

# EFFECTIVE PERFORMANCE AND INFLEUENCE OF AUTOMATED INBUILT HYDRAULIC JACK IN A FOUR WHEELER VEHICLE

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**ABSTRACT**– A hydraulic jack with inbuilt system is attached to automobile vehicle on front and rear part of the chassis. Further, an automobile hydraulic jack system can be easily attached to all currently manufacture automobile chassis and frames. A front suspension hydraulic jack is mounted centrally to the front suspension of an automobile and in between its front wheels and also a rear suspension hydraulic jack is mounted centrally to the rear suspension of the automobile and in between its rear wheels. Further, the system operates from a compressed fluid reservoir tank that has connections and an additional outlet are added to the compressed fluid reservoir tank for connecting a hydraulic lug wrench and another for a tire inflating hose. Additionally, if this work is implemented, would definitely help in the maintenance of automobiles and also in saving of time.

**KEY WORDS** : Hydarulic Jack, Automotive Systems, Actuators and Vehicle Structures.

## 1. INTRODUCTION

An inbuilt hydraulic jack is a jack that uses a liquid to push against a piston. This is based on Pascal's Principle and it states that pressure in a closed container is the same at all points. Further, if there are two cylinders connected, then the applying force to the smaller cylinder will result in the same amount of pressure in the larger cylinder [1]. On the other hand, since the larger cylinder has more area and the resulting force will be greater or in other words, the increase in area leads to an increase in force. Hence, the greater differences in size between the two cylinders have greater increase in the force will be. A hydraulic jack operates based on this two cylinder system. A jack is a mechanical device used as a lifting device to lift heavy loads or vehicles [2].

The most commonly used jack is car jack, floor jack or garage jack. By using this technology the following priorities are given like Safety, luxury and comfort. The Automated hydraulic jack inbuilt in a four wheeler drive is based on the PASCAL'S LAW (shown Fig 1.1). It can be also used in light weight and medium weight vehicles. The project can be made highly feasible and this jack is a device used to lift heavy loads. The device itself is light, compact and portable, but is capable of exerting great force. The device pushes liquid against a piston; pressure is built in the jack's container. The jack is based on Pascal's law that the pressure of a liquid in a container is the same at all points.

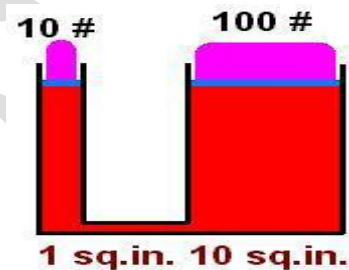


Figure 1. Pascal's Law

## 2. NEED FOR AUTOMATION

The The following features are required for the automation

- To achieve mass production.
- To reduce human effort.
- To increase the efficiency of the jack.
- To reduce the work load.
- To reduce the production cost.
- To reduce the production time.
- To reduce the material handling.
- To reduce the fatigue of workers.

## 3. LITERATURE REVIEW

When increasing the levels of technology efforts being put together to increase the comfort and safety. It can be done by implementation of better design. Operating the pump which press the oil to the control valve, subsequently the oil flows to the cylinder which can be directed using the control valve. During the lifting stroke, the pressure will be imparted to the piston and the stroke occurs [3]. Further, the Cost

estimation and analysis of the following parts are done on Ram cylinder, Ram, Top plate, Plunger cylinder, Plunger, Lever, Reservoir and the Base plate [4].

The design and fabrication of inbuilt hydraulic jack where testing of every parts are done. In a single time, one or both jacks can work and the vehicle can lift from one side and also parallel from two sides as per the requirements [5]. Here the hydraulic cylinder is actuated using pumps and reservoirs, where a control unit is used to control the flow of fluids and actuate the mechanism [6]. The main purpose of this content is to obtain a quick actuation using pneumatic cylinder it can be actuated using battery power supply from the car. The design and fabrication of every parts of the jack are done[7].

The efforts required in achieving the desired output can be effectively and economically be decreased by better design where Ivan Sunit Rout says that in this motorized automatic jack gear pump is used. Fabrication of gear pump is done as per the requirement. In this control switch and limit switch are provided for safety limits [8]. The development of automated pneumatic jack is done. Difficulties and problems in this type of jack is identified and rectified. This replaces the hydraulic jack and the fatigue is less[9-10].

