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MATRIC NO: 18/ENG05/002

DEPARTMENT: MECHATRONICS ENGINEERING

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ENG 214

(1) Question 1 solution

Data given

$V_1 = 5m/s$

$V_2 = 2m/s$

$L = Z_1 - Z_2 = 2m$

$\frac{P_1}{w} = 2.5m$, $h_f = \frac{0.35(v_1 - v_2)^2}{2g}$.

Applying Bernoulli's equation

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

$$\frac{P_2}{w} = \frac{P_1}{w} + \frac{1}{2g}(v_1^2 - v_2^2) + (Z_1 - Z_2) - h_f$$

$$= 2.5 + \frac{5^2 - 2^2}{2 \times 9.81} + 2 - \frac{0.35(5-2)^2}{2 \times 9.81}$$

$= 2.5 + 1.07 + 2 - 0.16 = 5.41$

$P_2 = 5.41 \times 9810 =$

53072.1×10^{-5} bar //

(2) Question 2

Solution

Data given

inlet diameter $= \frac{20cm}{100} = 0.2m$

throat diameter $= \frac{10cm}{100} = 0.1m$

$P_1 = 17.658 \, N/cm^2$

$= 176.58 \, kN/m^2$.

$D_2 = 0.1m$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi}{4} 0.1^2 = 0.00786\ m^2$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi\ 0.2^2}{4} = 0.03142\ m^2$

$\frac{P_1}{w} = \frac{176.58}{9.81} = 18\ m$

$P_2 = -30cm = \frac{-30}{100} = 0.3m$

$= -0.3 \times 13.6 = -4.08m$

$C_d = 0.98$

$h = \frac{P_1}{w} - \frac{P_2}{w} = 18.3 - (-4.08)$
$= 22.38m$

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

$= 0.98 \times \frac{0.03142 \times 0.00786}{\sqrt{(0.03142)^2 - (0.00786)^2}} \times \sqrt{2 \times 9.81 \times 22.38}$

$= \frac{0.000242}{0.0304} \times 20.95 = 0.167\ m^3/s$

$Q = 0.167\ m^3/s$

(3) Question 3 solution

Data given

Diameter of pipe $D_1 = \frac{30cm}{100} = 0.3m.$

Diameter of orifice

$= 15cm = 0.15m$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi\ 0.3^2}{4} = 0.07069\ 5m^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi\ 0.15^2}{4} = 0.01767\ m^2$

$C_d = 0.64$

$S_g = 0.9$

manometer reading =

~~50cm~~ 5cm of mercury

= 0.5m of mercury

$h = y\left[\frac{S_{hl}}{S_o} - 1\right]$

S_{hl} = Sg of mercury = 13.6.

$h = 0.5\left[\frac{13.6}{0.9} - 1\right]$

$h = 14.1 \times 0.5 = 7.05m$ of oil

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

$Q = 0.64 \times \frac{0.01767 \times 0.070695 \times \sqrt{2 \times 9.81 \times 7.05}}{\sqrt{(0.070695)^2 - (0.01767)^2}}$

$Q = \frac{0.009740}{0.004469} = 2.004 m^3/s$

$= \frac{0.0147}{0.00469} \times 0.64 =$

$2.006 m^3/s$ //

(4) Question 4 solution

Data given

Y = 170mm of mercury = 0.17m of mercury

Sg of mercury, S_{hl} = 13.6

S_1, Sg of seawater = 1.026.

$h = y\left(\frac{S_{hl}}{S_1} - 1\right)$

$= 0.17\left(\frac{13.6}{1.026} - 1\right) = 12.26 \times 0.17$

(5)

(i)

(ii)

(iii)

$h = 2\cdot0842$ //

Velocity / speed of submarine

$V = \sqrt{2gh} = \sqrt{2\times9\cdot81\times2\cdot0842}$

$V = 6\cdot39\ m/s$ //

(5) Question 5 solution

Data given

Flow rate $0\cdot05\ m^3/min$

$= \frac{0\cdot05}{60} = 0\cdot00083\ m^3/sec.$

$P = 15\ bar = 15\times10^5\ N/m^2$

Speed $= 1700\ rev/min$

$= \frac{1700}{60} = 28\cdot3\ rev/seconds$

normal displacement $= 10\ cm^3/rev$

$= \frac{10}{1000000} = 1\times10^{-5}\ m^3/rev.$

Ideal flow rate = normal displacement $\times$ speed

$= 28\cdot3\times1\times10^{-5} = 2\cdot83\times10^{-4}\ m^3/sec$

(i) Volumetric efficiency

$= \frac{\text{Actual flow rate}}{\text{ideal flow rate}}\times100\%$

~~$= \frac{0\cdot00083}{2\cdot83\times10^{-4}}\times100$~~ $\frac{2\cdot83\times10^{-4}}{0\cdot0083}\times100$

$= 34\cdot096\%$

(ii) Fluid power

$P_f = Q\cdot dP$

$= 0\cdot00083\times15\times10^5$

$= 1245\ watts$

(iii) Shaft power $= T\cdot\omega$

T = torque

ω = angular speed in rad/sec

Torque = 15 Nm

$\omega = 2\pi N$

$\omega = 2 \times \frac{22}{7} \times 28.3$

$= 177.886$ //

Shaft power

$= 15 \times 177.886$

$= 2668.29$ watts.

(14) Overall efficiency

$= \frac{\text{Fluid power}}{\text{Shaft power}} \times 100\%$

$= \frac{1245}{2668.29} \times 100$

$= 46.66\%$ //