

Design and Development of Hydraulic Press Machine

¹Prof. Nandakishor D. Bankar, ²Mr. Mahesh B. Shinde

¹Lecturer in Mechanical Engg. Department, MGM's Polytechnic, Aurangabad MH. India

²Students in Mechanical Engg. Department, MGM's Polytechnic, Aurangabad MH. India

ABSTRACT: Hydraulic press is a mechanical device which is based on the 'Pascal's law' which states that equal intensity of pressure exerts on all the directions in a closed system. Hydraulic press is a tool to produce compressive force by means of fluid. Major component of Hydraulic system are Hydraulic Power Pack, Control Valve, Actuator and Accessories. By means of hydraulic system larger forces can be produced in contrast with mechanical and electrical systems. Such forces can be used for the press work application such as blanking, punching, piercing, coining, trimming etc. The concept of the hydraulic press is based on Pascal's theory, which states that when pressure is applied on fluids in an enclosed system, the pressure throughout the system always remains constant. In hydraulic press, the force generation, transmission and amplification are achieved using fluid under pressure. The liquid system exhibits the characteristics of a solid and provides a very positive and rigid medium of power transmission and amplification. In a simple application, a smaller piston transfers fluid under high pressure to a cylinder having a larger piston area, thus amplifying the force. There is easy transmissibility of large amount of energy with practically unlimited force amplification. Hydraulic press is a tool to produce compressive force by means of fluid.

KEY WORDS: Hydraulic Press, H-frame, Design, Press work, Automation etc.

Date of Submission: 25-07-2021

Date of acceptance: 10-08-2021

I. INTRODUCTION

The hydraulic press depends on Pascal's principle: the pressure throughout a closed container system is constant. One part of the system is a piston acting as a pump, with modest mechanical force acting on a small cross-sectional area; the other part is a piston with a larger area which generates a correspondingly large mechanical force. Only small-diameter tubing (which more easily resists pressure) is needed if the pump is separated from the press cylinder. Press work is a method of mass production involving the cold working of metals, usually in the form of thin sheet or strip. Press working is one of the extensively employed methods of fabricating parts of intricate shapes with thin walls. Press working processes make use of large forces by press tools for a short time interval which results in cutting or shaping the sheet metal. Since, press working does not involve heating of the parts, close tolerances and high surface finish can be obtained on the part. Since presses can produce components at fairly fast rates, the unit cost of labor for operating the press is fairly low. Press working forces are set up, guided and controlled in a machine referred to as a Press. Thus an attempt has been made to atomize the process of press work using Hydraulic mechanism in press machine. The inputs and outputs of the control system including hydraulic mechanism are solely mechanical such as rotating shaft or reciprocating plunger. The prime remuneration of implementing this system is the movement of the mechanical. Devices can be operated by means of hydraulic components such as actuators to initiate the movement which could be in the form of lever to apply manually or by means of switches to operate automatically. Furthermore, direction control valves have been implemented to control the directions of piston movements and regulate the same. Thus the whole mechanism has been simplified with the use of hydraulic equipments. Moreover, the use of pressure control valve and direction control valves makes it easier to regulate the forces and control the speed of the setup. The principle of the hydraulic press is used in lift jacks, earthmoving machines, and metal-forming presses. A comparatively small supply pump creates pressure in the hydraulic fluid. The fluid then acts on a substantially larger piston to produce the action force. Heavy objects are accurately weighed on hydraulic scales in which precision-ground pistons.

