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Design and Fabrication of 5 Ton Hydraulic Press Machine

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ABSTRACT

A hydraulic press is a machine using a hydraulic cylinder to generate a compressive force. Frame, hydraulic cylinder and press table are the main components of the hydraulic press. In this project press frame, cylinder and press table are designed by the design procedure. They are analyzed to improve their performance and quality for press working operation. Using the optimum resources possible in designing the hydraulic press components can effect reduction in the cost by optimizing the weight of material utilized for building the structure. An attempt has been made in this direction to reduce the volume of material. So in this paper we consider an industrial application project consisting of mass minimization of H frame type hydraulic press. This press has to compensate the forces acting on the working plates and has to fulfill certain critical constraints. Here we use implementation for analysis and optimization of hydraulic press. The aim of this paper is to integrate the mechanical system of hydraulic press with hydraulic system to facilitate the ease of operation to manufacture the smaller parts in a bulk. In the present scenario, time constrain is a crucial part for completion of any production process. Thus with the aid of automization, the production time can be reduced as well as higher degree of accuracy can be achieved as the human efforts will be alleviated. Thus an attempt has been made to provide the smooth and rapid functioning of press work with the help of hydraulic system.

Keywords : Hydraulic press, Frame Structure, Press work, Hydraulic cylinder, Optimization, Automation.

I. INTRODUCTION

Hydraulic press is a tool to produce compressive force by means of fluid. It depends upon Pascal's principle that the pressure throughout an enclosed entity is constant. 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 etcetera. 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 have been simplified with the use of hydraulic equipment's. 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.

II. WORKING PRINCIPLE

Hydraulic press is a system where a liquid, usually crude oil, is pumped down hole under high pressure to operate a reciprocating pump or a jet pump. This is a very flexible pumping system and can be used to produce low- to high-volume wells. This system is capable of producing a higher volume of fluid than the mechanical lift pump. Hydraulic lift uses a pump and pumps oil very high pressure. The pump pressure is usually between 300-400 pounds per square inch and pushes the liquid to the bottom of the piston to lift it from its seat which relatively lifts the load connected to the head of the piston-cylinder assembly. The required power oil or produced water is reclaimed and reused to continue operating the wells. The pump produces oil on both the upstroke and the down stroke. The pump stroke speed is not easily adjustable due to varying load.

A hydraulic press is a machine that uses pressurized liquid to create force. These machines are composed of a simple cylinder and piston mechanism. The press consists of a large cylinder, with a large piston, and a small cylinder and a small piston. The large cylinder and the small cylinder are connected to one another by means of a pipe. The two cylinders, and the pipe connecting them, are filled with a liquid. At this point, the function of the hydraulic press depends on Pascal's Principle.

Pascal's Principle states that when pressure is added to a liquid at rest, there is an identical increase in pressure at all points. Applying this principle to the hydraulic press means that any force that is added to the piston in the smaller cylinder will be transferred to the piston in the larger cylinder, in a proportionally increased level of force. This allows a hydraulic press to produce a great deal of force from the application of a small amount of force to the small piston. The increase of the force produced by the larger piston is proportionally larger than the force exerted on the small piston.

The amount of increase depends on the ratio of the sizes of the pistons. The ratio of the areas of the two pistons is multiplied by the amount of force applied to the small piston to determine the amount of force that the large piston can produce. For example, if the ratio of the sizes of the two pistons is 10, and the amount of force applied to the small piston is 50 N, the amount of force that the large piston will produce is 500 N. Hydraulic presses can be used in any task that requires a large amount of force. These can include any type of lifting as well, since the hydraulic press can work as a type of lever. These presses are the most efficient contemporary press, as well as the most common.

Since the hydraulic press works on the basis of Pascal's Law, its working is similar to the one of the hydraulic system. A hydraulic press consists of basic components used in a hydraulic system that includes the cylinder, pistons, the hydraulic pipes, etc. The working of this press is very simple. The system comprises of two cylinders, the fluid (usually oil) is poured in the cylinder having a small diameter. This cylinder is known as the slave cylinder.

The piston in this cylinder is pushed so that it compresses the fluid in it that flows through a pipe into the larger cylinder. The larger cylinder is known as the master cylinder. The pressure is exerted on the larger cylinder and the piston in the master cylinder pushes the fluid back to the original cylinder.

The force applied on the fluids by the smaller cylinder results in a larger force when pushed in the master cylinder. The hydraulic press is mostly used for industrial purposes where a large pressure is required for compressing metals into thin sheets. An industrial hydraulic press uses the material to be worked upon along with the help of the press plates to crush or punch the material into a thin sheet.

