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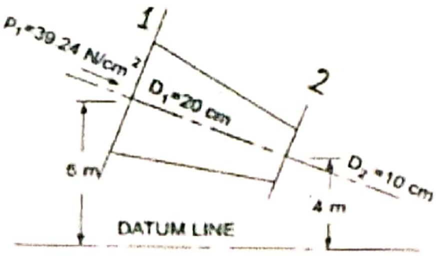
Problems of chapter Five

Problem 5.1 /

The water is flowing through a pipe having diameter 20 cm and 10 cm at section 1 and 2 respectively. The rate of flow through pipe is 35 L / s . The section 1 is 6 m above datum line and section 2 is 4 m above datum line. If the pressure at section 1 is 39.24 × 10⁴ N / m². Find the pressure at section 2? If the flow is ideal.

Solution:



$Q = A_1 V_1$

$$V_1 = \frac{Q}{A_1} = \frac{35\times 10^{-3}}{\frac{\pi}{4}\times 0.2^2} = 1.114 \ \text{m/s}$$

$Q = A_2 V_2$

$$V_2 = \frac{Q}{A_2} = \frac{35\times 10^{-3}}{\frac{\pi\times 0.1^2}{4}} = 4.456 \ \text{m/s}$$

Applying Bernoulli's equation between section 1 & section 2:

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

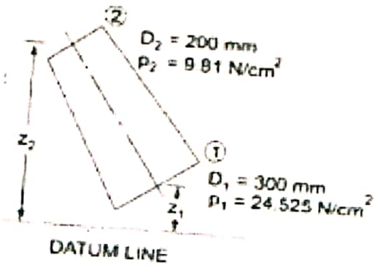
$$\frac{39.24\times 10^4}{1000\times 9.81} + \frac{(1.114)^2}{2\times 9.81} + 6 = \frac{P_2}{1000\times 9.81} + \frac{(4.456)^2}{2\times 9.81} + 4$$

$$P_2 = 41.051 \times 9810 \ \text{N/m}^2$$

Problem 5.2 /

Water is flowing through a pipe having diameter 300 mm and 200 mm at the bottom and upper end respectively. The pressure at the bottom end is 24.525× 10⁴ N/m² and the pressure at the upper end is 9.81× 10⁴ N/m². Determine the difference in datum head ($Z_2 - Z_1$), if the rate of volume flow through pipe is $0.04\ m^3/s$. (the flow is ideal)

Solution:



$Q = A_1 V_1$

$$V_1 = \frac{0.04}{\frac{\pi \times 0.3^2}{4}} = 0.565\ m/s$$

$$V_2 = \frac{0.04}{\frac{\pi \times 0.2^2}{4}} = 1.274\ m/s$$

Applying Bernoulli equation between section 1 & section 2 , we get :

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

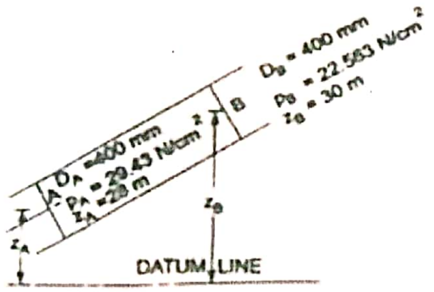
$$\frac{24.525 \times 10^4}{1000 \times 9.81} + \frac{(0.566)^2}{2 \times 9.81} + Z_1 = \frac{9.81 \times 10^4}{1000 \times 9.81} + \frac{(1.274)^2}{2 \times 9.81} + Z_2$$

$$Z_2 - Z_1 = 13.7\ m$$

Problem 5.3 /

A pipe of diameter 400 mm carries water at a velocity of 25 m/s. The pressure at the points A and B are given as $29.43 \times 10^4\ N/m^2$ & 22.563×10^4 respectively while the datum head at A & B are 28 m and 30 m respectively . Find the loss of head between A & B (H_L).