II. LITERATURE REVIEW & OBJECTIVE

Tejas Patel in this paper Authors show that hydraulic system is used to develop a press. The press will be useful for mass production of Washers. This may increase the productivity and increases the accuracy of the production. Even the press can be completely atomized by using the concept of electrohydraulics. Direction control valve can be solenoid actuated to make the system close loop. Which may lead to higher production rate.[1]

Mr. K. Shravan Kuma in this paper Authors show that multi-purpose machine as it can be used for performing different tasks. By changing the die different operation like bending, blanking etc. can be performed on a hydraulic press machine. The design has main focus on reducing operator fatigue and increase safety, improving the flexibility and makes operation more convenient, and to achieve dimensional and positional accuracy. Components of press are designed to avoid bending failure due to applied load. Mild steel is selected as material based on its properties such as high bending & tensile strength, its compatibility with operation like machining, welding, finishing, cutting etc. and cost as economic factor.[2]

Mr Piyush T. Patel in this paper Authors show that the machine was tested to ensure conformability to design objectives and service ability. By performing experiment for different thicknesses of sheets, it is concluded that molding operation is performed up to 5 mm. It is a multi-purpose machine as it can be used for performing different tasks. By changing the die different operation like bending, blanking etc. can be performed on a hydraulic press machine. The design has main focus on reducing operator fatigue and increase safety, improving the flexibility and makes operation more convenient, and to achieve dimensional and positional accuracy. Components of press are designed to avoid bending failure due to applied load. Mild steel is selected as material based on its properties such as high bending & tensile strength, its compatibility with operation like machining, welding, finishing, cutting etc. and cost as economic factor.

Neville Saches in this paper the Author focused on the causes of failure for understanding mechanical failure in machines components. Paper gives the brief introductions about the ductile fracture, fatigue failure and stress concentration. Paper also discussed the type of load is responsible to failure i.e., internal pressure, bending, torsion or a combination [3].

LeRoy Fitzwater, Richard Khalil, Ethan Hunter in this paper Authors show that the topology optimization method outlined herein provides convincing evidence to re-think the way aircraft structure is designed. Topology optimization is gaining popularity and requires some further development to document the effective use of this tool and to aid the engineer in producing quality designs. The benefits are numerous, including load path visualization, weight savings, increased systems design space, improved ballistic protection and fatigue resistance. These benefits offer a compelling incentive to employ this technology into the current design process to improve the performance of engineering products. Following figure shows the optimizations steps[4].

- 1) To analyze the problems present in existing press.
- 2) To design the critical components of the hydraulic press using geometric modeling software.
- 3) To analyze and optimize the critical areas of more than 2 ton hydraulic press.

III. DETAILS OF DESIGN, WORKING AND PROCESS

Hydraulic press is a mechanical device which is based on the 'Pascal's law' which states that equal intensity of pressure exerts on all the directions in a closed system. It applicable here in such a way that if there is any pressure change at one point in a closed system then same intensity of pressure will change at other point in the same system. Hydraulic press is able to develop high forces with the application of less effort. There are two main parts in the hydraulic press assembly, one is called as ram and second one is known as plunger. Ram works as output medium where as plunger gives input. In between ram and plunger hydraulic fluid is filled in a closed reservoir which is responsible for the whole operation i.e. force and pressure transmission. In practical situation both plunger and ram have different size and area. If 'A' is the area of ram and 'a' is the area of plunger then the mechanical advantage of the system is equal to A/a; which is the ratio of ram area to plunger area because pressure is defined as the force per unit area, if F is the force applied to the plunger and W is the load lift by the ram so according to the Pascal's law pressure is.

