Rexroth
Bosch Group

Lab Experiment

Pressure Compensated Piston Pump

Fundamentals

Pressure compensated pumps offer a distinct advantage over fixed displacement pumps in regards to power savings, especially under partial speed actuator conditions.

When full pump flow is not required at the actuator a throttle valve is used to add resistance to the circuit and reduce the flow rate. In a fixed pump/relief valve system, the excess pump flow is passed back to tank across the system relief valve at maximum pressure. This means that when there is a low speed, partial load condition the power lost across the relief valve to heat can easily be higher than the power which is being supplied to the actuator.

The principle of a variable displacement, pressure compensated pump is that the pump automatically varies it's displacement to maintain a preset pressure value at the outlet port. This means that the pump will supply only enough flow to maintain the system pressure and thus matches exactly the flow requirement of the actuator or actuators.

In our experiment we will use an axial piston pump of swashplate design however pressure compensated pumps can also be of bent axis, radial piston or unbalanced vane design.

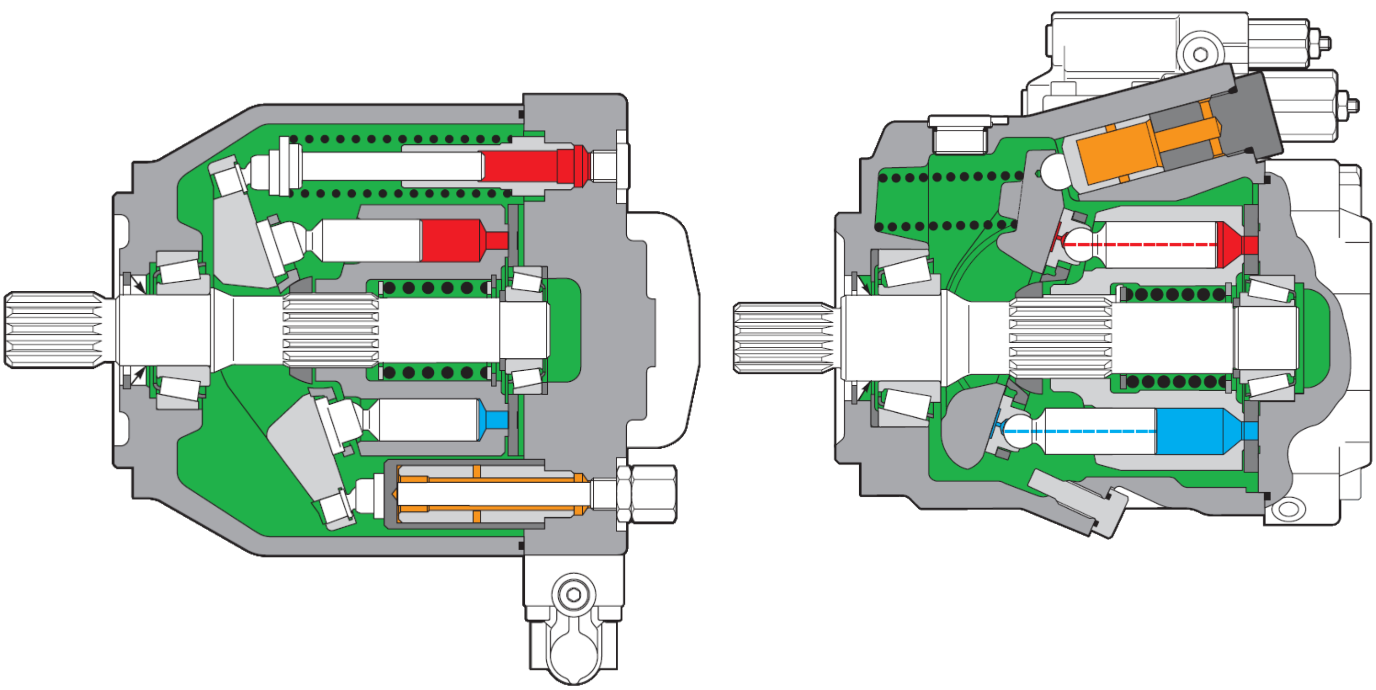


Fig. 1 Variable displacement swashplate piston pumps

Description of Experiment
In this experiment you will investigate the operation of a pressure compensated swashplate piston pump.