Solution:



Applying Bernoulli equation between section A & section B , we get :

$$\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\rho g} + \frac{V_B^2}{2g} + Z_B + H_L$$

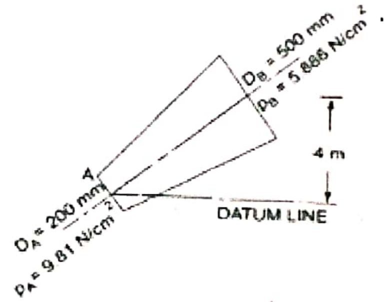
$$\frac{29.43 \times 10^4}{1000 \times 9.81} + \frac{(25)^2}{2 \times 9.81} + 28 = \frac{22.563 \times 10^4}{1000 \times 9.81} + \frac{(25)^2}{2 \times 9.81} + 30 + H_L$$

$H_L = 5$ m

Problem 5.4 /

A pipeline carrying oil of specific gravity (S = 0.87) , changes in diameter from 200 mm diameter at a position A to 500 mm diameter at a position B which is 4 meter at a higher level . If the pressure at A and B are 9.81×10^4 N/ m² and 5.886×10^4 N/ m² respectively and the discharge is 200 L /s, determine the loss of head (H_L) and direction of flow? the flow is real (actual).

Solution:



$$V_A = \frac{Q}{A_A} = \frac{200 \times 10^{-3}}{\frac{\pi \times 0.2^2}{4}} = 6.369 \text{ m/s}$$

$$V_B = \frac{Q}{A_B} = \frac{200 \times 10^{-3}}{\frac{\pi \times 0.5^2}{4}} = 1.018 \text{ m/s}$$

Applying Bernoulli's equation between section A & section B , we get :

$$\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + Z_A = \frac{P_B}{\rho g} + \frac{V_B^2}{2g} + Z_B + H_L$$

$$\frac{9.81 \times 10^4}{870 \times 9.81} + \frac{6.369^2}{2 \times 9.81} + 0 = \frac{5.886 \times 10^4}{870 \times 9.81} + \frac{1.018^2}{2 \times 9.81} + 4 + H_L$$

$H_L = 2.609$ m

Problem 5.5 /

A horizontal venturimeter with inlet and throat diameter 30 cm and 15 cm respectively is used to measure the flow of water. The reading of differential manometer connected to the inlet and the throat is 20 cm of mercury. Determine the rate of flow. Take $C_d = 0.98$.

Solution:

$x = 20$ cm

$$h = x\left[\frac{S_h}{S_o} - 1\right] = 20\left[\frac{13.6}{1} - 1\right] = 252 \text{ cm of water.}$$

$$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(0.3)^2 = 0.0706 \text{ m}^2$$

$$A_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(0.15)^2 = 0.0176 \text{ m}^2$$

$$Q = C_d \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \sqrt{2gh}$$

$$Q = 0.98 \times \frac{0.0706 \times 0.0176}{\sqrt{(0.0706)^2 - (0.0176)^2}} \times \sqrt{2 \times 9.81 \times 0.252}$$

$$Q = 0.125756 \text{ m}^3/\text{s}$$

بلص

Problem 5. 6 /

An oil of sp.gr. 0.8 is flowing through a venturimeter having inlet diameter 20 cm and throat diameter 10 cm. The oil – mercury differential manometer shows a reading of 25 cm. Calculate the discharge of oil through the horizontal venture meter. Take $C_d = 0.98$.

Solution:

$x = 0.25$ m

$$h = x\left[\frac{S_h}{S_o} - 1\right] = 0.25\left[\frac{13.6}{0.8} - 1\right] = 4 \text{ m of oil}$$

$$A_1 = \frac{\pi}{4} d_1^2 = \frac{\pi}{4} \times (0.2)^2 = 0.0314 \text{ m}^2$$

$$A_2 = \frac{\pi}{4} d_2^2 = \frac{\pi}{4} \times (0.1)^2 = 0.00785 \text{ m}^2$$