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Section:

A

Subject:

Fluid Mechanics

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Answer No 1 (a)

Total Energy Head:

From Bernouli principle, the total energy at a given point in a fluid in the energy associated with movement of fluid plus energy from static pressure in the fluid energy from height of fluid relative to an arbitary datum height.

Forms of Energy head:

There are three types of energy head which are given below.

is due to position above some datum line pressure Head + velocity head + Potential head = Total head.

Potential head = Total head - velocity head - Pressure head

Kinetic head:

It represent kinetic energy of fluid. Kinetic energy per unit weight of the fluid is known as kinetic head.

Mathematically:

$$K.E = \frac{V^2}{2g}$$

Pressure head:

In fluid mechanics, pressure head is the internal energy of a fluid due to the pressure exerted on it's container. It may also be called static pressure

Mathematical form:

Pressure head = Total head - kinetic head - Potential head

$$\psi = \frac{P}{\gamma} = \frac{P}{\rho g}$$

ψ is pressure head (which is actually a length)
P is fluid pressure
γ = is specific weight
ρ = Density of fluid
g = Acceleration due to gravity.

Answer 1(b)

Hydraulic grade line:

The hydraulic grade line is a line representing the total head available to the fluid- velocity head.

Mathematical form

$$HGL = \frac{P}{\gamma + h}$$

Energy grade line:

Energy grade line refer to a line that represents to the height of energy head of water streaming in a pipe, course or channel. The line is drawn over the pressure hydraulic grade line (inclination).

Hydraulic radius:

Hydraulic radius is defined as the cross sectional area of flow divided by the wetted perimeter, So the calculation of rectangle and trapezoid area and rectangle area will be included along with the perimeter for each.

Mathematical form:

$$R_h = \frac{A}{P}$$

where A = cross-sectional area of flow

P = wetted perimeter.

Answer No2 (a)

Given data:

Velocity = $V = 2 m/s$
Pressure = $P = 300 kPa$
datum = $Z = 5m$

Solution:

H = Pressure head + K.E + P.E

$$H = \frac{P}{\gamma} + \frac{V^2}{2g} + Z$$

$$H = \frac{300 \times 10^3}{9810} + \frac{2^2}{2 \times 9.81} + 5$$

$$\boxed{H = 35.7849 m}$$

Answer No 2 (b)

Given:

Diameter $= d_1 = 300mm$

Diameter $= d_2 = 200mm$

Pressure $= P_1 = 300kPa = 300\times10^3 N/m^2$

$= P_2 = 120kPa = 120\times10^3 N/m^2$

Datum $= Z = ?$

Solution:

$$Q = \frac{40}{1000} \frac{m^2}{sec}$$

$$d_1 = 300mm = 0.3m$$

$$d_2 = 200mm = 0.2m$$

$$A_1 = \frac{\pi d_1^2}{4}$$

$$A_1 = \frac{3.14\times(0.3)^2}{4}$$

$$A_1 = 0.0706 m^2$$

$$A_2 = \frac{\pi d_2^2}{4}$$

$$A_2 = \frac{3.14 \times (0.2)^2}{4}$$

$$A_2 = 0.0314 m^2$$

We know that

$$Q_1 = V_1 A_1$$

$$\therefore Q = \frac{40}{1000}$$

$$V_1 = \frac{Q_1}{A_1}$$

$$\therefore Q = 0.04$$

$$V_1 = \frac{0.04}{0.0706}$$

$$V_1 = 0.566$$

$$V_2 = \frac{Q}{A_2}$$

$$V_2 = \frac{0.04}{0.0314}$$

$$\boxed{V_2 = 1.27}$$

Now

$$\frac{P_1}{\gamma} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + Z_2$$

$$Z_2 = 0$$

$$\gamma = 9810$$

$$\frac{300 \times 10^3}{9810} + \frac{0.566}{2(9.81)} + Z_1 = \frac{120 \times 10^3}{9810} + \frac{1.27}{2(9.81)} + 0$$

$$30.60 + Z_1 = 12.314$$

$$\boxed{Z_1 = -18.286}$$

Answer No 3

Given:

Length of pipe = 500m
diameter = d = 0.2m
Specific gravity of oil = 0.9
Flow rate = Q = 0.06 m^3/sec
viscosity = $\mu = 6 \times 10^{5}\ N \cdot s/m^2$

Required:

Pressure loss = ΔP = ?

Solution:

$$f = \left(0.0032 + \left(\frac{0.221}{R^{0.237}}\right)\right)$$

where

R = Reynold's number

and is given by

$$R = \frac{V \times d}{\nu} \quad \text{——— (A)}$$

$$\nu = \frac{\mu}{\rho} = \frac{6\times10^{-5}}{900}$$

$$\nu = 6.67\times10^{-8}\ m^2/sec$$

Bernoulli equation

$$\text{Head loss} = h_L = \frac{fLV^2}{2gD} \quad \text{— (B)}$$

put values in (B)

$$h_L = \frac{(0.00879)(500)(1.95)^2}{2(9.81)(0.2)}$$

$$\boxed{h_L = 4.259\,m}$$

Now we will find pressure loss due to friction.

We know that

$$h_L = \frac{\Delta P}{\delta g}$$

$$\Rightarrow \Delta P = h_L \times \delta g$$

Put values

$$\Delta P = 4.259 \times 900 \times 9.81$$

$$\Delta P = 37602.7 \text{ Pa}$$

$$\boxed{\Delta P = 37.6027 \text{ kPa}}$$