Design of Semi-Automatic Hydraulic Broaching Machine-A Review

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***Abstract* - In today's industry world Hydraulic system are mostly conventionally operated. Today automation is need of the hour in industry. Most of the Vertical key way Broaching machines available in market are either mechanical of manual hydraulic. Machining attributes is a major channel of finish goods. In automation, Accuracy and Precision are prime requirement for each machine tool. Controller, Solenoid valves, servo control valves are crucial components of any automation. This review paper gives details of the some of the design techniques which can be used for automatic hydraulic machines. The automation studio tool helps to simulation ,animation, design of hydraulic circuit.**

***Keywords* - Broaching machine, hydraulic system and Automation Studio.**

I. INTRODUCTION

Hydraulics is very simplest technique to transmit energy to do work. It is highly precise in controlling energy and exhibits a broader adjustability range than either electrical or mechanical methods. A hydraulic system using oil is governed by the basic physical law of fluid flow as developed by the great scientist Blaise Pascal. This law is known as "Pascal's law". The industrial hydraulic system is a power transmission system using oil to carry the power. To design and apply hydraulics efficiently, a clear understanding of energy, work, and power is necessary. The inputs and outputs of any power and control system including the hydraulic system are mechanical such as a rotating shaft or reciprocating plunger. An added advantage is that this system is easily adoptable to a variety of energy forms and the signals may be initiated by electrical, manual, optical, electronic/digital. Hand levers, direction control valve , springs, pressure control valve, flow control valve solenoids and torque motors are common examples of control inputs, while the output may be the movement of a piston rod or Ram. The hydraulic systems are essential to control pressure and flow rate. By controlling the pressure of oil we can control load carrying capacity of actuator and by controlling the flow rate we can control the speed.

II. METHODOLOGY

A. Components used in hydraulic system 1. Hydraulic reservoirs

A hydraulic system is closed, and the oil used is in a tank or reservoir to which it is returned after use and also reused by using fixed or variable pump.. The volume of fluid in a tank varies according to temperature and the state of the actuators in the system, being minimum at low temperature with all cylinders extended, and maximum at high temperature with all cylinders retracted. Normally the tank volume is set at the larger of four times the pump draw per minute or twice the external system volume. A light oil viscosity 150 say bolt universal seconds at 100 (^{0} F)[11].

2. Filters

Metal particles, Dirt in a hydraulic system causes blocking of valves, failure of seals and early wear. Even particles of dirt as small as 20/x can cause damage, (1 micron is one millionth of a metre; the naked eye is just able to resolve 40/x). Filters in the hydraulic system are used to prevent metal particles, dirt entering in the parts of the hydraulic system, and are generally specified in microns or meshes per linear inch (sieve number) [11].

3. Directional Control Valves

Hydraulic systems require valves to control the direction of fluid flow from pump to various load devices. Two types of construction are generally used for common direction control valves, 1. Seat valve or poppet valve, 2. Spool valve or sliding valve Directional control valves are actuated by various techniques like plunger, cams, manual lever, electric solenoid, hydraulics.

4. Hydraulic Actuators

There are various types of actuators used in hydraulic systems, e.g. hydraulic cylinders, motors, etc. A cylinder is device which transforms fluid power into linear mechanical force and motion. It usually consists of a mobile element such as a piston and piston rod, plunger or ram operating within a cylinder bore. Functionally cylinders are classified as: Single acting cylinders and Double acting cylinders. In contrast to a cylinder hydraulic motor provides rotational motion is used in a hydraulic system for a variety of applications where rotary movement is the need. Hydraulic motors generally may be: Unidirectional, or Bi-directional. Torque from motor will according to the pressure and speed will be according to the flow rate[11].

5. Flow Control Valve

The speed of hydraulic actuator by varying the port opening of the flow control valve. This valve is basically a flow control valve which regulates the fluid flow by enlarging or reducing the port area while the oil is passing through the passage. Thus continuous step lesscontrol of speed of a cylinder or a hydraulic motor is possible with such a valve [9].

6. Proximity Sensor

A proximity sensors are used to detect the presence of nearby objects without any physical contact. The object being sensed is often referred to as the proximity sensor's target. A proximity sensor often emits a beam of electromagnetic radiation or an electromagnetic field, and looks for changes in the field. Different proximity sensor targets demand different sensors. For example, a capacitive photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target. Proximity sensors can have a high reliability. Functional life of proximity sensor is long life because of the absence of mechanical parts and due to lack of physical contact between sensor and the sensed object .

7. Programmable Logic Controller

Here to manage different electrical signal from various sensors PLC is used. To control the movement hydraulic actuators we have incorporated electrically operated DCVs, which are actuated according to the signals from PLC. Typically a PLC system has the basic functional components of processor unit, memory, power supply unit, input/output interface section communications interface and the programming device. Fig. 2. Shows the basic planning[11].

