Plc Based Position Control of An Electro-Hydraulic System

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Abstract- *With each passing days, the automation industry is reaching newer heights. Thus, more and more appropriate and precise selection of controller has been seen as an important aspect in industrial sector. Now a day due to application of hydraulic servo mechanism, it has been automated with the use of PLC and SCADA due to its precise and simulated application in the industry. With the advantages of PLC over others it has its vast application in field of Industrial Automation. PLC includes multiple input-output ports to monitor process variable with improved HMI and networking capabilities to perform a controlled application. This paper describes position control of EHS using PLC by using a proportional valve, Electro Hydraulic piston movement has been controlled by using proportional valve. Input given to the Proportional valve has been controlled using PLC ladder via program has been to get the desired position.*

Keywords- PLC; Electro-Hydraulic System (EHS); SCADA; Proportional Valve.

I. INTRODUCTION

In the advance hydraulics, Hydraulics has always have closely interlink with electrical and electronics control techniques. And to an ever increasing degree, combined system is now also being applied in the area of mobile hydraulics. Two techniques deal separately during the design and project engineering stages. The combination of these two systems is regarded as a single unit during trouble shooting and repair. The hydraulic proportional valves are currently used in a wide range of application involving high proportional control system.

The electrohydraulic system has been widely used in various industrial and machining sectors such as aerospace, high precision machining technology, elevator, robotic manipulator etc. because of its high torque to weight ratio. The EHS system includes various parameters such as temperature, pressure, wear- tear of components etc. which gives its non-linear and time varying output and thus results in complex design of a suitable controller for the system. Other parameters such as internal leakage of the valve, variation in fluid property such as compressibility, load disturbance, actuator's friction may further leads to the non-linear translational of the system.

But due to precise and robust control requirement in many applications, various control methods are applied and have been implemented to develop precision control over Electro-Hydraulic System.[1]

II. LITERATURE SURVEY

A. Problem Statement

In the existing Electro Hydraulic Servo System, the position control is done by positioning the object (10kg load) at minimum or maximum length of Stroke (i.e.at 0 or 300mm) ,the main objective is to positioning the object at any position between 0 to 300mm using PLC to program the working and using SCADA for graphical user interface

B. Objectives

Following are the main objectives:

- To study the EHS system in control system lab.
- To study and select cost effective valve for fluid control mechanism.
- To study and select effective position sensor.
- To design ladder diagram programming logic for electro-hydraulic system to control position of mass of 10kg using PLC.
- Prepare GUI using SCADA.

C. Electro-Hydraulic System

Due to its ability to provide large driving force, high response speed with continuous operation and possible speed reversal, hydraulic servo systems are widely used in many industrial applications such as in aeronautics, gear systems and in various numerical machine tools.

Altogether combining the flexible and precision electrical techniques of signal processing and measurements along with high pressure hydraulic mechanism, hydraulic servo system provides large force for lifting and moving of large heavy loads.

Having non-linear dynamics, internal leakages, load sensitivity, flow pressure relationship and other uncertain parameter due to fluid compressibility; control of hydraulic systems are somewhat difficult. To overcome this problem various control approaches are proposed by many researchers[2],[4],[5]. The response of hydraulic system can be made fast compared with the electric devices of same power rating, by applying electrical signal instantaneously (possible with very low power level) even at large distance between the source of control signal & actual mechanism, including the valve itself. Thus, EHS system uses this technique of low power electrical signal processing to precisely control the movement of large power pistons and motors. This interface between hydraulic equipment and electrical equipment is called as "hydraulic servo valve" and is used in various applications such as in control of aeroplane actuator as one of them.

D. *Block Diagram*

A simple Electro hydraulic system consists of hydraulic pump, reservoir/fluid tank, pressure relief valve, double acting single rod hydraulic cylinder; load connected to the cylinder and controller. The schematic system is shown in Fig2.

