Automatic Control of Hydraulic Machine using PLC

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Abstract

In most of the industries automation is to be implemented in many fields to reduce the processing time and manpower. This project implements the automation technique which carries out the automation process of hydraulic pressing machine using PLC (Programmable Logic Controller). Now days a semi-automatic hydraulic machine is used to assemble and de-assemble the motor parts. Here the high pressure is given for all the objects during the process. Due to the same pressure level high damages will occur. In this project work, an automatic control of hydraulic machine is proposed by using Programmable Logic Controller (PLC). The limit switch is connected with the control unit of the PLC. This limit switch is used to control the upward and downward movement of the solenoid in the Hydraulic machine. By using this automatic control system, the motor parts will be removed without damages.
Keywords: PLC, Hydraulic System

I. Introduction

Automation is one of the development processes in today scenario. It can be done in the industries where more number of labours are involved in the protection field. This causes demand for labours and also some production loss. In order to manage above issues, PLC is introduced where multiple of inputs can be processed with the single outputs. In earlier days the PLC was used to control the machineries by pressing switch but today HMI is used to reduce the number of ports.RS232 cable is used to interface the program, coded as desired. Specification reduces the labour work and I/O ports also. It can be able to operate on various devices by programming the ladder logics based on time limit. PLC can be able to program from small circuits to complex circuits by using the ladder logic. In this method of analysis, the existing method was discussed and how to overcome the disadvantage was analyzed. The proposed method overcomes the disadvantage of existing method. The semi-automatic machine is used in CRI pumps for disassembling the motor parts. Pressure is high for all the objects. Due to high pressure damage occur while removing the parts. This is the system existing in CRI pumps.

Hydraulic machine is used to assemble and de-assemble the motor parts. It is a semi-automatic machine. The movement of the solenoid for assemble and de-assemble purpose is in same level. So, the pressure level is also same. The motor is started by press the switch. After that the downward button has to press to down the solenoid. For upward movement the upward button has to press. The speed of the solenoid cannot control. The speed of the solenoid is controlled by control the speed of the motor and also the velocity of the hydraulic fluid. This is the operation of the Hydraulic machine.

The automatic control of hydraulic machine is done. The interlocking between the up and down button is done for performance of one operation. The limit switch is used to control upward and downward motion of the solenoid of the hydraulic machine and wait for the time period.RS232 cable is used to interface program with PLC by the suitable coding. In this technique the time delay for converting one to another value can be changed at any time by coding the value of time delay in seconds or milliseconds. It is universally applicable and user friendly to all application. It reduces number of the ports used in PLC for existing the output.

II. Hydraulic system

Hydraulic die cushions are used on both mechanical and hydraulic presses. They have several advantages when compared to an air cushion. These include:

1) Much larger forces can be obtained in the same press bed space.
2) Timed cushion lock-down or return delay: this feature is used to avoid deforming the part as the press opens.
3) The ability to control the instantaneous cushion pressure with a servo valve. This feature can be used to optimize the blank holder force as a deep drawing operation is in progress.

By controlling the hydraulic die cushion pressure with a servo valve, optimization of blank holder force can be achieved. Typically the pressure of air-actuated die cushions increases 10% or more between initial contact to the end of travel. A pressure increase of up to 40% is typical for self-contained nitrogen cylinders and some manifold systems. Metal movement on the blank holder may be severely retarded at the end of the forming cycle by this pressure increase. The result may be failure due to fractures. A programmable hydraulic die cushion can optimize blank holder forces through the forming sequence.

III. PROPOSED METHOD

In Hydraulic machine, hydraulic fluid is fed throughout the hydraulic cylinders and becomes pressurized according to the resistance present. The fluid is controlled automatically by control valves and distributed through hoses and tubes. The popularity of hydraulic machinery is due to the very large amount of power that can be transferred through small tubes and flexible hoses, and the high power density and wide array of actuators that can make use of this power. Hydraulic machinery is operated by the use of hydraulics, where a liquid is the powering medium.