$$P = F/a = W/A \text{ or } W = F (A/a)$$

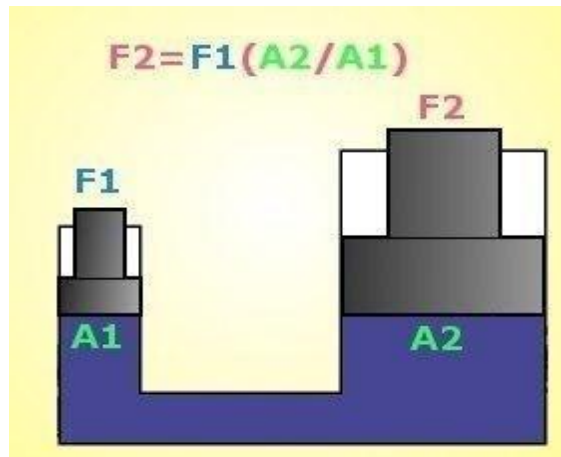


Figure 1: Concept of Pascal's Law

Above relations shows that by adjusting the area of the ram and plunger we can able to use it in several Applications where we can easily develop high forces by applying only small amount of force. In practical hydraulic press system, generally multiple rams are assembled together. The number of rams used depends upon the working load. In hydraulic press multiple rams of small sizes are preferred instead of a single large size ram to control the thrust forces because it is easy to control the thrust forces on small size as compare to large size. In press assembly one side/table is always fixed while the other is moving by the application of ram force and in between fixed as free side pressing operation is take place. Ram is operated by the hydraulic pressure of fluid. The high pressure liquid is supplied by using pump and hydraulic accumulator. Hydraulic accumulator works as the junction between the pump and the rams. Hydraulic accumulator stores the high pressure liquid when press is at stationary position. Hydraulic press is used where high thrust is required for operation.

3.1 Specification:

- Frame- Height: 725 mm
- Width-380 mm
- C-channel: 72x40mm
- Spring: Elastic Type- No. of Quantity: 2
- Free length: 230 mm
- Jack:-Capacity: 5 tons
- Height- 300 mm

3.2 Manufacturing Process:

Hydraulic presses are available in many types of construction which is also true of mechanical presses. Following construction details just gives the basic idea of dimensions of different parts used in the design module. Base is manufactured from 75x40 mm two c-channel of length 380 mm welded together .The height can be adjusted using rods. The die used for a particular given shape is welded at the bottom plate. The dimensions of the frame is 725x380 mm of c-channel of 75x40 mm with two support of c-channel Spring having free length 230 mm is fixed between middle plate and frame so as to get the flexible movement of the Movable plate. Punch is welded at the bottom of the movable plate. Jack is mounted in between the frame and middle plate. The basic Manufacturing process is shown in below figure. In 1797, Brahma built the first hydraulic press in history. Here EE depict racks, D - cover, and C - the press platform, integral with its piston, while the outer cylinder was cast together with a base for struts. In the present section can be seen next to the cylinder collar Maudsley, also shown separately enlarged by the letter Q. The cylinder press was connected to a flexible tube with separate pressure pump. Its solid piston movement was set in the initial GH via a lever rod H 'and the guide rod K. The pump is normally strengthened at the cast iron box serves as a reservoir for liquids (water, oil or glycerin) in the same reservoir fluid flowed back when the pressure reached set value and safety valve V lifted his load P or when the shutter opens the screw to release the liquid and allow the piston to move down again.

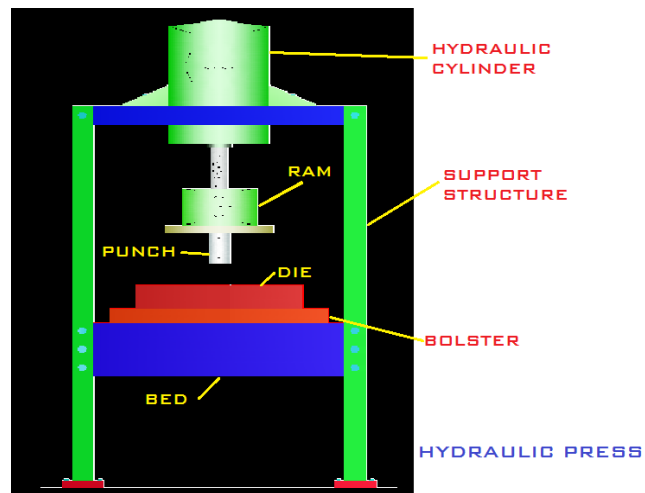


Figure 2: Design of Press Machine

3.3 Parts of Press Machine

Support structure

It is an assembly of support frame and bed. Both the channels bolster each other with the help of a supportive plate welded at the top of the structure. Further it is welded at the foundation to give the whole assembly a framed structure. The bed which holds a die is clamped on the holes as shown in the figure.