When the voltage is applied to the solenoid valve, the current sets up in the coil of the valve producing flux around it which results in an electromagnetic force to open the orifice of the valve. Thus, leading the pressurized fluid from reservoir to port through the proportional valve. Fluid flow respectively builds up pressure on piston of hydraulic cylinder. This pressure head leads to drive the piston and eventually drives the piston and eventually drives the load connected to it.
The load displacement is fed back to the controller through the position sensor which respectively controls the input of the solenoid valve.[3]

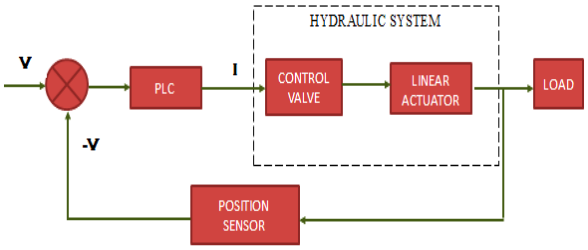

Fig 1. Block diagram of Electro Hydraulic system

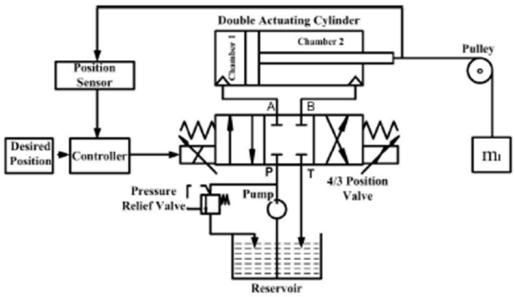

Fig 2. Schematic diagram of Electro Hydraulic system

EQUIPMENTS	DESCRIPTION
PLC	AB micrologix 1400 controller : • L-base unit ; • 32 pins(20 Digital i/p and 12 Digital o/p); • 2 i/p and o/p analog channels; • Serial ports – RS 232,RS 485; • Ethernet ports – 10/100 Ethernet/IP port; • LEDs/indicator lamps,Push Buttons,Switches; • PLC software – RS Logix 500; • SCADA Software – Factory Talk View Studio
Control valve	Proportional Valve: • Maximum Pressure: 350 bar • Repeatability: ± 1% • Hysteresis: ≤ 5%
Linear actuator	Double-acting cylinder : • Bore: 40mm • Stroke length: 300m • Rod diameter: 18mm
Load	10 kg mass
Position Sensor	Linear Potentiometer Position Sensor : • Range: 300mm • Output: 5kΩ to 5vdc • Linearity: ± 1%

E. *Experimental Setup*

HYDRAULIC POWER PACK – INLINE FILTER - DOUBLE ACTING SINGLE ROD CYLINER - PROPORTIONAL SOLENOID VALVE-CONTROL VALVE - TEMPERATURE INDICATOR - LINEAR POSITION SENSOR - LOAD(10 KG) – PLC

The experimental setup as shown in Fig.3 consists of hydraulic pack which has a primary drive: capacitor start capacitor run motor with reservoir (capacity20L) filled with Hydraulic Oil ISO 22 along with solenoid valve. The valve is used to regulate the flow of fluid to the double acting single rod cylinder with 40mm bore and 300mm stroke length across which the load (mass =10Kg) is hanged vertically using a pulley and rope. Alongside the cylinder linear potentiometer (5kΩ to 5V DC) is connected to give the feedback to the controller - PLC (CATALOG NO.: 1766- L32 B W A A). PLC, as a result will give the controlled output supply to the solenoid valve to control the forward and backward position of the piston. The inline filter in system is used to clean and filter the oil from the cylinder before porting it to the reservoir of power pack as there is always a chance of addition of 1 million particles greater than 1 micron per minute to the oil which may lead to wear and contamination of metal parts of the systems. The temperature indicator added with the power pack is to indicate the temperature of the fluid (oil) which should be below 50^0C