Description of exercise
The following simplified circuit shows a pressure compensated pump used to supply a hydraulic motor for a function such as a conveyor. The throttle valve is installed so that the speed of the conveyor may be adjusted by the operator.

The schematic on the following page shows the actual connections on the hydraulic training stand.

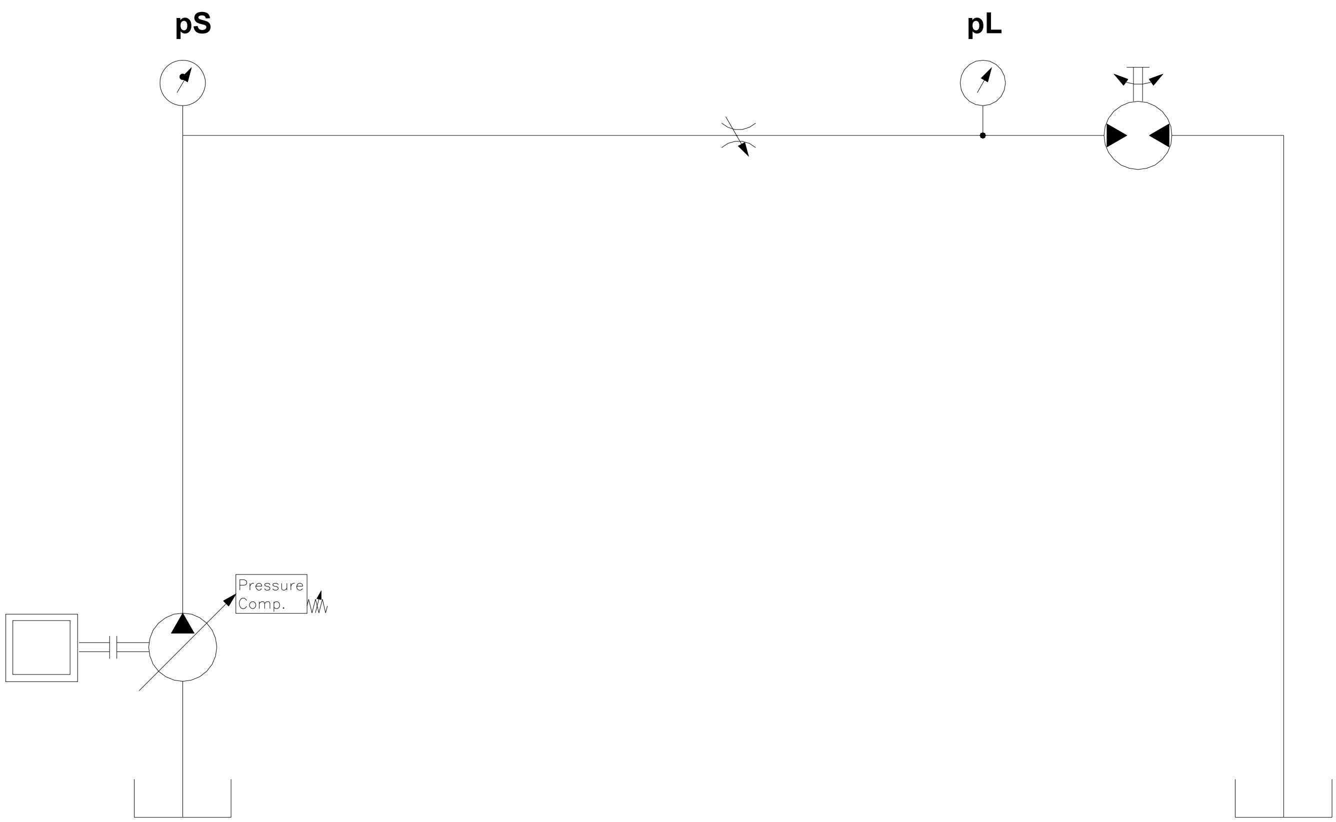
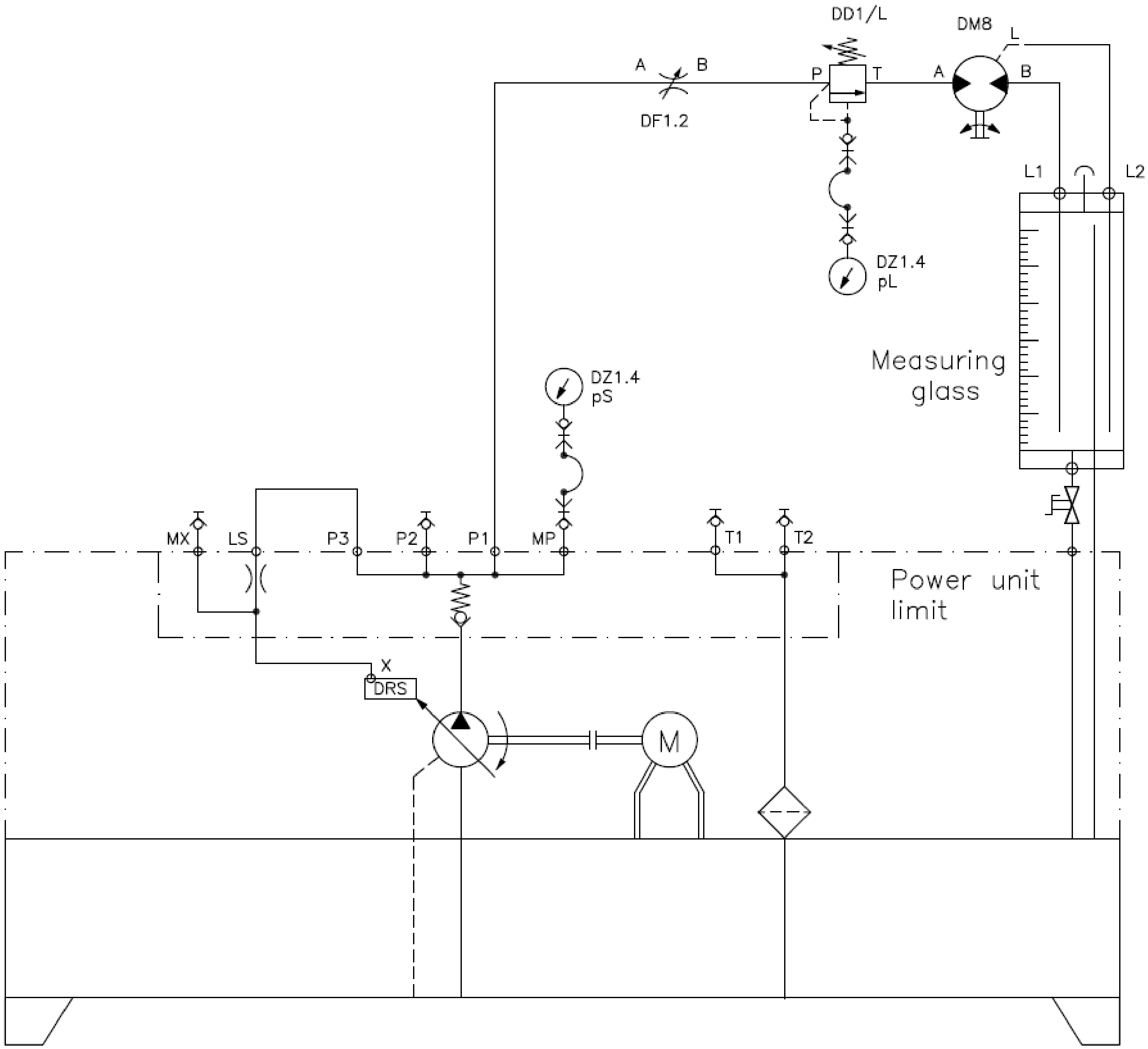
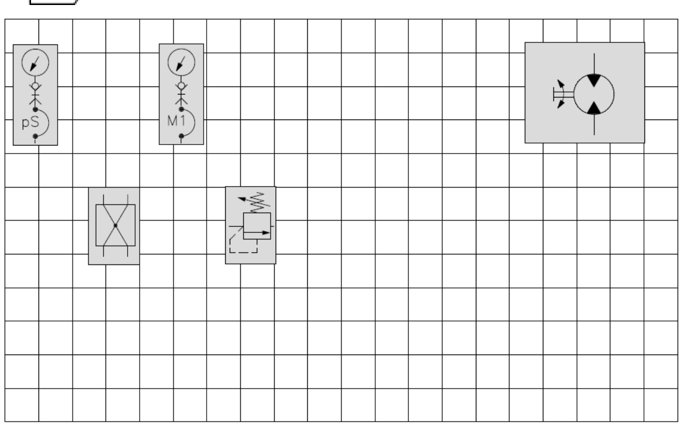