B. Automation Studio

Automation Studio is a completely integrated software package that allows users to design, simulate and animate circuits consisting of various automation technologies.

1. Simulation:

The simulation is the goal of a project or a diagram. It allows, among other things, to test, verify, view, and troubleshoot the modelization with diagrams.

Description of the Simulation mode:

1) Selecting the current project;
2) Selecting the current diagram;
3) Selecting several items;
4) Selecting simulation items;

2. Automation Studio Features:

1) Optional basic libraries including: pneumatics, hydraulics, ladder logic, digital electronics, Grafcet and Bill of Material.
2) Simulation pace can be adjusted to either slow-motion, step-by-step and pause.
3) Standalone editing and simulation. No need for drawing software such as AutoCadTM or AutoSketchTM.
4) Project revision tracking.
5) Rubber-banding keeps lines connected to components as they are moved.
6) Check connection command for easy troubleshooting.

A. Comparisons of electrical and hydraulic systems TABLE I

	Electrical	Hydraulic
Energy source	Usually from outside supplier	Diesel driven or Electric motor
Energy cost	Lowest Cost	Medium Cost
Rotary actuators	AC & DC motors, AC motors cheap Good control on DC motors.	Low speed. Good control.
Linear actuator	Short motion via solenoid. Otherwise via mechanical conversion.	Double acting Cylinders, Very high Force.

B. Design of hydraulic circuit

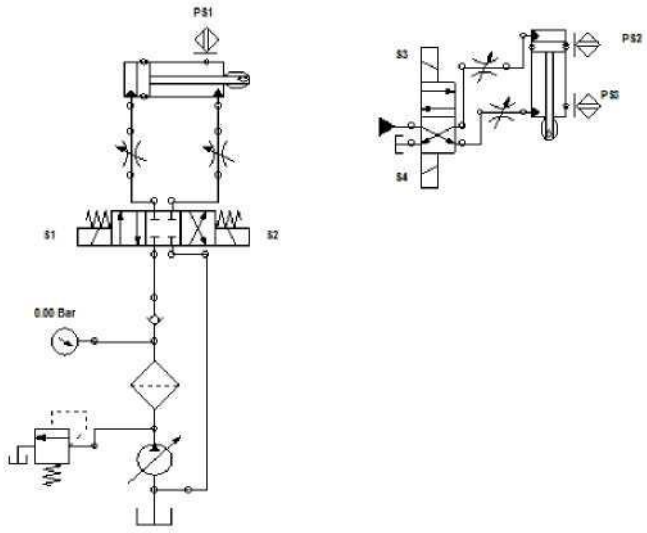

Fig. 1. Hydraulic circuit of blanking machine.

III RESULTS

C. Working

The hydraulic circuit consists four port and three position solenoid operated direction control valve. This circuit also consists of flow control valve to control the flow of hydraulic oil, pressure relief valve, filter, check valve and variable displacement pump. In this hydraulic circuit, position of hydraulic cylinder can sensed by PS1 proximity sensor as shown in fig.1. [9] and according to PLC programming solenoid operated valve to take the applicable action. This system simulation can run on automation studio.

III. LITURATURE SURVEY

Gabriele Altare et al. [2] presented a novel architecture for an Electro-Hydraulic Actuator. The system includes a brushless variable speed electric motor which drives a bi-rotational external gear pump. The pump can therefore deliver the hydraulic fluid to both the rod and the bore sides of the actuator without the need of a directional flow control valve. A spring loaded accumulator (ACC) serves as pressurized system reservoir and it is connected to the pump by means of a dual pressure valve (DP). The system was designed for the particular application case of the first

class aircraft seats control, however, the proposed schematic can be easily adapted to other mobile applications. The proposed EHA is based on a power supply system that uses a miniature external gear pump designed by the authors' research team, in a layout which uses counterbalance valves that guarantee load holding without energy consumption and which are capable to adjust the system pressure according to the load condition. To highlight the advantages in terms of controllability and power consumption, the proposed system configuration was compared to a reference configuration representative of a state of the art solution for EHAs. The results show the potentials of the proposed solutions, which permit the control of the actuator in any given operating condition without requiring use of additional electric or hydraulic energy storage device.

Yi Ye, Chen-Bo Yin et. al [8] In this paper, an improved particle swarm optimization algorithm is developed to tune the gains of Proportional-Integral-Derivative (PID) controller in order to cope with the position control problem of the valve-controlled asymmetric cylinder system employed in excavator considering the dead zone and saturation nonlinearities as well as discharge coefficient and friction. The working device of a hydraulic excavator consists of three types of valve-controlled asymmetric cylinders: bucket cylinder, arm cylinder and boom cylinder. As is well-known, cylinder is the most commonly used hydraulic actuator which converts the fluid power into linear movement and force Based on the mathematical equations of the system derived by physical modeling, the nonlinearities are discussed adequately, and then the simulation model is established in accordance with the parameters collected from tests and measurements. Experiments are carried out to compare with the simulations for validating the correctness of the simulation model. A precise co-simulation platform is accomplished by combining the model of the proposed controller and the simulation model of the bucket system. Simulations with three different position references are presented to reveal the effectiveness of the improved PSO algorithm in tuning the PID gains for the position control of nonlinear system.

