Design of Portable Electric Hydraulic Jack for Improving The Productivity

P Rachmawati*, I R Kurniawan
Universitas Muhammadiyah Yogyakarta, Indonesia

*putri.rachmawati@vokasi.umy.ac.id

Abstract. The hydraulic system is a system that works based on character and potential that exists in liquid. Maintenance is a work done in sequence to maintain or to improve existing facilities to comply with the standards. Nonconformities and limitations of tools and design concepts used by humans while working are still found in everyday life. The purpose of this research is to design the hydraulic portable device to facilitate the mechanics in car maintenance and repair especially a part of the bottom machine. The data collection is done by directly measuring the performance test of the portable hydraulic jack in Autocar Andi Jaya compared with the original jack. The conclusion of this research is a tool that has benefits in supporting the car when car service is performed. This tool generates the total number of completed car maintenance and repair outputs of 30 minutes of normal service completion compared to the ordinary jack. Therefore, an electric portable hydraulic jack can speed up the performance of the mechanics and the results in improving productivity.

1. Introduction

Jack is a tool used to lift a car so that mechanics can check parts of the bottom of the car. Many types of jacks can be found in car workshops both large workshops and simple workshops supported by hydraulic jacks and car lifts. Hydraulic jacks are the most widely used jacks because they are lightweight and easy to use [1], affordable cost of applying access tools, easy maintenance, and portable. However the hydraulic jack can only lift one side of the car that is approved by the mechanic to service the underside of the car. Usually, the mechanics can solve it more than one side of the car using the help of Jack Stand / stand jack, but the use of Jack Stand is not effective because the new Jack Stand can be applied after the car is lifted using a hydraulic jack. Electric hydraulic jack is a tool used by technicians to improve the car using the working principle of hydraulics so that the technician does not automatically need to spend a lot of labor[2]. In order for electrical control to be applied to the manual control of the hydraulic pump, the author needs to align the manual hydraulic pump (driven) system with electrical control (which drives) using an electric motor. With the installation of an electric motor, this will help the mechanic to make car repairs [3]. The driving motor as a converter of electrical energy becomes a mechanical drive, the use of an electric drive motor on a manual hydraulic pump. From the problems that arise in the upper hydraulic jack, the author has the idea to install an electrical control system on the hydraulic pump that will be applied to a portable hydraulic jack. Portable Hydraulic Jack is a jack that can lift all sides of the car used by mechanics to facilitate mechanics in carrying out car repair and
maintenance activities, so from the results of this study will be a jack that can lift all sides of the car and work automatically.

The design of a portable electric hydraulic jack is needed for car service aids so that it can be effective, efficient and make it easier for changing part while washing cars in the process of car engine maintenance in the workshop.

Research purpose is application design of a portable electric hydraulic jack in the workshop. Benefits of research are to simplify mechanics in carrying out the maintenance and repair process of the lower part of the car and speed up mechanics in service and car wash.

2. System Design

Designing or designing is a series of procedures to translate the results of analysis and a system into a programming language to describe in detail how the system components are implemented [4].

Hydraulic systems are systems that are often used and developed for industrial activities, from light industry to heavy industries such as the vehicle and mining industries as a means of driving on cutting machines, folding machines, press machines and lifting equipment with a capacity of hundreds of tons [4]. The parts or tools of this hydraulic system are quite simple, so that the operator or user obtains more secure safety and security, besides that the hydraulic system has the advantage of including an energy transfer system using fluid (hydraulic oil) so that it looks more flexible. The piston rod translation from the working cylinder caused by fluid pressure in the cylindrical space of the movement is used for forward and backward and up and down motion according to the installation ie vertical or horizontal direction [5]. Jack is a device that serves to help lift a vehicle not to support [6]. Ergonomics is a study of the relationship between people and their work environment.