Fig 1. Operations of Hydraulic press machine

Fig: 2. Manual Hydraulic Press Machine

III. LITERATURE SURVEY

Using the optimum resources possible in designing the hydraulic press components can effect reduction in the cost by optimizing the weight of material utilized for building the structure. An attempt has been made in this direction to reduce the volume of material, cost of the press and to make is portable. Errol et al. presented a 2D nonlinear magneto-mechanical analysis of an electromagnetic actuator based on finite elements. The presented method enables the simulation of the complete switching cycle off a switching, short stroke solenoid actuators with sufficient accuracy. This could be achieved by considering nonlinear magnetic, eddy current

induction and a physical correct implementation of the contact mechanics, which are relevantforthe complex dynamics of this valve types.

Today I'd like to discuss Hydraulic presses. Yes I know a broad subject so we are going to take it down to the basics give you a layman's description and give you a little history. After searching the web and showing my findings to my techs the most basic description of a Hydraulic press which is a machine tool and used in the manufacturing industry was found on wiseGeek.com here it.

"A hydraulic press is a mechanical machine used for lifting or compressing large items. The force is generated through the use of hydraulics to increase the power of a standard mechanical level. This type of machine is typically found in a manufacturing environment".

A good description of "hydraulic systems" and Pascal's Law which is what hydraulics is based on can be found on NASA's website I have copied it below. Hydraulic systems use a incompressible fluid, such as oil or water, to transmit forces from one location to another within the fluid.

Pascal's law states that when there is an increase in pressure at any point in a confined fluid, there is an equal increase at every other point in the container.

Brahma was a very resourceful individual and worked as a farmer, carpenter and locksmith. But his love was inventing and improving on the designs of other inventions. He invented a lock called the Brahma Lock and was the owner and operator of "the Brahma Lock Company" The lock he developed was the undisputed safest lock at that time and held that record for 67 years. He also improved upon the design of the modern day toilet and obtained the patent for it in 1778.

Hydrostatic press for uprooting trees Bramah also held patents for the first extrusion process for making lead pipes and another for making gun stocks (patent 2652). Also noted in several resources was Braham's insistence on quality control; he understood by machining to close tolerances machines especially engines ran better. He taught this to Arthur Woolf a Cornish steam engineer. With Braham's guidance Woolf's engines ran with high pressure steam which greatly increased their output. Woolf's designs were soon used by all engineer designers of that time period. Some would consider Bramah the father of quality control.

IV. Problem Statement and Objective:

Problem Statement:

► Problem Statement Oil Leaks

One of the most reported problems is an oil leak; you will notice oil around the ram, the hose end fittings and hydraulic lines. Make sure you are using the recommended oil for your hydraulic press and that all fittings are tightened.

► Overheating

Overwhelming pressure and friction, and contaminated or degraded hydraulic fluid, can cause your press to overheat. Hydraulic presses should never reach a higher temperature than 150° F, as overheating can cause damage to sealing compounds. Make sure you don't overwork your press, and regularly replace the oil and clean the filters.

► Slow Pressure Build-Up

Normally, hydraulic presses should reach required pressure levels in around one second, any longer than this means that there is a problem with the pump; the fluid is not being funneled to the ram quickly enough. This may be caused by leaks or dirt caught in the fluid, so make sure you examine the pump, as well as surrounding mechanisms like the relief valve and motor, to make sure everything is working properly and clean.

► Abnormal Noise

If you hear banging or knocking coming from your hydraulic press, this may be a sign of air in the fluid; you may also experience foaming and unusual actuator movement. Loss of lubrication, overheating and damage to components are some of the problems that stem from this. Check the fluid level and make sure it is correct, and check for leaks at the pump shaft seal. Regular maintenance and inspections will prolong the life of your hydraulic press, but will unfortunately not make it last forever. When you notice more severe problems like cracked frames, electrical problems and insufficient pump pressure, this is when it is time to say goodbye. Make sure you look after your technology and get the most out of it.

Objectives:

According to the problem statement, our objectives are as follows.

- ► Design of special purpose hydraulic power press machine of capacity 5 Ton according to customer requirement.
- ► Modeling of hydraulic press using suitable CAD software.
- ► Fabrication of hydraulic press.

Using the optimum resources possible in designing the hydraulic press components can effect reduction in the cost by optimizing the weight of material utilized for building the structure. An attempt has been made in this direction to reduce the volume of material, cost of the press and to make is portable. Ertl et al. presented a 2d nonlinear magneto-mechanical analysis of an electromagnetic actuator based on finite elements. The presented method enables the simulation of the complete switching cycle off a switching, short stroke solenoid actuators with sufficient accuracy. This could be achieved by considering non linear magnetics, eddy current induction and a physical correct implementation of the contact mechanics, which are relevant for the complex dynamics of this valve types. Combining the concepts of pre-magnetization as well as over excitation to optimize the actuator dynamics, the pure valve needle flight time at valve opening can be reduced to. The developed numerical tools enable a systematic study of several methods to optimize the dynamics. presented a model of a fast switching valve where both the magnetic path as well as the spool assembly are modeled. The model also includes a description of the hysteresis characteristics of the magnetic path. An optimization strategy has been utilized in order to parameterize the model against measured data. However, even for major deviations from the operational point used for the model adaptation, the model predicts the valve response sufficiently accurately.

