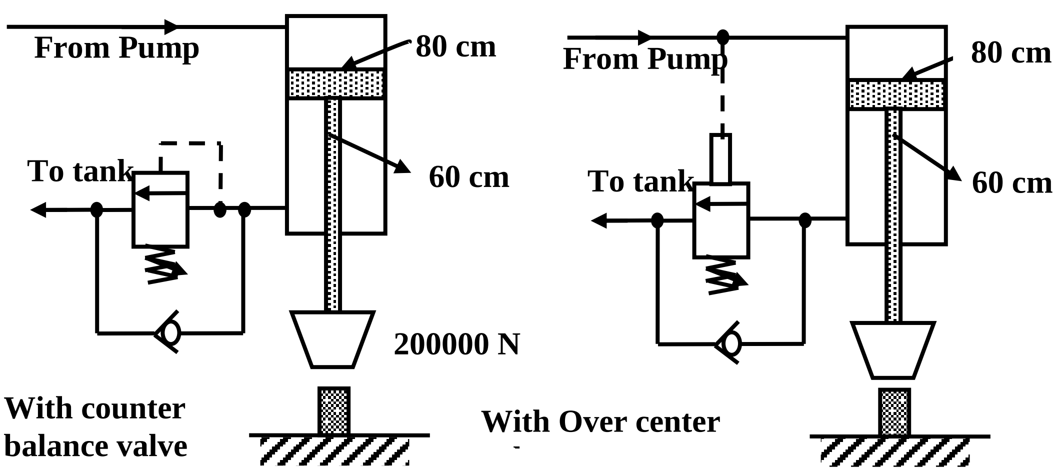
LECTURE 18 AND 19 – PRESSURE CONTROL VAVLES

SELF EVALUATION QUESTIONS AND ANSWERS

1. A piston of 50 mm diameter is to support a load of 20 kN. Find the pressure setting required if the counter balance valve is used

2. A hydraulic press has a capacity of 200 kN and has tools weighing 10 kN. Piston diameter is 80 mm and rod diameter is 60mm. Determine the i) pressure setting of Counter balance valve ii) Oil supply pressure to provide rated capacity iii) if over centre valve is used with pilot input ration of 2:1 set at 46.43 bar to balance the tool weight instead of counter balance valve , what is the supply pressure of oil required to give the rated capacity.



3. If in the problem 2, pump is unloaded using the unloaded valve. If the discharge pressure from pump during unloading is 2 bar, calculate the power loss.

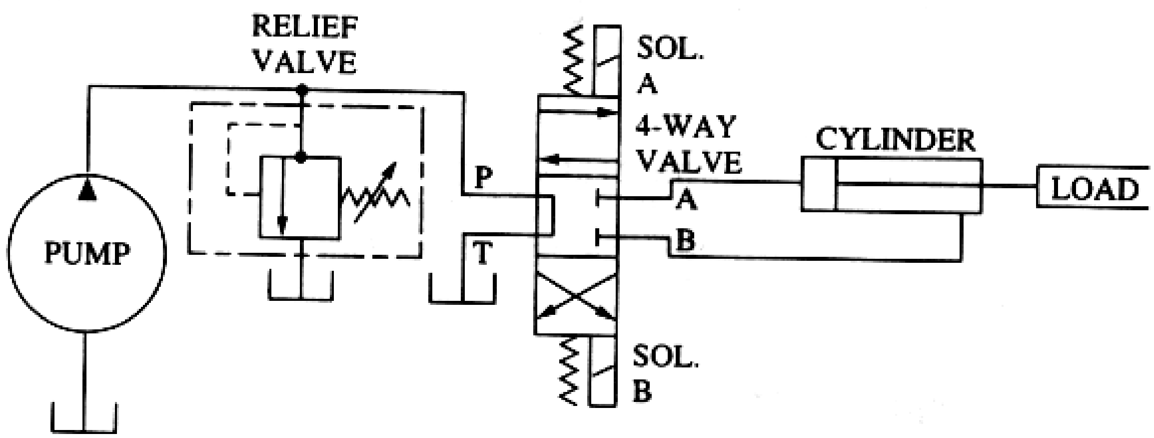
4. A pressure relief valve has a pressure setting of 125 bar. Compute the power loss across this valve if it returns all the flow back to tank from 15 LPM pump