3. Methodology and Result

The concept in this design is divided into the design of its own jack and hydraulic body. The principle of this research is divided into 2 types, namely: jacks and electrical systems in hydraulics. Body simulation jacks use inventor application, with the same concept as the carlift as a car service jack. Electrical systems use designs with AutoCAD [1]. Body design uses folding frame simulation. The method of designing this study with this study can be seen in a flow chart below:
The folding frame design can be seen below;

**Figure 1.** Process Flowchart

**Figure 2.** Folding Frame 2D

**Figure 3.** Folding Frame 3D
The result of the calculation obtained:

Table 1. Calculation of lift force of Portable Hydraulic Elektric Jack

| No | Hydraulic Tilt | Folding Frame | Tilt Folding Frame Support style (kN) | Folding Single Frame Support Force (kN) | Hydraulic Lift Force (kN) | Total hydraulic Lift (kN) |
|----|----------------|---------------|---------------------------------------|----------------------------------------|--------------------------|--------------------------|
| 1  | 11°            | 12°           | 13.07                                 | 6.54                                   | 77.04                    | 71.65                    |
| 2  | 24°            | 30°           | 5.44                                  | 2.72                                   | 36.14                    | 30.75                    |
| 3  | 29°            | 45°           | 3.84                                  | 1.92                                   | 30.32                    | 24.93                    |
| 4  | 32°            | 60°           | 3.14                                  | 1.57                                   | 27.74                    | 22.35                    |
| 5  | 31°            | 70°           | 2.89                                  | 1.45                                   | 28.54                    | 23.15                    |

The data table 1. above shows the results of hydraulic lifting force and folding frame support force and folding frame support force derived from portable electric hydraulic jack. If viewed through the graph, you will see the ups and downs of lift force data and support forces in each slope of the degree passed by portable electric hydraulic jack. The following graph is from the lift table data above:

Note:  

a = 11° dan 12°, b = 24° dan 30°, c = 29° dan 45°, d = 32° dan 60°, e = 31° dan 70°

From the calculation data and graph above it can be concluded that the higher the value of the hydraulic tilt angle and the folding frame, the smaller the force produced. That is, both hydraulic and folding frame will be stronger in lifting and supporting the weight of the car being lifted. Thus the optimal lifting force of the folding frame comes from the slope of 70° and the hydraulic comes from the slope of 32°. There are 2 calculations for power value (P), namely input and output power because the electric motor uses gearbox components. Input power using
the formula \( P = V \times I \times t \), that \( V = 180 \) Volts, current \( (I) = 0.75 \) Amperes, then divided by time. The results of the input electric motor are 135 Watts. The output power at the electric motor power is not the same because there is a gearbox component used the formula \( P = T \times n \) that \( T \) is the output torque = 577.5 Nm. \( n \) (the RPM coming out of the gearbox that has a value of 57 revolutions per minute), the result of the output power value is 32, 92 Watts. The power that came out was very large because of the gearbox components so that the rotation of the electric motor was very slow and very strong. The working principle of the installation of an electric control system on this portable hydraulic jack is when the switch is on then the electric motor will function to rotate the slab and on the slab, there is a lever so the lever will fluctuate pumping the hydraulic pump.

4. Conclusion
The results of replacing spare parts and total service with this portable electric hydraulic jack are compared with a crocodile jack of only 100 minutes while a crocodile jack of 130 minutes. The results obtained show that the design of this tool can increase mechanical productivity.

5. Acknowledgement
We are very grateful to LP3M Universitas Muhammadiyah Yogyakarta for helping to complete this research. We are thank you for Diploma program majoring the Mechanical Engineering Muhammadiyah University of Yogyakarta in supporting costs to attend the conference.

References
[1] Sainath K 2014 Design of Mechanical Hydraulic Jack *IOSR J. Eng.* 4 15–28
[2] Chin P E H 1985 United States patent *Geothermics* 14 595–9
[3] Agrawal M, Thakur M G, Mahajan D and Chahar T S 2018 Inbuilt Hydraulic Jack System for Four Wheelers : -A new trend in automobile sector 1386–90
[4] Middlesworth M 2014 A Step-by-Step Guide Rapid Entire Body Assessment ( REBA ) *Ergon. Plus Inc* 1–11
[5] Frederick R C, Dixon B, Middlesworth M, Agrawal M, Thakur M G, Mahajan D, Chahar T S, Chin P E H, B-b S, A-a S and Sainath K 2014 Optimizing Performance and Fuel Efficiency for a Formula SAE Car *IOSR J. Eng.* 4 15–28
[6] Plantard P, Shum H P H, Le Pierres A S and Multon F 2017 Validation of an ergonomic assessment method using Kinect data in real workplace conditions *Appl. Ergon.* 65 562–9