Badji Mokhtar Annaba University
Faculty of Technology
Department of ST , LMD_2nd year

Fluid Mechanics Examination
Duration: 2H
No documents are allowed

Course based-questions (4 points)

1) Classify the different types of fluids.
2) Explain how the flow regime is determined.
3) Give the mathematical formulas used to calculate head loss in pipe flow.

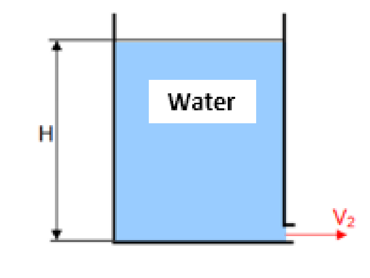
Exercise 1 (4 points)

1) A fluid has a dynamic (absolute) viscosity of $\mu = 14$ posies and a specific gravity of 0.87.

Calculate the kinematic viscosity of this fluid in (m^2/s) and in stokes.

Exercise 2 (5 points)

We consider a reservoir filled with water to a height (H = 3) m, equipped with a small orifice at its base with a diameter (d = 10) mm.

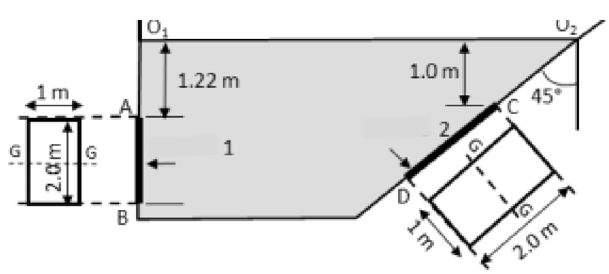


1) By specifying the assumptions taken into account, apply Bernoulli's theorem to calculate the velocity (V_2) of the water flow.

2) Calculate the volumetric flow rate (Q_v) in (l/s) at the outlet of the orifice. We assume that (g = 9.81) m/s².

Exercise 3 (7points)

1) Determine the resultant of water pressure forces acting on valves 1 and 2, see the figure.



Good Luck

Solution of Course based-questions (4 points)

1) Fluids can be classified according to their compressibility into: compressible fluids (Gases) **(0.5)** and incompressible fluids (Liquids) **(0.5)**, and based on their viscosity as ideal fluids which are assumed to have zero viscosity, and real fluids, which exhibit viscous effects. **(0.5)**

2) The flow regime is determined by calculating **(0.5)** the Reynolds number. **(0.5)**

3) There are two main mathematical formulas used to calculate head loss in pipe flow:

- Linear (Regular) head loss **(0.25)**

$$\Delta H_L = \gamma \frac{L}{D}\frac{V^2}{2g}$$ **(0.5)**

- Singular head loss **(0.25)**

$$\Delta H_S = K_i \frac{V^2}{2g}$$ **(0.5)**

With:

γ: Linear head loss coef.
V : Mean pipe velocity (m/s).
L: Pipe length (m).
D: Pipe diameter (m).
g: Gravity (m/s²).
K_i: Singular head loss coef.

Solution 1 **(4 pnts)**

1) Note that: 1poise= 0.1 Pa. s (Unit of the Dynamic viscosity) **(0.25)**

1 stokes= 10^{-4} m²/s (Unit of the kinematic viscosity) **(0.25)**

The dynamic viscosity is related to the kinematic viscosity by the equation bellow:

$$V = \frac{\mu}{\rho} = \frac{14 \times 0.1}{0.87 \times 1000} = 1.61 \times 10^{-3} (m^2/s) = 16.1\ stokes$$

(1) **(0.5)** **(1)** **(1)**

Solution 2 **(4 pnts)**

1) Flow velocity V_2? We apply Bernoulli's theorem with the following assumptions: $V_1 \approx 0$ because the level in the reservoir varies slowly ($V_1 \ll V_2$) and $P_1 = P_2 = P_{atm}$ **(1)**

$$\frac{{V_2}^2 - {V_1}^2}{2g} + \frac{{P_2}^2 - {P_1}^2}{\rho g} + (Z_2 - Z_1)$$ **(0.5)**

$$V_2 = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 3} = 7.67\ m/s$$ **(0.5)** **(0.5)**

2) Volumetric flow rate ?

$$Q_v = V_2 \times S$$ **(0.25)**

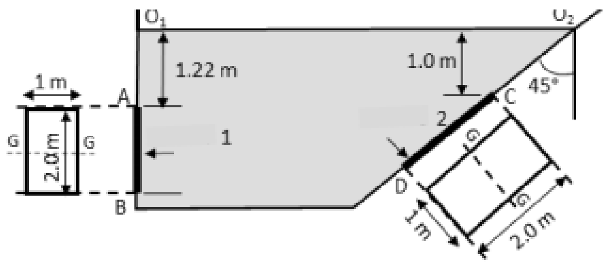
Good Luck

(0.25) $S = \frac{\pi \times D^2}{4} = \frac{3.14 * (10 \times 10^{-3})^2}{4} = 7.87 \cdot 10^{-2}\, m^2$ N.A $Q_v = 0.6\ L/s$ (0.5)

(0.5)

Solution 3 (7 pnts)

Solution



*** For Valve 1**

(0.5)

$F_{R1} = P_{G1}.S_1 = \rho.g.(1.22 + 1.0).S_1$

(0.5) (0.5) (0.5)

$= 10^3 \times 9.81 \times 2.22 \times (2.0 \times 1.0) = 43556.4\ N$

The application point for F_{R1} is given by this formula:

$h_{C1} = h_{G1} + \frac{I_{GG1}}{h_{G1}.S_1}$ avec $I_{GG1} = \frac{1.0 \times 2.0^3}{12} = 0.666\ m^4$ For a regtangular forme

(0.5) (0.5)

$$h_{C1} = \left(1.22 + \frac{2.0}{2}\right) + \frac{0.666}{\left(1.22 + \frac{2.0}{2}\right) \times (2.0 \times 1.0)} = 2.37\ m$$ (0.5)

For Valve N° 2

(0.5) (0.5)

$F_{R2} = P_{G2}.S_2 = \rho.g.\left(1.0 + \frac{2.0 \times \sin(45°)}{2}\right).S_2$

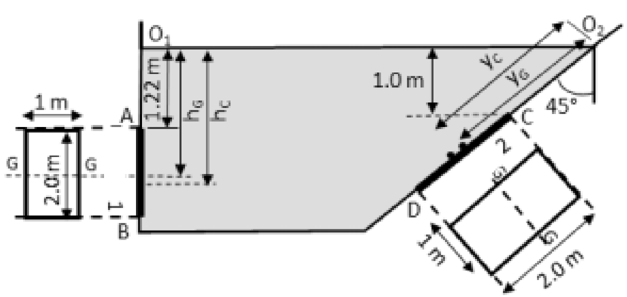
$$= 10^3 \times 9.81 \times \left(1.0 + \frac{2.0 \times 0.707}{2}\right) \times (2.0 \times 1.0) = 33491.34\ N$$ (0.5)

(0.5)

The application point for F_{R2} :

(0.5) $y_{C2} = y_{G2} + \frac{I_{GG2}}{y_{G2}.S_2}$; $I_{GG2} = \frac{1.0 \times 2.0^3}{12} = 0.666\ m^4$ (0.5)

$$y_{C2} = \left(\frac{1.0}{\sin(45°)} + \frac{2.0}{2}\right) + \frac{0.666}{\left(\frac{1.0}{\sin(45°)} + \frac{2.0}{2}\right) \times (2.0 \times 1.0)} = 2.55\ m$$ (0.5)



Good Luck

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