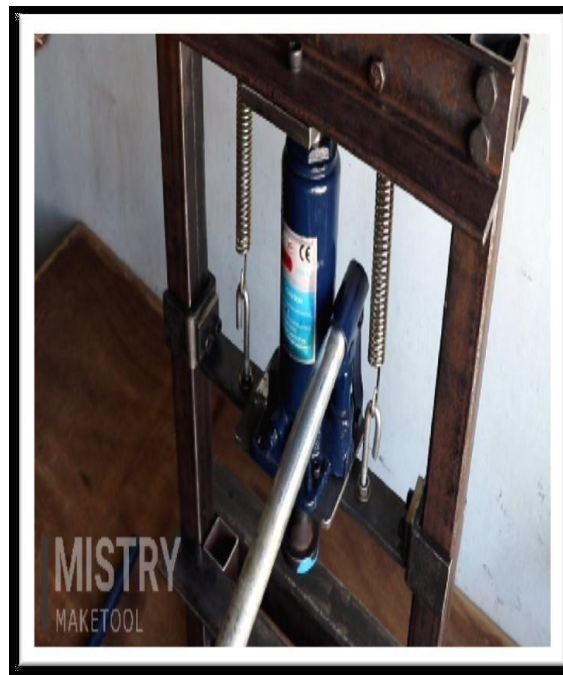


Figure 1: Actual Press Machine

Bed

Bed is a plate on which the die is supposed to held. It is used for mounting the die on support frame at desired position. Figure 3 shows the design of bed where the holes produced on the sides shows the support plate to be clamped on support frame.

Die

Die is an integral part of any manufacturing process which enables the desired shape that one require. Here for the experimental purpose a compound die have been used which produces a washer from the strip of sheet metal. The dimensions of the outcome washers are as follow. Outer diameter = 30 mm , Inner diameter = 10 mm. A blanking die produces a flat piece of material by cutting the desired shape in single operation. The finished part is referred to as a blank. Generally a blanking die may only cut an outer contour of part, often used for parts with no internal features.

Punch

Punch is the male component of die. In compound die we used two punch one cuts inner diameter of washer and another cuts outer diameter of same. Punch which cuts I.D. is placed at bottom side of female die. Second punch that cuts outer diameter of washer is attached with piston rod of hydraulic cylinder. Position of same punch is above side of die. Here figure 6 shows the section view of punch that cuts outer diameter.

Plunger and Hydraulic cylinder

Plunger has been purchased from the market. Main function of plunger in our project is it provides required hydraulic pressure to our hydraulic cylinder. Hydraulic cylinders get their power from pressurized hydraulic fluid, which is typically oil. The hydraulic cylinder consists of a cylinder barrel, in which a piston connected to a piston rod moves back and forth. The barrel is closed on each end by the cylinder bottom (also called the cap end) and by the cylinder head where the piston rod comes out of the cylinder. The piston has sliding rings and seals. The piston divides the inside of the cylinder in two chambers, the bottom chamber (cap end) and the piston rod side chamber (rod end). The hydraulic pressure acts on the piston to do linear work and motion.

3.4 Details of components

Name of part and Material used

- 1 Base-Mild steel
- 2 Movable plate-Mild steel
- 3 Spring-Mild steel
- 4 Upper plate-Mild steel
- 5 Jack-Mild steel
- 6 Body-Cast iron
- 7 Die-Mild steel

3.5 Types of Hydraulic Press

There are many different types of hydraulic presses catering to the various requirements of industries. Some of them are as follows:

Arbor Presses: These presses are usually used when the work involved is not of a heavy- duty nature. These presses come in a variety of sizes and specifications. But compared to other hydraulic presses, they do not compress large amounts of pressure required to generate more output.

Laminating Presses: Unlike other hydraulic presses that are operated automatically, these presses make use of manual labor. Laminating presses have two openings that are known as plates. One is used for heating whereas the other is used for cooling. This makes the lamination process comparatively faster.