A. Principle:

Pascal's Law states that the "Pressure applied to any part of a confined fluid transmits to every other part with no loss. The pressure acts with equal force on all equal areas of the confining walls and perpendicular to the walls". This is the basic principle for any hydraulic system.

B. Operation:

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

C. Structure of Hydraulic Machine:

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. This is the operation of the hydraulic machine

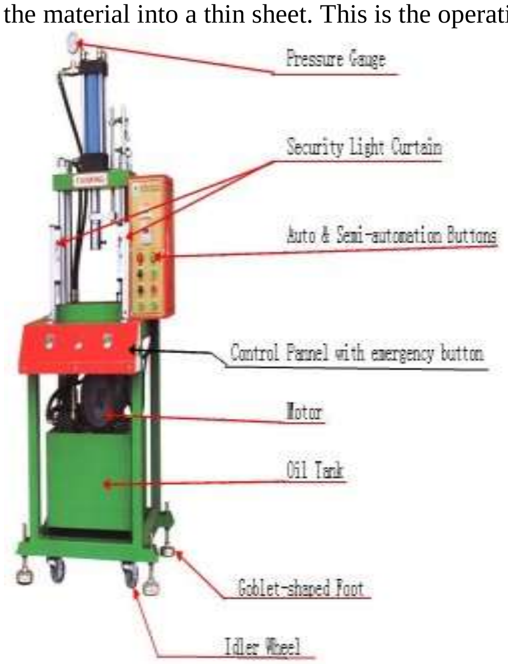

Fig. 3.1: Structure of hydraulic machine

D. Hydraulic Presses:

Hydraulic presses are a powerful class of machine tools; they derive the energy they deliver through hydraulic pressure. Fluid pressure, in a particular chamber, can be increased or decreased by the use of pumps, and valves. Sometimes devices and systems may be used to increase the capacity of the pumps in more powerful presses. These presses can operate over a long distance and at a constant speed. Hydraulic presses are generally slower relative to other press machine types. This involves longer contact with the work; therefore the cooling of the work can be an issue when hot forming a part with hydraulic force. Hydraulic presses are capable of being the most powerful class of presses. Some may be as large as buildings, and can deliver awesome pressure. The largest hydraulic presses are capable of applying 75,000 tons, (150,000,000 lbs), of force. The hydraulic press shown is being used to manufacture a metal forging. Extrusion is also a very common use for such a press, although extrusion is often performed horizontally. The basic working principles of the hydraulic press are simple, and rely on differences in fluid pressure. Fluid is pumped into the cylinder below the piston, this causes the fluid pressure under the piston to increase. Simultaneously, fluid is pumped out of the top channel, causing the fluid pressure above the piston to decrease. A higher pressure of the fluid below the piston than the fluid above it causes the piston to rise. In the next step, fluid is pumped out from below the piston, causing the pressure under the piston to decrease. Simultaneously, fluid is pumped into the cylinder from the top, this increases the fluid pressure above the piston. A higher pressure of the fluid above the piston, than the fluid below it, moves the piston downward.

E. Hydraulic Press Speeds:

Most press users are accustomed to describing press speeds in terms of strokes per minute. Speed is easily determined with a mechanical press. It is always part of the machine specifications. The number of strokes per minute made by a hydraulic press is determined by calculating a separate time for each phase of the ram stroke. First, the rapid advance time is calculated.

