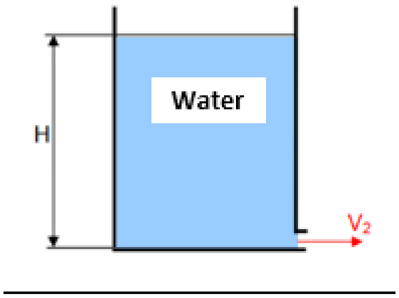
Exercise 1

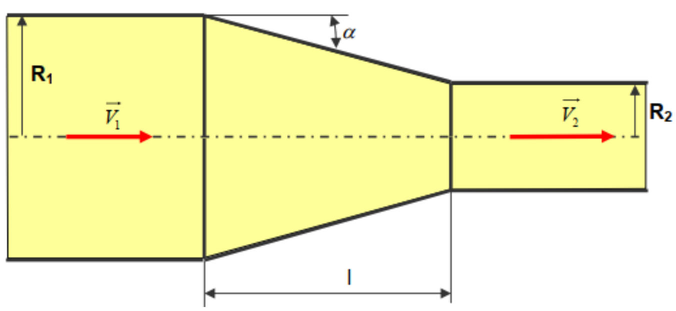
We consider a reservoir filled with water to a height (H = 3) m, equipped with a small orifice at its base with a diameter (d = 10) mm.

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 (Qv) in (l/s) at the outlet of the orifice. We assume that (g = 9.81) m/s².



Exercise 2



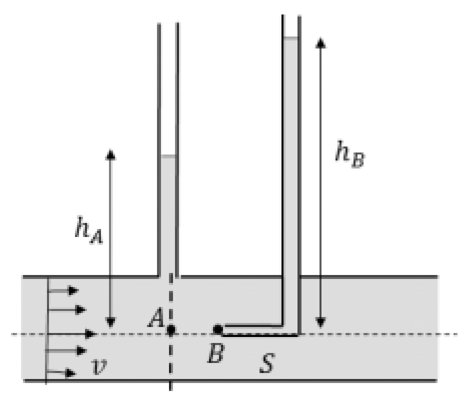
We want to accelerate the circulation of an ideal fluid in a pipe such that its velocity is multiplied by 4. To do this, the pipe has a converging section characterized by the angle α (see the diagram above).

1) Calculate the ratio (R_1/R_2).

2) Calculate (R_1 - R_2) as a function of (L) and α. Deduce the length (L). (R_1 = 50 mm, α = 15°)

Exercise 3

We use a Pitot tube to measure the speed of water at the center of a pipe. The stagnation pressure height (B) is 5.58 m and the static pressure at the wall in the pipe (A) is 4.65 m. What is the speed of the water? (We neglect the pressure losses between the two points A and B).



Solution 1

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 ($V_1 << V_2$)et $P_1 = P_2 = P_{atm}$

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

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

2) Volumetric flow rate ?

$$Q_v = V_2 \times S$$

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

Solution 2

1) We apply the continuity equation :**$V_1S_1=V_2S_2$,with : $S_1 = \pi \times R_1{}^2$ et $S_2 = \pi \times R_2{}^2$**

Therefore : $\frac{R_1}{R2} = \sqrt{\frac{V2}{V1}} = 2$ Because, **$V_2 = 4\ V_1$** according to the exercise data

2) $\tan\alpha = \frac{R1-R2}{l}$ $et\ R_2 = \frac{R1}{2}$ $So,\ l = \frac{R1-\frac{R1}{2}}{tan\alpha}$, $l = \frac{R1}{2tan\alpha} = 93.3\ mm$

Solution 3

Hypothesis :

- Permanent uniform incompressible flow
- We consider an isobar surface between points A and B.
- In A : $P = P_A$ V= V_A Z=Z_A
- In B : $P = P_B V_B = 0$ (stagnation point, static equilibrium entry section of the tube) and Z=$Z_A = Z_B$
- According to Bernoulli's equation between A and B, we have:

$$\left(\frac{P_A}{\rho g} + \frac{V_A^2}{2g} + z_A\right) \underset{\text{No Energy loss}}{\overset{\text{Low distance AB}}{=}} \left(\frac{P_B}{\rho g} + \frac{V_B^2}{2g} + z_B\right) \quad \text{with} \quad z_A = z_B$$

$$P_A + \frac{1}{2}\rho V_A^2 = P_B$$

According to the hydrostatics :$H_A = \frac{P_A}{\rho g}$ $H_B = \frac{P_B}{\rho g}$ (pseudo-static uniform permanent flow)
where, V_A is :

$\boldsymbol{V_A} = \sqrt{\boldsymbol{2g(H_B - H_A)}}$=$\sqrt{\boldsymbol{2g}(5.58 - 4.65)}$= **4.85 (m/s)**