



$$v_1 = 5\text{ms}^{-1} \quad z_1 - z_2 = 2\text{m}$$

$$v_2 = 2\text{ms}^{-1}$$

$$h = \frac{0.35(v_1 - v_2)^2}{2g} = \frac{0.35(5-2)^2}{2 \times 9.81} = 0.161$$

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

$$\therefore \frac{P_2}{w} = \frac{P_1}{w} + \frac{1}{2g} \{ v_1^2 - v_2^2 \} + (z_1 - z_2)$$

$$\frac{P_2}{w} = \frac{2.5}{1000 \times 9.81} + \frac{1}{2 \times 9.81} \{ 5^2 - 2^2 \} + 2$$

$$= \frac{1}{3924} + \frac{350}{327} + 2$$

$$P_2 = \left[\frac{12049}{3924} \right] \times 1000 \times 9.81$$

$$P_2 = 30122.5 \text{ N/m}^2$$

$$d_1 = 20 \text{ cm} \approx 0.2 \text{ m}$$

(18) Eng 06/071)

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.2)^2}{4} = 0.031 \text{ m}^2$$

$$d_2 = 10 \text{ cm} \approx 0.1 \text{ m}$$

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.1)^2}{4} = 7.85 \times 10^{-3} \text{ m}^2$$

$$C_d = 0.98$$

$$P_1 = 17658 \text{ N/cm}^2 \approx 1.7658 \text{ kN/m}^{-2}$$

$$P_2 (\text{v.p.}) = 50 \text{ cm Hg} \approx 500 \text{ mm Hg}$$

recall v.p. is always negative

$$\text{sg of mercury} = 13.6 \quad P_2 = -500$$

$$\text{sg of water} = 1000$$

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

$$\text{recall } h = P_1 - P_2 = \frac{1.7658 + 500}{1000 \times 9.81} = 0.0511$$

$$Q = \frac{0.031 \times 7.85 \times 10^{-3} \sqrt{2 \times 9.81 \times 0.0511}}{\sqrt{(0.031)^2 - (7.85 \times 10^{-3})^2}}$$

$$= \frac{2.4335 \times 10^{-4} \times 1.00}{8.99 \times 10^{-4}} = 0.27$$

Equation 3)

(18/Eng06/071)

$$D_1 = 15\text{cm} \approx 0.15\text{m}$$

$$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4} = 0.018\text{m}^2$$

$$D_2 = 30\text{cm} \approx 0.3\text{m}$$

$$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.3)^2}{4} = 0.071\text{m}^2$$

$$S = 50\text{cm Hg} \approx 0.5\text{m Hg}$$

$$cd = 0.64$$

$$h = S \left[\frac{S.S \text{ of mercury}}{S.S \text{ of oil}} - 1 \right]$$

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

$$h = 7.06$$

$$Q = cd \cdot A_1 \cdot A_2 \frac{\sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$= \frac{0.64 \times 0.018 \times 0.071 \sqrt{2 \times 9.81 \times 7.06}}{\sqrt{(0.018^2) - (0.071)^2}}$$

$$= \frac{8.1792 \times 10^{-4} \times 11.77}{0.09} = \cancel{0.74} \text{ m}^3 \text{ sec}^{-1}$$

Question 4.) [18/ENSO6/071]

$$V = \sqrt{2g h}$$

where $h = \left\{ \frac{\text{S.G of mercury}}{\text{S.G of Liquid}} - 1 \right\}$

$$\gamma = 170 \text{ mm Hg} \approx 0.17 \text{ m kg}$$

$$\text{S.G of Hg} = 13.6$$

$$\text{S.G of seawater [Liquid]} = 1.026$$

$$\therefore h = 0.17 \left\{ \frac{13.6}{1.026} - 1 \right\}$$

$$h = 2.083$$

$$\therefore \text{Speed (v)} = \sqrt{2g h}$$

$$= \sqrt{2 \times 9.81 \times 2.083}$$

$$\Rightarrow 6.39 \text{ ms}^{-1}$$

(Question 5) (18/EN306/071)

Actual flow rate = $0.05 \text{ m}^3/\text{min}$ $\approx \frac{0.05}{60} \text{ m}^3/\text{sec}$
 $= 8.33 \times 10^{-4} \text{ m}^3/\text{sec}$

Speed = $1700 \text{ rev/min} \approx \frac{1700}{60} \text{ rev/sec} = 28.33 \text{ rev/sec}$

Pressure = $15 \text{ bar} \approx 15 \times 10^5 \text{ Nm}^{-2}$

Nominal displacement = $10 \text{ cm}^3/\text{rev} \approx 10 \times 10^{-6}$
 $= 1 \times 10^{-5} \text{ m}^3/\text{rev}$

Torque = 15 NM

⑤ volumetric Efficiency

$$= \frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100$$

Ideal flow rate = nominal displacement \times speed
 $= 1 \times 10^{-5} \times 28.33$
 $= 2.833 \times 10^{-4} \text{ m}^3/\text{sec}$

$$V.E = \frac{8.33 \times 10^{-4}}{2.833 \times 10^{-4}} \times 100 = 294.03\%$$

⑥ fluid power = $Q \cdot dP$

$$= 8.33 \times 10^{-4} \times 15 \times 10^5$$
 $= 1249.5 \text{ Nm sec}^{-1}$

⑦ shaft power = T. ~~Angular~~ speed

$$= 15 \times [2\pi 28.33]$$
 $= 2670 \text{ watts}$

$\rightarrow \text{Nm}^{-1}$

Overall Efficiency = $\frac{\text{Fluid Power} \times 100}{\text{Shaft Power}}$

$$= \frac{1249.5}{2670} \times 100$$
$$= 46.8\%$$

18/Eng06/071