Chiaming Yen et al. [3] This research develops a web-based collaborative computer-aided pneumatic circuit design software. This software allows user to conduct pneumatic circuit design by applying the circuit components on menu bar to draw the pneumatic devices, connecting the devices with signal lines, filling in the parameters for all the devices and simulating the designed hydraulic circuit as shown in fig.2. This software helps to provide better simulation results for each device, separate threads are used to perform continuous scans to each component. Therefore, the actions of the pneumatic devices and circuits can be simulated throughout the design phases. To provide better simulation results for each device, separate threads are used to perform continuous scans to each component.

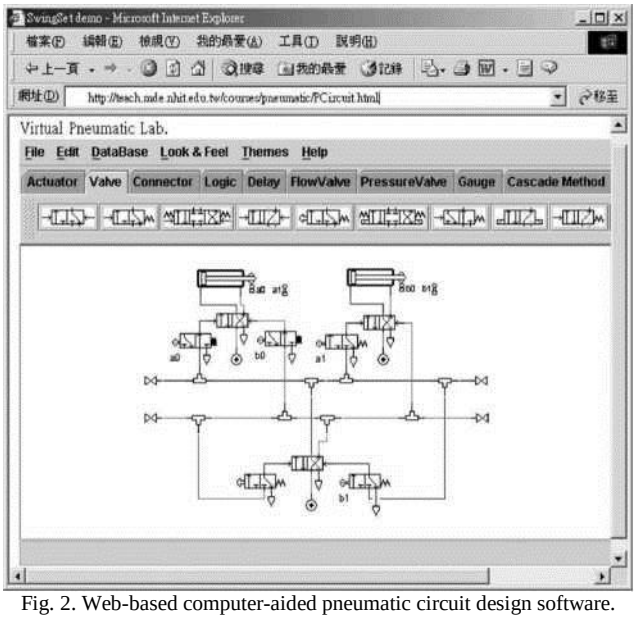

Fig. 2. Web-based computer-aided pneumatic circuit design software.

Therefore, the actions of the pneumatic devices and circuits can be simulated throughout the design phases. In the debug mode, users can set the system animation to a lower speed and check the control circuits step by step. The circuit design results can be saved either on each local disk for Java application users or on web-based databases for collaborative users. To extend the software developed in this paper, users can edit the configuration file to add new devices into the system. The software is developed in the form of Java application and Java applet. Therefore, it can be used in any computer with Java virtual machine or be accessed by a web browser over the internet.

C.M. Vang [4] gives an idea for the design and implementation of an automatic hydraulic circuit design system using case-based reasoning (CBR) as one of successful Knowledge Engineering paradigms. The major contribution of this hydraulic circuit design is the reduction in design lead time for the stage of similar circuit retrieval and past analysis of attributes for circuit components. The important part of case-based reasoning ,that reuse past experience in current problem so that identical parts of current problems can be directly reused. The circuit design method adopted according to information provided by user such as maximum thrust required, speed of actuator, duty cycle, function. Then a proposed methodology in automatic circuit design and dynamic learning with the use of CBR is described. Finally an application example has been selected to illustrate the usefulness of applying CBR in industrial hydraulic circuit design with learning, as shown in the (3) and (4)

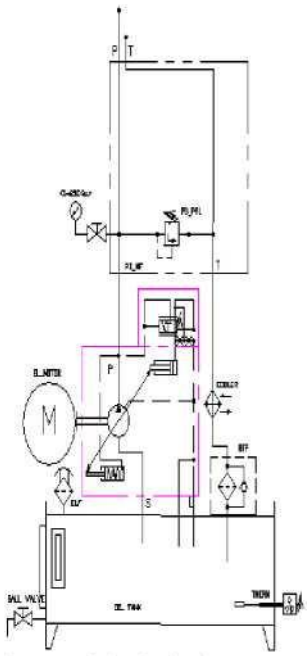

Fig.3.standard sub-circuit.

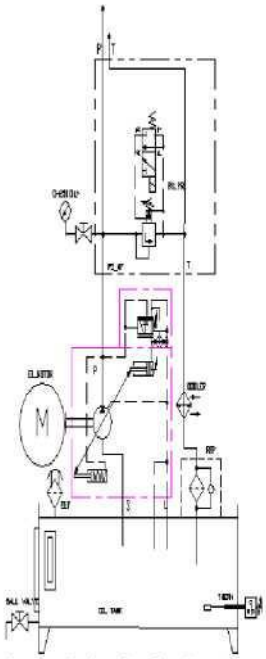

Fig.4.Subcircuit after learning.