5. Repeat the problem 3 with pressure setting of 140 bar and 1.62 LPS and comment

6. Repeat the problem 3 with 80 bar and 50 LPM and comment

7. A primary port of certain hydraulic cylinder is operating at 210 bar. A secondary circuit supplied from a primary circuit through a pressure reducing valve requires a constant flow of 40 LPM at 150 bar. Calculate the loss of power over the pressure reducing valve. (Ans 4 kW)

8. What is the cracking pressure of the relief valve of Figure shown below? If the area of the poppet piston is 1 cm2 and the spring is adjusted to a force of 50 kg



Q1 Solution

Load pressure p is given by

$$Presure = \frac{load}{area} = \frac{20000}{\frac{\pi \times 0.05^2.}{4}} = 101.9\ bar$$

PRV setting is given by 1.3 x 101.9 = 132.47 bar

Q2 Solution

Full bore area = 0.082×π/4=0.005 m^2

Annulus area = (0.0082-0.0062)×π/4 = 0.0028m^2

Case 1: Using counter balance valve

Pressure at annulus side to balance tools =$\frac{10\times 10^3}{0.0028}$ ×10-5 = 35.71 bar

Suggested counterbalance valve setting 35.71×1.3 = 46.5 bar

Pressure at full bore side of cylinder to overcome counterbalance = 46.43×0.0028/0.005

=26 bar

Pressure to achieve 100kN pressing force=$\frac{20010^3 \times 10^{-5}}{0.005}$ +26= 426 bar

Case 2: Using over -center valve (brake valve)

Let us use an over-center valve with a 2:1 pilot input ratio, set at 46.43 bar to balance the tools , instead of the counterbalance valve

Pressure on the pilot required to open the valve=46.43/2=23.23 bar; pressure at full bore side to drive down the tooling=11.5 bar

Pressure required to achieve 100kNpressing force is =

$\frac{(200-10)\times 10^3 \times 10^{-5}}{0.005}$=380 bar

This is greater than 46 bar pressure needed to pilot the over-center valve open. Therefore there will be no back-pressure set up on the annulus side of the piston during the pressing operation

Q3 Solution

$$kW\ power\ = \Delta p \times Q = \frac{(2 \times 10^5) \times (90 \times 10^{-3})}{60} = 0.30kW$$

Q4 Solution

Therefore there is a reduction of loss of power due to unloaded valve

$$kW\ power\ = \Delta pQ = \frac{(125x10^5)x(0.0016x10^{-3})}{60} = 3.125kW$$

Q5 Solution

$$kW\ power\ = \Delta pQ = (140x10^5)x(0.0016x10^{-3}) = 22.7kW$$

Q6 Solution

$$kW\ power\ = \Delta pQ = (80x10^5)x(0.0090x10^{-3}) = 12kW$$

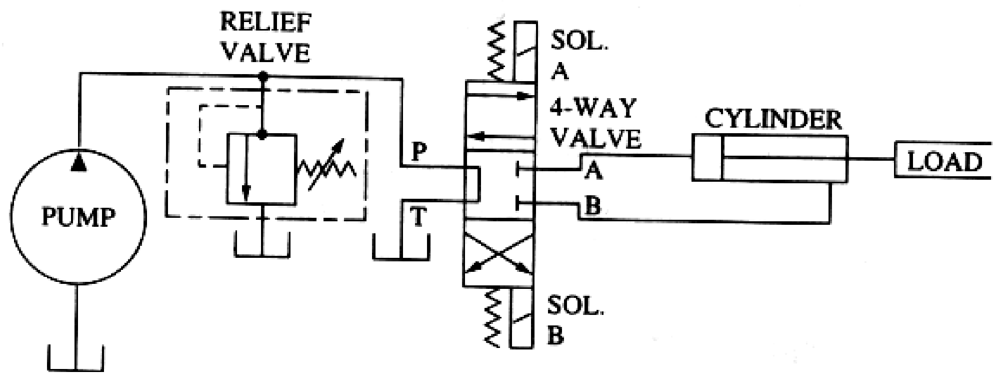
Q7 Solution

The power loss over the pressure-reducing valve will be:

$$power\ loss = \frac{(210-150)\times 40}{600} = 4\text{ kW}$$

This may well be more than can be dissipated by natural cooling. In practice , the cost of fitting a heat exchanger and operating costs should be weighed against alternative circuitry such as two-pump system.

Q8 Solution



$$\frac{490.33\ N}{1cm^2} \times \frac{10000}{m^2} = 4903000\frac{N}{m^2} - 4903\ kPa$$