V. Methodology

In achieving the aim of this work, component parts of the machine were designed using various design equations. The design results were used to select materials for various components. The detailed drawing of the developed hydraulic press machine was done using SOLIDWORKS software. In fabricating the machine, mild steel was used as the locally sourced material. The use of mild steel is due to the fact that its strength, rigidity and mach inability falls within the design specifications. It is also available and cost effective.

1. MATERIAL SELECTION:

Material selection plays a very important role in machine design. For example, the cost of materials in any machine is a good determinant of the cost of the machi8ne. More than the cost is the fact that materials are always a very decisive factor for a good design. The choice of the particular material for the machine depends on the particular purpose and the material for the machine depends on the particular purpose and the mode of operation of the machine

components. Also, it depends on the expected mode of failure of the components.

Engineering materials are mainly classified as: Metal and their alloys, such as iron, steel, copper, aluminum etc. Non-metals such as glass, rubber, plastic etc. metals are further classified as ferrous metals and non-ferrous metals.

Ferrous metals are those metals which have iron as their main constituent, such as cast iron, wrought iron and steels. Non-ferrous metals are those which have a metal other than iron as there main constituent, such as copper, aluminum, brass, tin, zinc etc. Also, certain mechanical properties of metals have greatly influenced our decisions. These properties include:

- ► Strength: It is the ability of a material to resist the externally applied force without break down or yielding the internal resistance offered without break down or yielding the internally applied force is called stress.
- ► Stiffness :It is the ability of a material to resist deformation under stress.
- ► Elasticity: It is the property of a material to regain its original shape after deformation when the external force are removed.
- ► Plasticity: It is property of a material which retains the deformation produced under load, permanently.
- ► Ductility: A very important property of the material enabling it to be drawn into wire with the application of a tensile force. A ductile material is both strong and plastic. Ductile materials
- ► Brittleness: It is the properties of a material opposite to ductility, it is the property of breaking of a material with little permanent deformation when subjected to tensile load, brittle materials snap off without giving any sensible elongation. Cast iron is a brittle material.
- ► Hardness: It embraces difference properties such as resistance to water, scratching, deformation and machinability etc. it also measure of the ability of a metal to cut another metal.

Types of Steels:

Mild Steel: It contains 0.05 to 0.3 percent carbons it has for almost all purpose replaced wrought iron, its greater strength giving it under viable advantages. Mild steel can be rolled, wielded and down. It can even be cast, though not very successfully. Among its application are plates for ship building, bicycle frame tubes, mesh work, bolts, nuts, studs etc. solid and hollow constructional sections, sheet metal parts and steel castings such as flywheels and locomotive wheel centers.

Stainless Steel: These are steel with high rust and corrosion resistance to meet specific application requirements. They also have high strength and toughness. It is an alloy of iron with about 11% chromium and other metals like nickel, molybdenum etc. the properties of rust and corrosion resistance, toughness and strength, aesthetics and how coefficient of friction were considered to meet all requirements and the choice of stainless steel for the scissors members.

Fabrication of Hydraulic1P4ress Machine:

► L-Section and Square Pipe:

First step to make a hydraulic press is cutting of required metal cut everything to its proper length and dimension such as L- square pipe etc. parts. So, we section angle.

Fig: 3. L-Section and Square Pipe

► Drilling Operation:

Then next step is drilled a holes for proper assembly of all cutting to make a metal parts frame of hydraulic press.

Fig: 4. Drilling of a Square Pipe

For cutting and drilling of parts you must ensures the safety protection. A pair of work gloves is good insurance against a wire brush if it should slip, as well as cutting down on the vibration being transmitted to your hands. With that in mind, eye and hearing protection is a must. An angle grinder with a cut off blade makes a racket which soon causes a ringing in the ear without proper protection, it also sprays a shower of sparks which can bounce back off nearby objects, beware the hot spark bouncing back off a wall over the top of your safety goggles, it's not a fun experience

Fig: 5. Drilling of a L-Section

With that in mind, eye and hearing protection is a must. An angle grinder with a cut off blade makes a racket which soon causes a ringing in the ear without proper protection, it also sprays a shower of sparks which can bounce back off nearby objects, beware the hot spark bouncing back off a wall over the top of your safety goggles, it's not a fun experience

Fig: 6. Parts of Hydraulic Press

► Assembly of all metal parts

Second step is assembly of all cutting metal parts. I assembled all the metal parts without any kind of welding. I only used bolts and nuts for proper assembly of metal parts to make a frame of the hydraulic press.

