

Chapter 1

Introduction to Fire Safety & Principles of Hydraulics

Pressure and Water head

Exercise 1

A static water pressure of 6 bar is required at a certain point from a supply to be obtained from an elevated reservoir. At what vertical height above this point must the water surface be?

Sample Answer:

Water head (vertical height)

$$\begin{aligned}
 H &= \frac{P}{0.0981} \\
 &= \frac{6}{0.0981} \\
 &= 61.162 \text{ m}
 \end{aligned}$$

Thus, the required vertical height or water head is **61.162 m**.

Exercise 2

The water level of a tank in a sprinkler installation is 40 metres above a pressure gauge. What pressure in N/m^2 and bar should register on the gauge?

Sample answer:

Pressure in pressure gauge

$$\begin{aligned}
 P &= H \times 0.0981 \\
 &= 40 \times 0.0981 \\
 &= 3.924 \text{ bar}
 \end{aligned}$$

$$\begin{aligned}
 &\text{To convert from bar to } \frac{N}{m^2} \\
 &= \text{pressure in bar} \times 10^5 \\
 &= 3.924 \times 10^5 \\
 &= 392400 \frac{N}{m^2}
 \end{aligned}$$

Answer: Pressure gauge will register **3.924 bar** and **392400 $\frac{N}{m^2}$**

Self-practice:**Exercise 3**

A pump pressure of 5 bar is required to operate a branch when it is working at ground level. If the branch is operated at the height of 25m above the ground what must be the pump pressure in order to maintain the same output?

Exercise 4

A firefighter has to fight fire at 7 bar pressure using a standard nozzle. Fire has taken place on the roof of a warehouse at the height of 33 feet above the ground. Calculate the pump pressure required to fight the fire above the roof at 7 bar.

Exercise 5

A pressure of 6 bar has to be achieved to operate a fire hose in a high-rise building. If wet-riser is installed in the building and a firefighter at 24th floor operates the hydrant, what must be the pump pressure to maintain the same output? Consider height of each floor is 3 m.

Pressure loss due to friction**Exercise 6**

The flowrate in 50 m of 45 mm diameter hose is 400 litres per minute (lpm). What is the loss of pressure in the hose if the friction factor is 0.005?

Sample answer:

$$\begin{aligned} \text{Pressure, } P_r &= \frac{9000fLL^2}{d^5} \\ &= \frac{9000 \times 0.005 \times 50 \times 400^2}{45^5} \\ &= 1.950 \text{ bar} \end{aligned}$$

Exercise 7

Calculate the pressure loss due to friction when water flow is 600 lpm, length of hose is 50 m and –

- 90 mm diameter with a friction factor of 0.007.
- twin lines of 45 mm diameter hose.

Sample answer:

A. For the 90 mm hose:

$$\begin{aligned} P &= \frac{9000 \times f \times l \times L^2}{d^5} \\ &= \frac{9000 \times 0.007 \times 50 \times 600^2}{90^5} \\ &= 0.192 \text{ bar} \end{aligned}$$

B. For the twin hoses, the flowrate in each hose is: $600/2 = 300$ lpm

$$P = \frac{9000 \times f \times l \times L^2}{d^5}$$

$$= \frac{9000 \times 0.005 \times 50 \times 300^2}{45^5}$$

$$= 1.097 \text{ bar}$$

Table: Estimated friction factor for various types of hose.

Diameter of hose	Friction factor
38mm, 45mm, 64mm and 70mm	0.005
90mm with standard instantaneous couplings	0.007
90mm with full flow couplings	0.005
100mm and 125mm	0.004
150mm	0.003

Self-practice:

Exercise 8

Calculate the pressure loss due to friction when the flowrate in 60 m of 100 mm diameter hose is 800 litres per minute (lpm).

Exercise 9

The flowrate in 30 m of 64 mm diameter hose is 450 litres per minute (lpm). What is the loss of pressure in the hose if the friction factor is 0.005?

Flow through Nozzles

Exercise 10

Calculate the flowrate from a 15 mm type A nozzle when working at a pressure of 4 bar.

Sample answer:

$$\text{Flow rate } L = \frac{2}{3} d^2 \sqrt{P}$$

$$= \frac{2}{3} \times 15^2 \times \sqrt{4} = 300 \text{ lpm}$$

Self-practice:**Exercise 11**

Calculate the flowrate from a 12 mm firefighting nozzle when working at 7 bar pressure.

Exercise 12

Calculate working pressure when a 19 mm diameter firefighting nozzle is delivering water at 450 lpm.

Exercise 13

Calculate working pressure from a 25 mm type firefighting nozzle when used at 600 litres per minute (lpm) flowrate.