder accumulators which are have different pressure for domestic water system.
3) To analysis the efficiency of different pressure of portable bladder accumulator.

1.4 Scope and Key Assumption

1) Design accumulators for domestic water system.
2) Fabricate accumulators.
3) Implement designed accumulators.
4) Rectification of designing accumulators.
5) Compare the efficiency of different pressure of accumulators.

1.5 Definition of Term

1. Domestic Water system (DWS)

    Domestic Water system (DWS) is a system for the collection, handling, transmission, storage and distribution of water from source to consumers, for example, houses, irrigation installations, industrial, commercial institutions, and public offices for water related natural processes such as street flushing, fire fighting, and so forth (Department of Irrigation and drainage ,1982).

2. Spring

Spring is an elastic device that regains its initial condition after being packed together or extended. Usually spring is formed from a spiral or wire (Lüdecke, 2006).

3. Hydraulic

Run by the pressure created by forcing water, petroleum, or other liquid through a relatively narrow pipe or opening (Hydrotrole USA, 2010).

4. Accumulator

An accumulator is an energy storage device. It is a pressure storage reservoir in which a non-compressible hydraulic fluid is contained under pressure by an extraneous origin. That external source can be spring, a raised of pressure, or a compressed gaseous state (Hunt, 1996).

5. Shock pulsation

Fluid's thought process power is produced by responding or peristaltic positive displacement pumps. It is most regularly created by the speeding up and deceleration of the pumped liquid. This uncontrolled vitality shows up as pressure spikes. Vibration is the noticeable case of throb and is the offender that ordinarily drives the best approach to part failure (Zaruba, 1993).

6. Water Hammer

A banging noise heard in a water pipe following an abrupt alteration of the flow with resultant pressure surges, sometimes reaching above 110 kPa (Lohrasbi et al, 2008).

1.6 Organization

Before starting on designing and developing an accumulator, the first step is data collection and research for better understanding on the project. This was done by using resources from the internet, book, journal, questionnaire, literature review, and presents study cases that relevance to the project. This report consists of understanding of domestic water systems, how a water hammer occurs and how it can cause pipe leaking, the function of an accumulator and how an accumulator can help preventing pipe leaking. All this data and research will be put in Introduction chapter and Literature Review chapter. Where Introduction chapter is for understanding what this project is all about and the Literature Review is more about the related data, technical data of the pipe, question and answer and resources that have been collected so that the reader has more understanding on the important scope in this project.

For the Methodology chapter, it will consist of conceptual design stage, drawing of selected design and testing kits, technical data of the chosen material, list of material, list of costing and procedure on machining or developing the accumulator.

CHAPTER 2

LITERATURE REVIEW

2.1 Domestic Water

The role of water conveyance systems is to transport water from a water treatment centre to private consumer, for utilization as drinking water, water for cooking, water for sterile conditions, and other water use in a domestic uses. Water supply additionally is crucial for business and industry to work in a metropolitan domain. Of no less significance is the interest to give water to appropriately find fire hydrants to supply the general population with an effectual level of impact protection. Metropolitan water systems additionally may need to give water to extraordinary administrations that incorporate offering of water to foremen for raising structures, road cleaning, parklands and diversion, and incidental employments (USGS Water Science School, 2009).

A water system has two main requirements: First, it needs to deliver equal amounts of water to meet consumer consumption requirements plus needed fire flow demands. Second, the water system needs to be reliable; the needed sum of water needs to be available 24 hours a day, 365 days a year (Harry E, 2008).

Based on Web of Water Encyclopedia (2011), Domestic supplies refer to individual families, often in rural areas, that throw their own water source and piping. All water sources are reliant on precipitation. Of the aggregate normal yearly precipitation of around 320bcm for Peninsular Malaysia in the range of 47% keep running off as surface stream and is useable for use. The aggregate yearly necessity is evaluated to reach around 14bcm by 2020 which compares to 12% of the aggregate water accessible. In any case, water supply administration and development in Malaysia is not thought, but rather is done on a territory by-state premise; and to cater for the distinctions in supply and interest interstate water exchange developers have been completed (WHO, 2001).

WWF Malaysia (2004) state that, Malaysia gets bottomless precipitation averaging 3,000 mm every year that adds to an expected yearly water asset of exactly 900 billion cubic meters. Roughly 97% of our new water supply for cultivating, residential and industrial needs are gotten from untamed water sources principally streams. Malaysia has 189 stream basins - 89 in Peninsular Malaysia, 78 in Sabah and 22 in Sarawak. All the waterways begin and stream from the uplands. Domestic water systems are customarily furnished with water under more or less 480 kPa pressure and a few segments of household water systems, arranged at low rises are furnished with water under pressure as high as 690 kPa. This reasonably high pressure conveyance of water to residential water systems is included all together that adequate water pressure may be maintained at higher height parts of the system, however most household water clients don't require the conveyance of water at pressure approximately 480 - 690 kPa, with the potential special case of programmed water utilizing appliances. Regardless, programmed water utilizing apparatuses may be modified to run effectively under impressively less water pressure (Guisti, 1979).

The yearly inward renewable water assets are evaluated at 630 km3. As open water is promptly accessible as the year progressed, it is absorbed primarily for watering system and household purposes. The groundwater potential is situated to a few pockets of the seaside area and is generally misused by provincial individuals to supplement their pipeled water supply. Surface water represents to 97% of the aggregate water utilization, while groundwater represents to 3% (chart 1). In 1995, the aggregate generation of drinking water from treatment plants was 3.95 Km^3, while the sum supplied to residential and modern parts was just 2.98 Km^3 (chart 2). Give or take 320% of the water delivered is lost in the dispersion system because of a few qualities, for example, pipe spillage, under-metering, and other unaccounted water misfortunes (Kundell, 2014).