Exercise N° 1 :

ANSWER

1) We calculate the Reynolds number : $R = \frac{V.d}{\nu}$

A.N. $R = \frac{10{,}5.0{,}03}{1.10^{-6}} = 315000 \rangle 100000$: therefore the flow is rough turbulent.

2) $R = \frac{10{,}5.0{,}03}{110.10^{-6}} = 2863{,}63$: $2000 \langle R \langle 3000$: flow is Transient

3) $R = \frac{10{,}5.0{,}03}{290.10^{-6}} = 1086{,}2$: $R \langle 2000$ so the flow is laminar.

Exercise N° 2 :

ANSWER

1) $V = \frac{q_v}{S} = 4.\frac{q_v}{\pi . d^2} = 0{,}2\ m/s$

2) $\Re = \frac{V.d}{\nu} = \frac{V.d}{\left(\frac{\mu}{\rho}\right)} = 27000$;

$2000 < \Re < 10^5$ this is a smooth turbulent flow.

3) We apply the Blasius formula $\lambda = 0{,}316.\Re^{-0{,}25} = 0{,}025$

linear pressure drop is: $J_{12} = -\lambda . \frac{V^2}{2}\left(\frac{L}{d}\right) = -0{,}24\ J/kg$

4) We apply the generalized Bernoulli theorem between points (1) and (2):

$$\frac{1}{2}(V_2^2 - V_1^2) + \frac{1}{\rho}.(P_2 - P_1) + g.(Z_2 - Z_1) = J_{12} + \frac{P_{net}}{\rho . q_V}$$

$V_2 = V_1$, $P_2 = P_1$ so : $P_{net} = \rho . q_v . (g(Z_2 - Z_1) - J_{12}) = 962\ w$

5) $P_a = \frac{P_{net}}{\eta} = 1202\ w$

Exercise N° 3 :

ANSWER

1) $V = \frac{4.q_v}{\pi.d^2}$ A.N. $V = \frac{4.2.10^{-3}}{\pi.0{,}13^2} = 0{,}15\ m/s$

2) $R_e = \frac{V.d}{\left(\frac{\mu}{\rho}\right)}$ A.N $R_e = \frac{0{,}15.0{,}13}{\left(\frac{10^{-3}}{10^3}\right)} = 19500$

3) $2000 < R_e < 10^5$: this is smooth turbulent flow.

4) Blench Formula : $\lambda = 0{,}316.R_e^{-0{,}25}$ A.N. $\lambda = 0{,}316.19500^{-0{,}25} = 0{,}02674$

5) Linear pressure drop: $\Delta H_l = -\lambda.\frac{V^2}{2}.\left(\frac{L_1 + L_2 + L_3}{d}\right)$

A.N. $\Delta H_l = -0{,}02674.\frac{0{,}15^2}{2}.\frac{10+12+8}{0{,}13} = -0{,}09256\ J/kg$

6) Singular head loss: $\Delta H_s = -2.K_s.\frac{V^2}{2}$ A.N. $\Delta H_s = -2.0{,}33.\frac{0{,}15^2}{2} = -0{,}00742$

7) Bernoulli's equation: $\frac{1}{2}(V_2^2 - V_1^2) + \frac{1}{\rho}.(P_2 - P_1) + g.(Z_2 - Z_1) = \frac{P_n}{\rho.q_v} + \Delta H_{1,2}$

Or $V_1 = V_2$, $P_1 = P_2 = P_{atm}$ & $\Delta H_{1,2} = \Delta H_l + \Delta H_s$

donc : $P_n = \rho.q_v.[g.(Z_2 - Z_1) - (\Delta H_l + \Delta H_s)]$ A.N. $P_n = 1000.2.10^{-3}.[9{,}81.(10-0) + 0{,}1] = 196{,}4\ w$

8) $P_a = \frac{P_n}{\eta}$ A.N. $P_a = \frac{196{,}4}{0{,}7} = 280{,}57\ w$