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Faculty of Engineering

Mechatronics Department

Hydraulic and Pneumatic Control Laboratory

Hydraulic Cylinder Speed Control

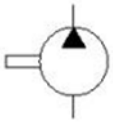
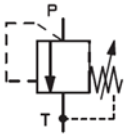
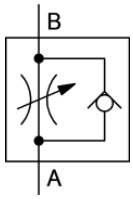
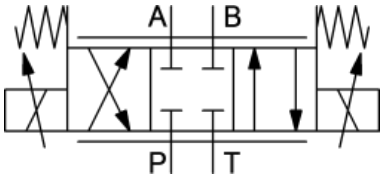
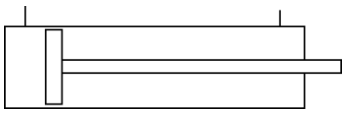
Name: ----------

Presented to: Prof. Dr. / Magdy Abdel-Hameed

1. Objective

- To describe the operation of a flow control valve;
- To establish the relationship between flow rate and velocity;
- To operate meter-in, meter-out, and bypass flow control circuits.

2. Hydraulic Components used

Uni directional Pump	
Pressure relief valve	
1-Way Flow Control Valve	
4/3 Proportional DCV	
Double acting cylinder	

3. Description

Flow rate is the volume of fluid passing a point in a given period of time. Flow rate is measured in liters per minute (l/min) in S.I. units.
Velocity is the average speed of a particle of fluid past a given point in hydraulics, velocity is often measured in centimeters per min (cm/min) in S.I. units
In a hydraulic line, the rate of oil flow is equal to the oil velocity multiplied by the line cross-sectional area. In equation form:

$$Flow\ rate_{(l/\min)} = \frac{Velocity_{(cm/\min)} \times Area_{(cm^2)}}{1000}$$

Flow rate and rod speed

The speed at which a cylinder rod moves is determined by how fast the pump can fill the volume behind the cylinder piston. The more flow the cylinder receives, the more quickly the volume behind the piston will fill with oil and the faster the rod will extend or retract. The speed of a cylinder rod is calculated by dividing the oil flow rate (Q) by the piston area (A) being acted upon. In equation form:

$$Rod\ speed\ (V) = \frac{Flow\ Rate\ (Q)}{Piston\ Area\ (A)}$$

Flow control valves

A flow control valve is an adjustable resistance to flow that operates very much like a faucet. By adjusting the resistance, or opening, of this valve, you can modify the rate of oil flow to a cylinder and, therefore, the speed of its piston rod. Since the Flow Control Valve increases the circuit resistance, the pump must apply a higher pressure to overcome this resistance. This may open the relief valve partially, causing some part of the pumped on to return to the reservoir through the relief valve, and less on to go to the flow control valve and cylinder.

Flow control circuits

There are three ways to meter the oil flow in order to control the speed of a cylinder, which are: meter-in, meter-out, and bypass.
With the meter-in method, the flow control valve is connected in series between the pump and the cylinder, as Figure 1(a) shows. It restricts the working oil flow

to the cylinder. The extra flow delivered by the pump is drained back to the reservoir through the relief valve.