Proper assembly to make a frame body of the hydraulic press is shown in the image.

Fig: 7. Assemble of Metal Parts

► A 5 ton bottle jack and springs

We used 5 ton bottle jack to make this hydraulic press. Also I used 2 mechanical springs to allow the hydraulic jack in its first position. Both the hydraulic jack and springs are attached with the frame by using of bolts. Springs are attached by using of J bolts.

Fig: 8. Hydraulic Bottle Jack and Springs

Assembled Parts of Hydraulic Press Machine

Fig: 9. Hydraulic Press Machine at Different Angles

3D Modeling

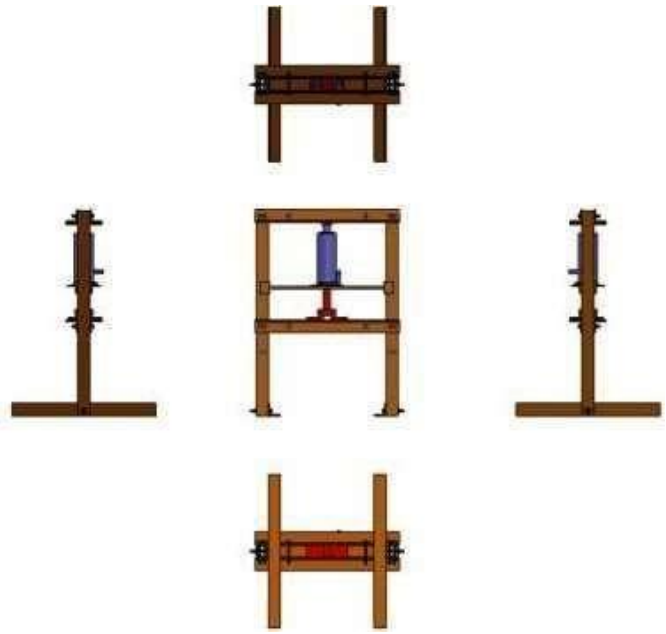

Fig: 10. Front view of Hydraulic PressMachine

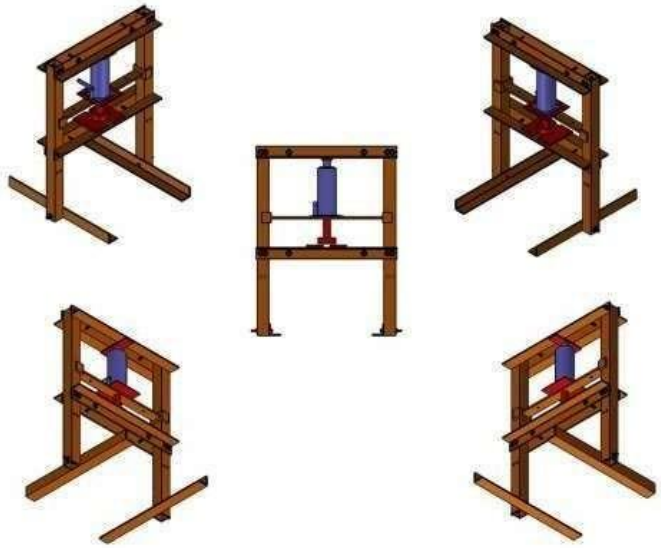

Fig: 11. Isometric view Of Hydraulic Press Machine

VI. RESULTS AND DISCUSSION

The developed manually operated hydraulic press was achieved by following the stated objectives of this work. The machine developed was made from locally sourced materials. Mild steel was used in fabricating majority of the components of the machine. One important feature of this press machine is interchangeability of mould and die without dismantling the ram assembly.

The machine developed is shown in Figure Shows cylinder engine block before pressing sleeve into it while shows cylinder engine. Prior to machine performance evaluation, machine frame, structural members, weld, pump and cylinder mechanism were inspected in order to check for any fault or leakages of hydraulic oil. Tests were carried out on the multipurpose press machine by using it to press different metals (materials) at maximum pressure. The hydraulic press machine developed was used to perform various press works. The machine worked without any challenge as there was no distortion, deformation, no weld failure, no leakages and the operation of hydraulic pump, ram and pump mechanism was quite satisfactory under the varying loads.

In evaluating the performance of the hydraulic press machine length 800 mm, breadth 600 mm and thickness of material 5mm was put on the machine working table.

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