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1. A $L = 2.0m = z_1$ $z_2 = 0$

$v_1 = 5 m/s$

$v_2 = 2 m/s$

$\frac{P_2}{\rho g} = 2.5m$

$h = 0.35(v_1 - v_2)^2/2g = 0.1606m$

$g = 9.81 ms^{-2}$

$$z_1 + \frac{P_1}{\rho} + \frac{v_1^2}{2g} = z_2 + \frac{P_2}{\rho g} + \frac{v_2^2}{2g} + h$$

$$\left(2 + 2.5 + \frac{5^2}{2\times 9.81}\right)m = \left(0 + \frac{P_2}{\rho g} + \frac{2^2}{2\times 9.81} + 0.1606\right)m$$

$$\frac{P_2}{\rho} = 2 + 2.5 + \frac{25}{2\times 9.81} - \frac{4}{2\times 9.81} - 0.1606$$

$$\frac{P_2}{\rho} = 5.41 m \text{ ans}$$

2. $d_1 = 20cm = 0.2m$

$d_2 = 0.1m = 10cm$

$P_1 = 17.658 N/cm^2$

$P_2 = 30cm \times 13.6 \times 100 =$

$P_2 = (30cm \times 13.6) \times 1000 \times 9.81 \times 0.01 = 40.025 N/cm^2$

=

2. $d_1 = 20cm =$ $P_1 = 17.658 N/cm^2$

$d_2 = 10cm$

$P_2 = (30cm \times 13.6) \times 0.001 \times 9.81 \times 10^2 = 4.002 N/cm^2 \times 10^2 N/cm^2$

$h = \frac{P_1 + P_2}{\rho g} = \frac{17.658 N/cm^2 - 4.002 N/cm^2}{0.001 \times 9.81 N/cm^3} = 1392.049 cm$

2. $d_1 = 0.2m$

$d_2 = 0.1m$

$P_2 = 17.658 N/cm^2 = \frac{17.658}{0.01 \times 0.01} N/m^2 = 176580 N/m^2$

$h_{Hg} = 30cm = 0.3m \quad h_{H_2O} = 0.3 \times 13.6 = 4.08m$

$P_1 = -1000 \times 9.81 \times 4.08m$

$= -40024.8 N/m^2$

$h = \frac{176580 - 40024.8}{1000 \times 9.81} = 13.92m$

$Q = Cd \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2 \times g \times h}$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi \times (0.2)^2}{4} \quad A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (0.1)^2}{4}$

$= 0.03142 m^2 \quad = 0.00785 m^2$

$Cd = 0.98$

$Q = 0.98 \times \frac{0.03142 \times 0.00785}{\sqrt{0.03142^2 - 0.00785^2}} \times \sqrt{2 \times 9.81 \times 13.92}$

$= 0.1313 m^3/s$ ans

3. ~~$\Delta P = \frac{0.17 \times 13.6}{1.026}$~~

3. $P = \frac{0.5 \times 13.6}{0.9} \times 9.81 \times 900 = 66708 N/m^2$

$h = \frac{66708}{9.81 \times 900} = 7.556m$

$$Q = C_d \times \frac{A_0 \times A_1}{\sqrt{A_1^2 - A_0^2}} \times \sqrt{2 \times g \times h}$$

$A_0 = \frac{\pi (0.15)^2}{4}$ $\quad A_1 = \frac{\pi (0.3)^2}{4}$ $\quad C_d = 0.64$

$= 0.0177\ m^2$ $\quad = 0.0706\ m^2$

$$Q = 0.64 \times \frac{0.0177 \times 0.0706}{\sqrt{0.0706^2 - 0.0177^2}} \times \sqrt{2 \times 9.81 \times 7.556}$$

$Q = 0.14247\ m^3 s^{-1}$ ans

4. $h_{H_2O} = \frac{0.17 \times 13.6}{1.026} = 2.2534\ m$

$\frac{v^2}{2g} = 2.2534 m$

$v = \sqrt{2 \times 9.81 \times 2.2534}\ m$

$= 6.649\ ms^{-1}$ ans

5. $P = 15 \times 10^5\ N/m^2$

$\omega = \frac{1700 \times 2\pi}{60} = \frac{170}{3}\pi\ rad/s^{-1}$

Fluid displacement $= \frac{1 \times 10^{-5}\ m^3}{2\pi} = \frac{5 \times 10^{-6}\ m^3}{\pi\ rad}$

$Q = \frac{5 \times 10^{-6}\ m^3}{\pi} \times \frac{170\pi\ rad}{3\ s} = 2.833 \times 10^{-4}\ m^3/s = 0.017 m^3/min$

Volumetric efficiency $= \frac{0.017\ m^3/min}{0.05\ m^3/min} = 0.34 = 34\%$ ans

i. Fluid power $= P \times Q = 15 \times 10^5\ N/m^2 \times 2.833 \times 10^{-4}\ m^3/s$

$= 424.995\ W$ ans

Shaft power = P_{60} $T\omega$

$= 15\,Nm \times \frac{170\pi}{3}\, s^{-1}$

$= 2670.354\,W$ ans

Efficiency $= \frac{424.995}{2670.354} = 0.16 = 16\%$