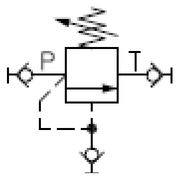
Fig. 2 Pump/actuator circuit

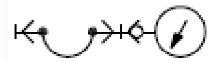
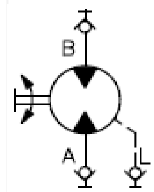
Rexroth
Bosch Group





Components:
You will require the following components:

	Hose assembly	
1x	Pressure relief valve DD1.1	
1X	Throttle valve DF1.2	

2x	Pressure gauge DZ1.4	
1X	Hydraulic motor DM8	

Pressure hoses
Stop watch

Before beginning the experiment read the **Rules for hydraulic trainer operation** sheet.

Setting up the experiment
Set up the circuit observing the following points:
1. Make sure the pump is switched off and the hydraulic circuit is not pressurized.
2. Mount the required components on the grid and lock them
3. Connect the separate units with pressure hoses according to the connection diagram. Take care that the connection hoses are not kinked or under undue stress.

Experimental procedure
Steps in the experimental procedure:
1. Has your instructor checked the constructed circuit?
2. Check again that all connection hoses are firmly coupled. (pull/turn to test)
3. Close the throttle valve DF1.2 completely
4. Back out the setting (CCW) of loading relief valve DD1 until a setting of zero. This will ensure that there is minimum pressure on the downstream side of the throttle valve.
5. Open the shut-off valve on the measuring glass to allow it to drain to tank.
6. Ensure the red E-STOP button is not engaged on either of the starters. (rotate the button to reset)
7. Switch on the pump via the green START push button

Experiment

a) Open the throttle valve DF1.2 one turn.
b) Adjust the loading valve DD1 until 10 bar is read at pressure gauge DZ1.4/pL.
e) Measure and record the pressure upstream of the throttle valve via gauge DZ1.4/pS.
f) Close the shut-off valve of the measuring glass.
g) Measure the time required to fill 1 litre into the measuring glass.
h) Enter the time and pressure at gauge pS in the table and open the shut-off valve of the measuring glass again.
i) Now set the pressure at pL to each of the settings shown on the table. Measure the pressure at pS and the time to fill one litre without changing the setting of the throttle valve.
j) Switch off the pump.

Calculate the respective volume flow Q for the measured times using the following formula:

$$Q = \frac{\text{volume (1 litre)}}{\text{measured time (sec)}} \text{ x } \frac{\text{60 seconds}}{\text{1 minute}}$$

$$Q = \frac{60}{\text{measured time (sec)}}$$

Calculate the pressure drop across the throttle valve at each load pressure setting and record this in table 1.

Pressure drop (Δp) = pS – pL

Rexroth
Bosch Group

Evaluation

Load pressure set @ DD1	Resultant readings			
pL (bar)	pS (bar)	Δp (bar)	t (sec)	Q (l/min)
10				
15				
20				
25				
30				
35				
40				
45				
50				
55				

Table 1

Conclusions

I. The primary purpose of the pressure compensated pump is to maintain a constant pressure at its outlet port. How well did our pump perform in this function?

II. Note and explain what happened when we tried to achieve a pressure setting of 55 bar at the loading relief valve. What would this mean as it relates to the operation of the conveyor circuit which is shown in Fig. 2?

III. What would be the result of opening the throttle valve further at a load pressure of 30 bar?

IV. What would be the result of closing the throttle valve completely at a load pressure of 30 bar?