F. Stages of Hydraulic Press:

Next the pressing time or work stroke is determined. If a dwell is used that time is also added. Finally the return stroke time is added to determine the total cycle time

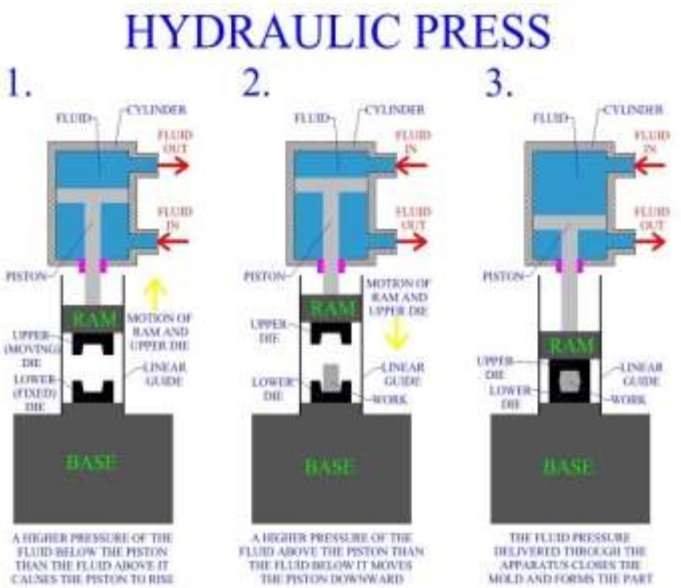

Fig. 3.2: Stages of hydraulic press

The hydraulic valve reaction delay time is also a factor that should be included for an accurate total time calculation. These factors are calculated in order to determine theoretical production rates when evaluating a new process. In the case of jobs that are in operation, measuring the cycle rate with a stopwatch is sufficient Most hydraulic presses are not considered high speed machines. In the automatic mode, however, hydraulic presses operate in the 20 to 100 stroke per minute range or higher. These speeds normally are sufficient for hand fed work. The resulting production rate speeds are comparable to that of mechanical OBI and OBS presses used single stroking applications. Here, there is no additional clutch and brake wear to consider in the case of the hydraulic machine.

IV. PROPOSED SYSTEM CONTROL USING PLC

PLC is called as Programmable Logic Controller. It is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides. It is used in many industries. Eight input and four output are used for proposed system. The interlocking between the limit switch is given for continuous motion of the machine. In this automatic control process, the motor is started by pressing the start button. The solenoid is always in up position while starting the motor. By using the controller action the solenoid starts to move downward direction. The movement of the solenoid valve is controlled by the limit switches, which is connected with the control unit of the PLC, open and close the contacts. After completing the process of assemble or de-assemble process the motor is turned off. This is the operation of the system. When the solenoid reaches the particular position, the limit switch opens the contact. After remove the bearing of the motor from the shaft, the limit switch closed the contact. Now the solenoid moves in upward. This is the continuous process which is automatically happened. The limit switch controls the movement of the solenoid by open and closing.

A. Block Diagram of Proposed System:

The block diagram is shown for the proposed system. For proper and efficient working of a press, it is necessary to maintain pressure of cylinder as constant which helps for the smooth flow of pressure in a hydraulic cylinder. His can be achieved with the help of PLC. The automatic control of hydraulic machine is done though PLC. The interlocking done between the up and down push button. The limit switch is used to control upward and downward motion of the solenoid of the hydraulic machine and wait for the time period. For manual operation the push button is turned ON and remains same till the operation ends .The motor in the hydraulic machine is running till it reaches stop or emergency condition.

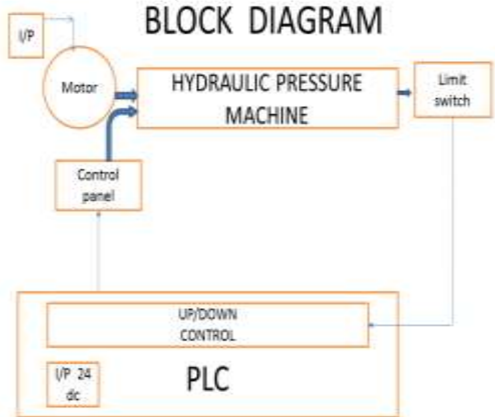

Fig. 3.3: BLOCK DIAGRAM

B. Programmable Logic Controllers (PLC) using Ladder Logic:

Before the advent of solid-state logic circuits, logical control systems were designed and built exclusively around electromechanical relays. Relays are far from obsolete in modern design, but have been replaced in many of their former roles as logic-level control devices, relegated most often to those applications demanding high current and/or high voltage switching.