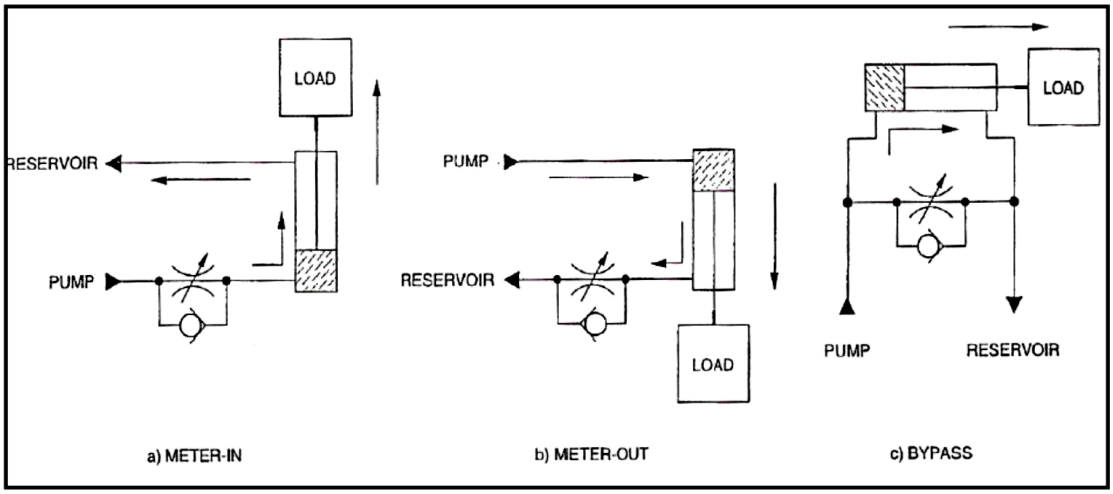


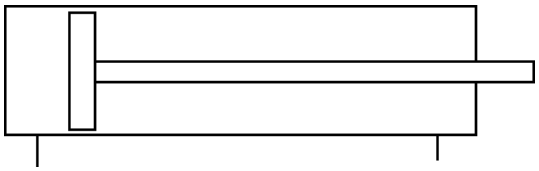
Figure 1: Basic flow control circuits.

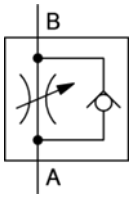
This method is useful to control cylinders having a load that resists to the pump delivery, as cylinders raising a load.

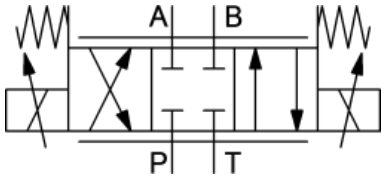
With the meter-out method, the flow control valve is connected in series between the cylinder and the reservoir, as Figure 1 (b) shows. It restricts the flow away from the cylinder. The extra flow delivered by the pump is drained back to the reservoir through the relief valve. This method is useful to slow down cylinders having a load that tends to run away, as cylinders lowering a load.
With the bypass method, the flow control valve is connected between the pump and the reservoir, as Figure 1 (c) shows. The extra flow is diverted directly to the reservoir through the flow control valve. This method is more energy efficient than the meter-in and meter-out methods because the extra flow returns to the reservoir at the load pressure rather than at the relief valve pressure. However, this method is less accurate because it does not provide direct control of the working flow to the cylinder.

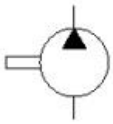
4. Design of hydraulic circuit

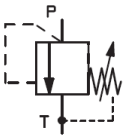
Meter In configuration



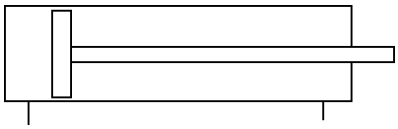


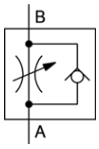


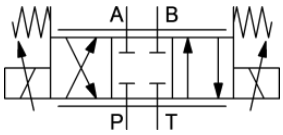


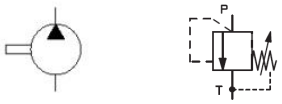


Meter Out configuration

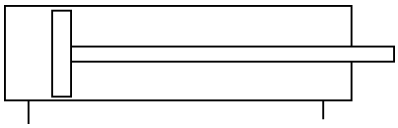


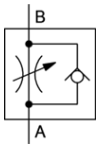


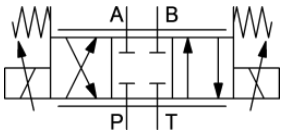




Bypass configuration







5. Procedure steps

a. Connect the hydraulic components for the meter-in configuration.
b. Draw and connect the electrical wiring.
c. Open the flow control valve to allow for full flow
d. Record the Extension time of the cylinder.
e. Adjust the flow control valve to change the extension time for the cylinder to 5s.
f. Record the setting of the flow control valve.
g. Connect the hydraulic components for the meter-out configuration.
h. Repeat steps (c->f)
i. Connect the hydraulic components for the Bypass configuration.

	Meter-In	Meter-Out	Bypass
Fastest Extension Time (sec)			
Valve setting for 5s extension time (Turns)			

4. Discussion

1. Are the fastest extensions times in the three cases equal? Why?

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2. Why are different valve settings required for meter-in and meter-out to achieve the same extension time?

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3. With the given components can you suggest an additional method to control the speed of the cylinder?

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4. What are the advantages and disadvantages of the method that you proposed in (Q3)?

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