IMPROVEMENT OF LOW PRESSURE WATER HYDRAULIC SYSTEM

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Special dedication to my family, supervisor, my friends and all that help me to completely my thesis.

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ABSTRACT

This thesis presents a study on Improvement of Low Pressure Water Hydraulic System. This study mainly is focuses building improvement of hydraulic power unit, improvement design of control system, fabricate improvement of water hydraulic power unit and system and performs run testing system. Otherwise, another purpose of this study is to use *FluidSIM FESTO* Software to simulate improvement of low pressure water hydraulic system. In addition, another purpose of this study is to use *Programmable Logic Control (PLC) OMRON* as control system for this improvement of low pressure water hydraulic system. Several testing will run to improve of low pressure water hydraulic system with explore the limitation and come out with solution to solve the problem occurs. The performance of this system will testing in terms of temperature distribution, cylinder speed, and output force cylinder testing. The result has been record and analysis to verify the ability of improvement of low pressure water hydraulic system and to make comparison with development of low pressure water hydraulic system. The results shows improvement of water hydraulic system was improve than development of water hydraulic system. Conclusion, objective of this thesis was achieved and this thesis successfully done.

ABSTRAK

Tesis ini menerangkan tentang kajian pembaikan sistem hidraulik air tekanan rendah. Kajian ini tertumpu kepada pembinaan pembaikan unit kuasa hidraulik, pembaikan mereka sistem hidraulik air, memasang unit kuasa pembaikan sistem hidraulik air dan sistem dan menjalankan kaedah ujian utuk menguji setiap sistem. Tujuan lain kajian ini untuk memggunakan perisian komputer "*FluidSIM FESTO"*. Selain daripada itu, tujuan seterusnya kajian ini untuk menggunakan "*Programmable Logic Control (PLC) OMRON"* dimana ianya mengawal sistem bagi pembaikn sistem hidraulik air tekanan rendah dan digunakan secara meluas dalam industri. Beberapa ujian akan dijalankan bagi pembaikan sistem hydraulic air tekanana rendah dengan mencari had sistem hidraulik air ini dan mengatasi masalah yang berlaku. Keupayaan sistem ini akan diuji melalui ujian distribusi suhu, ujian kelajuan lejang dan ujian daya keluaran lejang. Keputusan ujian akan dicatatkan dan dianalisis bagi mengenal pasti keupayaan pembaikan sistem hidraulik air tekanan rendah dan melakukan pembandingan dengan sistem hidraulik air tekanan rendah terdahulu. Keputusan menunjukan pembaikan berjaya dilakukan dalam sistem hidraulik air yang terdahulu. Kesimpulanya, objektif tesis ini tercapai dan berakhir dengan jayanya.

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LIST OF ABBREVIATIONS

PSM 1	=	Projek Sarjana Muda
PLC	=	Programmable Logic Control
UTeM	=	Universiti Teknikal Malaysia Melaka
RO	=	Reverse Osmosis
F	=	Force, newton
N	=	Newton
P	=	Pressure, bars
A	=	Area, m^2
^{o}	=	Angle, degree
^{o}C	=	Degree Celcius
m	=	Meter
b	=	Bore, m
v	=	Speed, ms^2
s	=	Stroke Length, m
t	=	Time, s
%	=	Percentages

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Now day, in our nature is nothing more closely associated with cleanliness, freshness, and purity. The new technology today comes out with water application in role as a power medium for hydraulic system. As the result, this system is call as Water Hydraulic System. What is an actually Water Hydraulic System? Water Hydraulic System is related with Fluid Power. "Fluid Power is a technology that deals with the generation, control, and transmission of power, using pressurized fluids". (Anthony Esposito, 7th Edition) In Fluid Power, when the fluid is a liquid is called "*Hydraulic"* and when the fluid is a gas is called "*Pneumatics"*. That is why, in this case when water as liquid and used in fluid power system is called Water Hydraulic System.

Furthermore, when water is a liquid in fluid power system there are many variety of reasons the advantages of Water Hydraulic System. Firstly, as we know water based fluids are fire resistant and fireproof. Water also promotes safety in other ways with workers do not breathe harmful oil vapors or risk exposure to skin and eyes. Application of fluid power system in our life is wide. For example, Hydraulic Chain Saw can operate under high pressure to provide huge forces and torque to drive loads. It operation used hydraulic gear motor which is a flow rate range is 4 to 8 gpm and a pressure range is 1000 to 2000 psi.

1.2 OBJECTIVES

This Bachelor of Degree Project (PSM) is about the improvement low pressure water hydraulic system. The objectives of this project are as follow:

i) To fabricate the improvement of low pressure water hydraulic system.
ii) To conduct the experiment to test the improvement system.
iii) To compare between improvement of low pressure water hydraulic system with development of low pressure water hydraulic system in term of cylinder speed and output force of cylinder.
iv) To installing filter in improvement of low pressure water hydraulic system
v) To find temperature distribution of improvement of low water hydraulic system.