#### 4. IDENTIFICATION OF PROBLEM

In current scenario using of other jacks may lead to slipping of vehicle while lifting so that there is no complete lifting of jack. And also during the lifting operation the pressure produced to lift the vehicle cannot be controlled which is the main drawback of other jacks. The major problem in jack is time required for the complete lifting of vehicle. Currently, the jacks available are difficult to lift for the elderly, women and are especially disadvantageous under adverse weather conditions. Right now, the available jacks further require an operator to remain in prolonged bent or squatting position to operate the jack. Further, by doing work in a bent or squatting position for a period of time is not ergonomic to human body and it will give a back problem in due of time. Moreover, the safety features are also not enough for operator to operate the jack. The requirements are identified through the literature review.

#### 5. PROBLEM RECTIFICATION

In this project, we consider the source for lifting since after completing there is no need of any external source for lifting the jack. Here, the pressure produced to lift the jack is controlled. Also, slipping vehicle from the jack head can be avoided and it is easy to operate comparing with other

working jacks. At the same time the jack is automatically operated and the complication of finding the jack point is neglected and it can be operated by a rookie.

#### 6. METHODOLOGY ADOPTED

The working medium adopted is hydraulic fluid and this fluid is transmitted through tubes into the hydraulic cylinder, where the power is converted into a reciprocating motion. Further, this reciprocating motion is obtained by using a non return flow valve and this reciprocating motion is transmitted to the jack through the piston which moves on the cylinder and the methodology adopted is shown in the figure 6.1.

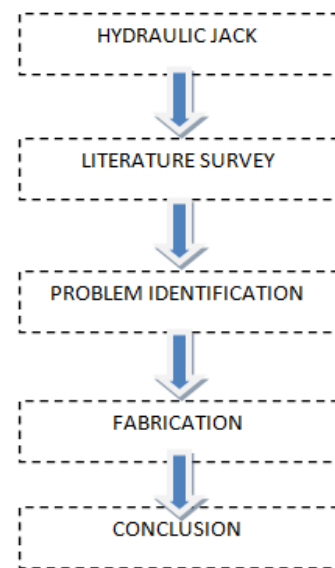


Figure 2. Research Methodology

The hydraulic jack is placed under the vehicle chassis and the vehicle is to be lifted and the oil is flow into the cylinder at the condition when the valve is opened. Further, vehicle over the jack gets the reciprocating motion through the piston which is connected to the jack and by using a hydraulic jack the vehicle can be lifted with ease in operation and has many advantages, such as:

- Power can be easily transmission.
- Less loss in transmission
- Low cost.
- Easy to work and reduces the manual stress.

#### 7. DESIGN REQUIREMENTS

##### 7.1.1. Specification of Parts

The specification and design requirements for the certain parts are discussed in this section.

##### 7.1.2. Jack (Dc - 12volt)

- 1) Lifting capacity - 2Tons
- 2) Net Weight - 3.5kgs

- 3) Maximum height - 12to35cms

### 7.1.3. Pump and Motor (Dc - 12volt)

- 1) Pressure - 150PSI
- 2) Oil used - SAE [Grade 2000]
- 3) Filter - Steel caged filter
- 4) Flow rate - 32ml/min
- 5) Temperature range - Max 140deg
- 6) Viscosity – 0.2 to 1500cp

### 7.1.4. Vehicle Specification

- 1) Weight- 45kgs
- 2) Width- 600mm
- 3) Length- 900mm (Axle-800mm)
- 4) Body material – Mild Steel
- 5) Ground clearance- 260mm
- 6) Load – Max 100kgs

According to the specification the design of this project is made and prototype is created

## 7.2. DESIGN SPECIFICATIONS

### 7.2.1. Design Parameters

- 1) Thickness of the cylinder = 4 mm
- 2) Inner diameter of cylinder = 45 mm
- 3) Pressure inside the cylinder = 9.43 N/mm<sup>2</sup>
- 4) Outer diameter of cylinder = 53 mm
- 5) Factor of safety = 3
- 6) Maximum tensile strength = 210 N/mm<sup>2</sup>
- 7) Yield strength = 210/3 = 70 N/mm<sup>2</sup>