C- Frame Presses: These presses have a 'C' like shape, which is specifically designed to maximize the floor space for the workers in order to move around easily at the workplace. Unlike other presses that have multi-processes, the C- frame presses only include a single press application. Its application includes straightening, drawing and mostly includes assembling work.

Pneumatic Presses: These presses are the most basic hydraulic presses used in industries because they compress the air to create a pressure in order to gain movement. The advantage of pneumatic presses is that the operations are performed fast whereas the disadvantage of this press is that it cannot create extremely high pressures, as other hydraulic presses are able to create. The pneumatic presses are often used in car and aircraft brakes system. The industrial uses of pneumatic presses would include assembling, drawing, punching, etc.

Power Presses: These presses are used in large industries that demand the use of heavy machinery and equipments. There are 2 kinds of power presses on the basis of the type of clutch used. They are full revolution and part revolution clutch. In case of a full revolution clutch, the clutch cannot be disrupted until and unless the crankshaft makes a full revolution.

Assembly Presses: These presses use the extreme pressure generated by the pistons and the hydraulic fluids to assemble and maintain the parts.

H- Frame Presses: These presses have a peculiar 'H' shape and are capable of handling more than one press application.

3.6 Application

The major application of the hydraulic press is in industry where big size metal objects transform into thin sheets by the application of pressure force. The common use for hydraulic pressing is primarily used for forging, clinching, molding, blanking, punching, deep drawing, and metal forming operations. With the growth and importance of light-weighting in the aerospace and automotive industry, more applications are constantly developing in Thermoplastics, Composites, SMC Sheet Molded Composites, RTM Resin Transfer Molding, GMT Glass Mat Transfer and Carbon Fiber Molding. All of these applications require precise control and repeatability.

IV. CONCLUSIONS

Thus here a hydraulic system is used to develop a press using pressurized Oil. The press will be useful for mass production in Industry. This may increase the productivity and increases the accuracy of the production. The machine was tested to ensure conformability to design, objectives and serviceability. It is a multi-purpose machine as it can be used for performing different tasks. By changing the die we can do different operations like bending, blanking, forging, clinching, molding, punching, deep drawing, and metal forming operations etc. The design has main focus on reducing operator fatigue and increasing safety, improving the flexibility and making operation more convenient, and to achieve dimensional and positional accuracy. Components of press are designed to avoid bending failure due to applied load. Mild steel is selected as material based on its properties such as high bending & tensile strength, its compatibility with operations like machining, welding, finishing, cutting etc. and cost as an economic factor.

REFERENCES

- [1]. Tejas Patel "Design and Development of Hydraulic Press with Die" 5th National Conference on "Recent Advances in Manufacturing (RAM-2015)", 15-17 May, 2015
- [2]. K. Shraavan Kumar (2017) "Design & fabrication of hydraulic press" IJSDR Volume 2, Issue 7
- [3]. Neville Sachas. "Root cause failure analysis understanding Mechanical failure". Plant maintenance Recourses center home Revised. Hungary .03 August 2009.
- [4]. LeRoy Fitzwater, Richard Khalil and Ethan Hunter. Topology Optimization Risk Reduction. Presented at the American Helicopter Society 64th Annual Forum, Montreal. Canada. April 29-May 1, 2008.
- [5]. Bhandari, V.B. (2009), "Design of Machine element", Tata McGraw-Hill Education.
- [6]. Khurmi, R.S. and Gupta, J.K. (2005), "A Textbook of Machine Design", Eurasia Publication House (P.V.T.) Ltd. 14th Edition, 1230pp. ISBN: 81-219-2537-1.
- [7]. R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Edn. 8, Laxmi Publications P. Ltd., 22 Golden House, Daryaganj, New Delhi 110 002 –2003.

Prof. Nandakishor D. Bankar, et. al. "Design and Development of Hydraulic Press Machine." *International Journal of Modern Engineering Research (IJMER)*, vol. 11(07), 2021, pp 38-43.