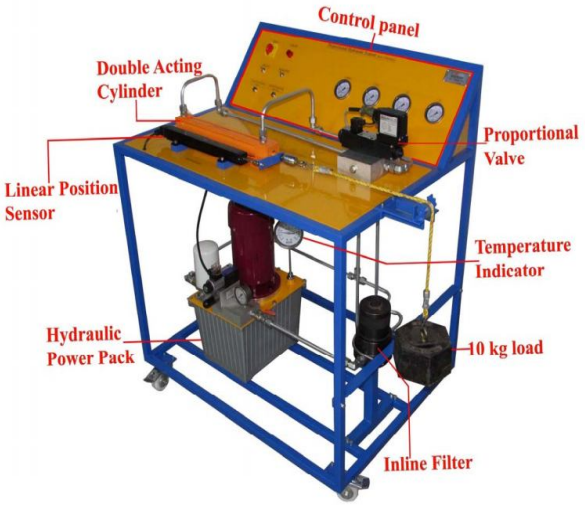

Fig.3- experimental Setup

F. Applications

The electrohydraulic system has many applications in the industrial sector and with the remote control of PLC can further be used with high accuracy. Some of the basic applications are:

1. Lift platform:

Switched directional control valves are used to control the hydraulic motors and the extension or retraction of the individual cylinders. Their speeds are controlled through proportional flow control valves.

2. Molding pressure control:

In the case of particularly strongest requirements on the work piece precision it is possible to control the material pressure at the centre of the mold.

3. Machine tool:

The linear motions of the feed drive are best performed electro-hydraulically

III. FUTURE SCOPE

With increasing automated control over the system the manual operated system will all be replaced by advanced hydraulic techniques by the end of the decade. Thus laying foundations of following advantages:

1) Heavy equipment can be lifted efficiently at construction site.
2) Can be used as handling equipment in aerospace industry
3) Electrohydraulic system with distributed control is opening its doors to open architecture.
4) Accurate prediction of when to exactly replace component so as to help scheduling maintenance.
5) Variable displacement pumps systems in off-road systems.

IV. CONCLUSIONS

Thus from this project we can conclude that the position control of EHS has been done in most cost efficient way and high performance manner and following are the concluding remarks:

1) PLC has reduced the error of the system and smooth the movement of the piston stops at the exact desired position and reduces the vibration of the piston when it extends or retracts.
2) From the comparative study of the valves we can conclude proportional valve used in system is more effective, efficient and cost effective.
3) Successfully developed ladder diagram programming logic for electro-hydraulic system to control position of mass of 10kg using PLC.

4) By using SCADA, we use the graphical interface to test the program, thus reduces energy and time.
5) Successfully implement graphical description of the EHS system using SCADA.

REFERENCES

[1] Abdulgaffar Doddamani, Charukeerthi A, "Advance Hydraulics Technologies and Their Modern Applications", *International Journal of Advance Engineering and Research Development*, Vol. 3, Issue 1, January -2016.
[2] Željko Šitum, Mihael Lobrović," PLC/PAC/PC - Based Control Of An Electro-Hydraulic Servo System ", *Ventil* ,Vol. 19, No.1, pp. 34-40, 2013.
[3] Ruchira Gore, Ashpana Shiralkar, Shailaja Kurode," Incomplete State Feedback Control Of Electro-Hydraulic Servo System Using Second Order Sliding Modes" ,*14th International Workshop on Variable Structure Systems (VSS)*, pp. 210-215, 2016.
[4] Olabanji, O. M. , Mpofu, K.," Programmable Logic Control Of An Electro-Hydraulic System For A Reconfigurable Assembly Fixture Used For Press Brake Assembly ",*Int. Journal of Advanced Manufacturing Technology*,Spinger- Verlag, London, June, 2015.
[5] Ashpana Shiralkar, Shailaja Kurode, Prasad G. Desai," Modeling of electro-hydraulic servo valve and Robust Position Control using Sliding Mode Technique ",*Proceedings of 1st International and 16th National Conference on Machines and Mechanisms*, pp. 607-614, Dec., 2013.