### 7.2.2. Design Calculation

Assuming internal diameter = 45mm

$$1) \text{ Area} = \pi r^2 = \pi (22.5)^2 = 1590.43 \text{ mm}^2$$

$$2) \text{ Here, Pressure } P = F/A$$

Assuming pressure force (F) = 15000 N

$$P = 15000/1590.43 = 9.43 \text{ N/mm}^2$$

$$3) \text{ Applying Lame's theory}$$

Where,  $P_x = b/x^2 - a$ ..... Radial Pressure

Where a and b are constant.

$$P_x = b/x^2 - a$$

$$9.43 = b/(22.5)^2 - a \text{..... (1)}$$

Where,  $\sigma_x = b/x^2 + a$ .....Hoop stress

$$\sigma_x = b/x^2 + a$$

$$70 = b/(22.5)^2 + a \text{.....(2)}$$

By solving this equation

$$b = 20105.72$$

$$a = 30.28$$

For external radius of cylinder  $P_x = 0$

$$P_x = b/x^2 - a$$

$$0 = 20105.72/x^2 - 30.28$$

$$x^2 = 664$$

$$x = 25.77 \text{ mm}$$

$$\text{Therefore, thickness of cylinder} = 25.77 - 22.5 = 3.27 \text{ mm}$$

Therefore, here we take the thickness of the cylinder is 4 mm.

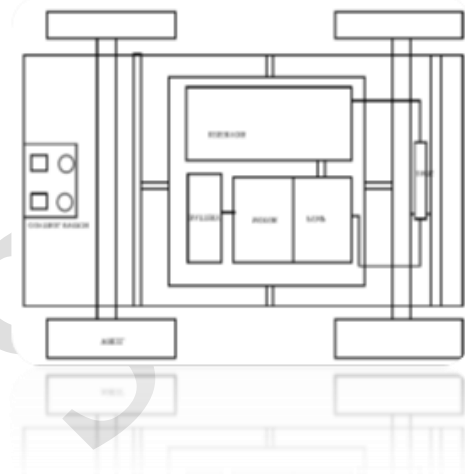


Figure 3. Layout of the Model

According parts and design considerations the layout of the model is created and shown in the fig 7.1.

### 7.3. TIMING ANALYSIS

Lifting time analysis between Hydraulic jack, Motorized screw jack and screw jack. Time required for lifting is

- Screw Jack = 190 seconds
- Motorized Screw Jack = 80 seconds
- Auto Hydraulic Jack = 55 seconds

From the lifting time analysis automated hydraulic jack is most preferable.

## 8. FABRICATION OF STRUCTURE

A square (M.S) beam of 900 mm length and 600 mm breadth is taken and welded together, in order to get a required frame structure. For placing the battery and control switches 15cm \*10cm box is created on the top of the frame. Then the frame is placed on the axle of length 800mm. For placing the jack front end mid of the frame is chosen the jack is placed on the clamp which can be operated in oscillatory motion and also in fixed condition. The fabricated model of the entire structure shown in the below figure 8.1.



Figure 4. Fabricated Model

## 9. CONCLUSION

In the automatic lifting venture, the jack requires less or minimum efforts and also it saves time. Further, the jack is automatically operated and the complications of finding the jack point are neglected and it can be easily operated by a rookie and women. Though, it will also make the maintenance of the vehicle easy and the user can easily operate the jack in any environmental condition. At the same time, timing is considered automatic hydraulic jack is more effective than others at any conditions and it will be the most preferable one. Also, the maintenance of vehicle will be very easy and considering the servicing of vehicle will be easy and cheap. Hence, this type of system is very useful for ladies and since during the problem of puncher of tyres, they can easily change the wheel and save the time. Further, a single person can go on a long drive. Seeing that the whole system is operated by battery and the jacks will also work when vehicle will not in starting condition.

## 10. SCOPE FOR FUTURE WORK

The arrangement of hydraulic inbuilt jack system is designed for small car in this project. Further, modifications to be done and this arrangement can be widely use in future for heavy vehicles. This innovation would be very helpful for the women, elders and other fellow folks to easily change the tires when stuck in the middle of nowhere. Also, this innovation would save time of installing a manual jack and unloading the vehicle as the problem of unloading would be minimized. Hence, it would help in washing of the lower body of the car as it would raise the car by about 2 feet. Further, it would help the mechanic to repair on road as the innovation would increase the road clearance of the car and would be easily repaired.

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