1.3 SCOPES

The generally scopes of the project are as shows below:

i) Reverse Osmosis Water (RO-Water) as fluid in hydraulic system.
ii) Re-design the existing system by using PLC control system.
iii) Validate the system control.
iv) Build up a water hydraulic power unit component.
v) Improve in low water hydraulic system :
    1) Install filter at output reservoir
    2) Replace 5/2 way Double Solenoid Control valve with 3/2 way compact solenoid control valve with 6mm port.

1.4 PROBLEM STATEMENT

Applications of hydraulic and pneumatic systems are useful in industries. The common fluids used to transfer power in the fluid power system are oil and gas. However, with discovery of the new technology, water can also be used as a fluid used in hydraulic system. This new fluid as pressure medium has been discovered and water is a suitable medium comes along with characteristic of non toxic, nonflammable, low cost, and no adverse effect for our environment. As a result of several researches and testing, engineers have viewed water hydraulics with renewed interest with water able to be used as hydraulic fluid. Unfortunately, for hydraulic system with low pressure, it needs further development and testing is required to verify the problem occurs when using water as a fluid.

CHAPTER 2

LITERATURE REVIEW

This chapter is presentation the review of low water hydraulic system literature which consists of several numerous studies from the past and presents. Nevertheless, basic theories of fluid power system will be presented in this chapter. These study are features the theories that are explained and analyze the application and phenomena of hydraulic system and low pressure fluid power system.

2.1 LITERATURE REVIEW

The studies on the related literature of Low Pressure Water Hydraulic System that have been published on a research will be presented in this section. All sources from various journal, references books and technical paper have been studied to understand the topic area of this project.

2.2 ANALYSIS DEVELOPMENT OF LOW PRESSURE WATER HYDRAULIC SYSTEM

Development of low pressure water hydraulic system had been done before. The analysis for several testing included water hydraulic system, pneumatic system and hydraulic system. All result for each system will be compared and analysis.

2.2.1 Breakaway Pressure

Breakaway pressure is the minimum pressure needed for cylinder to start moving during extension and retraction. In this study, the minimum pressure needed for cylinder to start moving are 0,2 bars using water hydraulic system for pneumatic system, the minimum pressure needed is more than 0 but less than 0.5 bars.

For water hydraulic system, the breakaway pressure for the cylinder is accurate because the pressure is obtained using digital pressure gauge. First the initial pressure is set to zero. The pressure slowly increased by turning the pressure relief valve. In the test that had been run, the cylinder does not move when the pressure is zero. However, cylinder starts to move when the pressure reached 0.2 bars.

2.2.2 Overall Speed and Output Force of Cylinder

The speed and output force has been determined for water hydraulic system, pneumatic system and hydraulic system. Based on results, it is known that speed for extension and retraction for both system (pneumatic and water hydraulic system) increase when the pressure given increase. The difference between these systems is that pneumatic system speed faster than water hydraulic system.

This is because water has a higher density than air. While for hydraulic system, the speed obtained is for reference only due to different size of cylinder used in this test. For output force both water hydraulic system and pneumatic system, the cylinder output increase when the pressure given increase. The retraction force is higher than extension force. This is because the pressure reading during retraction is larger than pressure reading during extension.

While for hydraulic system, extending force is higher than retraction force at pressure of 2.4 bars and 6 bars. At test pressure 8 bars, the retraction output force is higher than output force of extending force.

The difference between water hydraulic and pneumatic system in term of output pressure is not that big. This is because water hydraulic is tested at low pressure instead higher pressure. Meanwhile for hydraulic system, the force are lower than water hydraulic system and pneumatic system because of the size of hydraulic .the size of cylinder effect the output force by shown equation:

$$\text{Force, } F = P \times A \tag{2.1}$$

2.2.3 Internal Leakage of Cylinder

It is already stated that there is no leakage in cylinder extension and retraction process for water hydraulic system, pneumatic system and water hydraulic system. External leakage test is not included in this study, thus leakage test for internal and external leakage cylinder should be conducted to determine any leakage.

2.2.4 Leakage of Control Valve

For water hydraulic system, electro pneumatic double solenoid control valve is used as the control unit for the actuator. Due to the fact that water is used, the control valve may cause electric shock and leakage when pressure of 8 bars is applied. And since pneumatic control valve is used because the control system uses PLC, the data obtained are not accurate. For pneumatic and hydraulic system, there is no visible leakage at the around valve. Figure 2.1 shows the leakage of the control valve.