Systems and processes requiring “on/off” control abound in modern commerce and industry, but such control systems are rarely built from either electromechanical relays or discrete logic gates. Instead, digital computers fill the need, which may be programmed to do a variety of logical functions. In the late 1960’s an American company named Bedford Associates released a computing device they called the MODICON. As an acronym, it meant Modular Digital Controller, and later became the name of a company division devoted to the design, manufacture, and sale of these special-purpose control computers. Other engineering firms developed their own versions of this device, and it eventually came to be known in non-proprietary terms as a *PLC*, or Programmable Logic Controller. The purpose of a PLC was to directly replace electromechanical relays as logic elements, substituting instead a solid-state digital computer with a stored program, able to emulate the interconnection of many relays to perform certain logical tasks. A PLC has many “input” terminals, through which it interprets “high” and “low” logical states from sensors and switches. It also has many output terminals, through which it outputs “high” and “low” signals to power lights, solenoids, contactors, small motors, and other devices lending themselves to on/off control. In an effort to make PLCs easy to program, their programming language was designed to resemble ladder logic diagrams. Thus, an industrial electrician or electrical engineer accustomed to reading ladder logic schematics would feel comfortable programming a PLC to perform the same control functions. PLCs are industrial computers, and as such their input and output signals are typically 120 volts AC, just like the electromechanical control relays they were designed to replace. Although some PLCs have the ability to input and output low-level DC voltage signals of the magnitude used in logic gate circuits, this is the exception and not the rule.

Signal connection and programming standards vary somewhat between different models of PLC, but they are similar enough to allow a “generic” introduction to PLC programming here. The following illustration shows a simple PLC, as it might appear from a front view. Two screw terminals provide connection to 120 volts AC for powering the PLC’s internal circuitry, labeled L1 and L2. Six screw terminals on the left-hand side provide connection to input devices, each terminal representing a different input “channel” with its own “X” label. The lower-left screw terminal is a “Common” connection, which is generally connected to L2 (neutral) of the 120 VAC power source.

C. Limitations and Successor Languages:

Ladder notation is best suited to control problems where only binary variables are required and where interlocking and sequencing of binary is the primary control problem. Like all parallel programming languages, the sequential order of operations may be undefined or obscure; logic race conditions are possible which may produce unexpected results. Complex rungs are best broken into several simpler steps to avoid this problem. Some manufacturers avoid this problem by explicitly and completely defining the execution order of a rung, however programmers may still have problems fully grasping the resulting complex semantics. Analog quantities and arithmetical operations are clumsy to express in ladder logic and each manufacturer has different ways of extending the notation for these problems. There is usually limited support for arrays and loops, often resulting in duplication of code to express cases which in other languages would call for use of indexed variables as microprocessors have become more powerful, notations such as sequential function charts and function block diagrams can replace ladder logic for some limited applications. Some newer PLCs may have all or part of the programming carried out in a dialect that resembles BASIC, C, or other programming language with bindings appropriate for a real-time application environment.

D. Output:

Fig. 4: Output

V. CONCLUSION

The proposed system provides the automatic and semi-automatic control of hydraulic machine. The presses are controlled and the dismantling of parts is done without any damaged. The time consumption and man power is reduced. The time delay can be done according to the load condition. This process can be used for mantling the motor parts also. This process can be used effectively in any automation industry. The clearance of the object after dismantling is same.

REFERENCE

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[5] Pires (2005) stated that, one of the very important characteristics of the manufacturing systems is flexibility and agility of the manufacturing process.