A. Tony Thomas et. al [5] Hydraulic press is a machine using a hydraulic cylinder to generate a compressive force to perform various pressing operations like metal forging, punching, stamping, etc. When the cylinder's extension force is controlled, the machine can be employed for pressing operations on different materials with ease. The control problem is posed to achieve flexibility in the machine. Mathematical model describes the behaviour of the system in terms of mathematical equations and logical models. The steps for modelling of hydraulic press using system identification technique in MATLAB are discussed in this paper. Using this model, three controllers, PID controller, Internal model controller and Fractional order controller are developed and their responses are compared. This found to have unfavorable oscillations while rising and settling time of 10.1 seconds and peak overshoot of 55.56%. Then an internal model controller is used to find the behaviour of the system. This found to have larger settling time of 20.6 seconds and peak overshoot of 6.76%. then the response of the system with fractional order controller is studied. It is found to have a comparatively smaller settling time of 6.8 seconds and smaller peak overshoot of 20.48%. Hence it is concluded that the hydraulic pressing machine controlled by a Fractional Order Controller will produce force as per the requirements at the output. The design of the hydraulic kit taken for study is shown in the Fig.5. Resorvoir(3), pump(4), filter(7), cylinder(10).

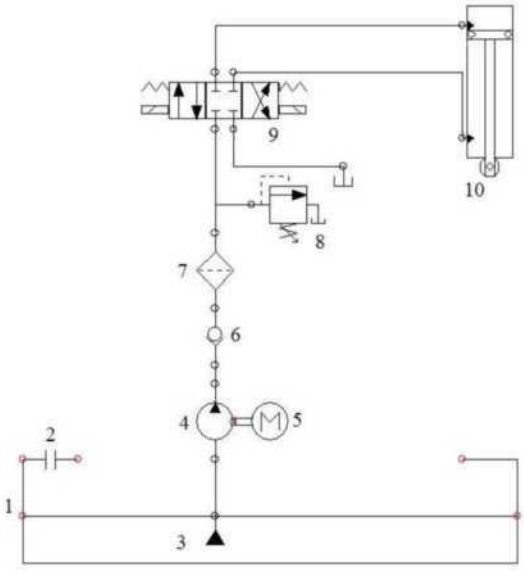

Fig.5. Circuit diagram of hydraulic press.

Saurin Sheth et. al [6] 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 in fig(6). Thus here a hydraulic system is used to develop a press. The press will be useful for mass production of Washers. Even the press can be completely automize by using the concept of electro-hydraulics. Direction control valve can be solenoid actuated to make the system close loop. Which may lead to higher production rate.

Fig.6. Hydraulic Press with Die

Janne Koivumaki et. al [7] In this paper, a stability guaranteed Cartesian free-space motion control for the redundant articulated hydraulic construction crane is addressed in order to increase system safety and productivity. To cope with the nonlinearities of coupled mechanical linkage dynamics of articulated systems and the inherently strong nonlinearities of hydraulic actuator dynamics, the proposed controller is designed based on the recently introduced Virtual Decomposition Control (VDC) approach. The VDC approach, which was developed especially for the control of complex robotic systems, allows the conversion of the control problem of the entire system to a control problem of individual subsystems, while rigorously guaranteeing the stability of the entire hydraulic system. In the experiments it is demonstrated that, the proposed controller is able to extensively cope with the highly nonlinear nature of the articulated hydraulic system, and an improved control performance is achieved compared to the current state- of-the-art studies in the category of the hydraulic robot manipulators.

Tejas Patel et. al [9] this paper gives information about Hydraulic Blanking Machine controlled by PLC having following advantages over the conventional Blanking machine. Blanking speed according to plate thickness can be varied. Clamping of workpiece is automatic. Step less motion of blanking stroke is achieved. Power consumption is according to the thickness and Material of plate.

IV. CONCLUSION

Automation plays important role in the industrial applications. Lot of industries are lack of automation therefore effect on the productivity of machine or plant. The problems arises in the automated hydraulic circuit can easily find out as compared to conventional circuits or machines. The Vertical key way broaching Machine controlled by Solenoid valve and switch button having following advantages over the conventional Vertical key way broaching machine. Power consumption is according to the thickness and Material of plate. we are studied various automation techniques in the above literatures . 2.1.4842.5761,2014.

MATLAB tool helps to design hydraulic circuit. The automation studio is the only tool for automation of hydraulic, electro-hydraulic, pneumatic circuit. These tool not only useful to design new hydraulic cylinders but also, piston sizing, animation, simulation and modification.

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