LECTURE 5-DISTRIBUTION OF FLUID POWER

SELF EVALUATION QUESTIONS AND ANSWERS

1. A pump produces a flow rate of 100 LPM. It has been established that fluid velocity in the discharge line should be between 5 and 7 m/s. determine the minimum and maximum pipe inside diameter that should be used.

2 What minimum size of commercial pipe tubing with a wall thickness of 2mm would be required at the inlet and out let of a 100 LPM pump? The inlet and outlet velocities are limited to 1.6 m/s and 6 m/s respectively.

3.A steel tubing has a 35mm outside diameter and a 29mm inside diameter. It is made up of commercial steel of tensile strength of 600 MPa. What is the safe working pressure? Assume tubing is subjected to high pressure shock. Determine the tensile stress for an operating pressure of 12 MPa.

4.A steel tube of 31 mm inner diameter has burst pressure of 70 MPa. If the tensile strength is 400 MPa. Find the minimum acceptable OD.

5.Select the proper steel tube for a flow rate of 0.00190 m3/s and a operating pressure of 70 bars. The maximum recommended velocity is 6.1 m/s and the tube the material is dead soft cold drawn (DSCD) steel having a tensile strength of 379 MPa.

Q1 Solution:

100 LPM = 0.1/60=1.667×10^{-3} m^3/s

We know that Discharge Q= Area × velocity

$$A_{min} = \frac{\pi}{4}(d_i^2) = \frac{\text{Discharge}}{\text{velocity (max)}} = \frac{1.667\times10^{-3}}{7} = 2.3814\ \times10^{-4}m^2$$

Solving we get $d_i = 17.41$ mm (for maximum velocity)

$$A_{max} = \frac{\pi}{4}(d_i^2) = \frac{\text{Discharge}}{\text{velocity (minmum)}} = \frac{1.667\times10^{-3}}{5} = 3.334\ \times10^{-4}m^2$$

Solving we get $d_i = 20.6$ mm (for minimum velocity)

Q2 Solution:

100 LPM = 0.1/60=1.667×10^{-3} m^3/s

We know that Discharge Q= Area x velocity

$$A_{min} = \frac{\pi}{4}(d_i^2) = \frac{\text{Discharge}}{\text{velocity (max)}} = \frac{1.667\times10^{-3}}{6} = 2.7783\ \times10^{-4}m^2$$

Solving we get $d_i = 18.8$ mm(for maximum velocity)

Refer to that Table we select 20(OD) ×16(ID) for pump inlet

$$A_{max} = \frac{\pi}{4}(d_i^2) = \frac{\text{Discharge}}{\text{velocity (velocity)}} = \frac{1.667\times10^{-3}}{1.6} = 1.11\times10^{-3}m^2$$

Solving we get $d_i = 37.06$ mm (for minimum velocity)

Refer to that Table we select 42(OD) ×36(ID) for pump outlet

Q3 Solution:

$$\text{Bursting pressure} = \mathrm{P_{BP}} = \frac{2\,\mathrm{t\,s}}{\mathrm{d_i}} = \frac{2 \times 3 \times 600}{29} = 124.13\ \mathrm{MPa}$$

Since the tubing is subjected to high pressure shock, we can take factor of safety as 10

$$Working\ pressure = \frac{maximum\ pressure}{Factor\ of\ safety} = \frac{124.3}{10} = 12.43\ MPa = 124.3bar$$

Tensile stress = $\sigma = \frac{P \times D_i}{2 \times t} = \frac{12 \times 29}{2 \times 3} = 58\ MPa$

Q4 Solution:

$$\text{Bursting pressure} = \mathrm{P_{BP}} = \frac{2\,\mathrm{t\,s}}{\mathrm{d_i}}$$

$$70 = \frac{2 \times \mathrm{t} \times 400}{31}, \text{solving we get t} = 2.71\ mm$$

Also $OD = ID + 2t = 31 + 2 \times 2.71 = 36.425\ mm$

Q5 Solution:

$$\mathrm{A} = \frac{\pi}{4}(\mathrm{d_i^2}) = \frac{\text{Discharge}}{\text{velocity}} = \frac{1.90 \times 10^{-3}}{6.1} = 3.115\ \times 10^{-4}\mathrm{m^2}$$

Solving we get $\mathrm{d_i} = 19.91\ \mathrm{mm}$

Let us select OD=22mm , ID =20mm wall thickness =1mm

$$\text{Bursting pressure} = \mathrm{P_{BP}} = \frac{2\,\mathrm{t\,s}}{\mathrm{d_i}} = \frac{2\ \times 1 \times 379}{20} = 37.9\ MPa$$

$$Working\ pressure = \frac{maximum\ pressure}{Factor\ of\ safety} = \frac{37.9}{8} = 4.74\ MPa = 47.4\ bar$$

Since the bursting pressure is less than the working pressure, 1mm wall thickness is not enough. Let us select next size 28×24×2mm

$$\text{Bursting pressure} = \mathrm{P_{BP}} = \frac{2\ \mathrm{t\ s}}{\mathrm{d_i}} = \frac{2\ \times 2 \times 379}{24} = 63.2\ MPa$$

$$Working\ pressure = \frac{maximum\ pressure}{Factor\ of\ safety} = \frac{63.2}{8} = 7.90\ MPa = 79\ bar$$

Since the bursting pressure is more than the working pressure, 28×24×2mm pipe is acceptable.