Fluid Mechanics 18/ENG04/062

(1)

$L = 20m$

$V_1 = 5m/s$

$V_2 = 2m/s$

$P_1 = 2.5m$

$$h_f = \frac{(0.35(V_1 - V_2)^2)}{2g} =$$

P at lower end

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

$$P_2/w = P_1/w + 1/2g(V_1^2 - V_2)^2 + (Z_1 - Z_2)h_f$$

$$P_2/w = 2.5 + \frac{(5^2 - 2^2)}{2 \times 9.81} + 2\frac{(0.35(5-2)^2)}{2 \times 9.81}$$

$= 25 + 1.07 + 2(0.16055)$

$= 5.409$ bar

(2) Inlet diameter = 20cm = 0.2m

throat diameter = 10cm = 0.1m

$P_1 = 17.658 N/cm^2$

P_2

$Cd = 0.98$

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

$$= \frac{3.142 \times (20/100)^2}{4}$$

$= 0.0314 m^2$

$$A_2 = \pi d^2/4$$

$$= \frac{3.142 \times 0.1^2}{4}$$

$= 0.007858 m^2$

$P_1 = 17.658\ N/cm^2$

$= \frac{17.658}{(100)^2}$

$= 1.7658 \times 10^{-3}\ N/m^2$

$P_1/w = \frac{1.7658 \times 10^{-3}}{9.81}$

$= 1.8 \times 10^{-4}\ m.$

$P_2/w = 0.3 \times 13.6$

$= 4.08m$ or

$h = P_1/w - P_2/w$

$= 1.8 \times 10^{-4} - (4.08)$

$h = 4.08018m$

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

$= 0.98 \times \frac{0.0314 \times 7.8583 \times 10^{-3}}{\sqrt{(0.0314)^2 - (7.8583 \times 10^{-3})}}$

$\times \sqrt{2 \times 9.81 \times 4.08018m}$

$Q = 0.071\ m^3/s$

(b) $d = 15cm = 0.15m.$

$d_2 = 30cm = 0.30m$

50 cm of mercury = 0.5m

$Q = ?$

$S.G = 0.9 \quad Cd = 0.64$

$A_1 = \pi d^2/4$

$= \frac{\pi \times (0.15)^2}{4}$

$= 0.0176\ m^2$

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

$= \frac{\pi \times (0.30)^2}{4}$

$= 0.0706m.$

$h = y\left(\frac{13.6}{0.9} - 1\right].$

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

$= 7.05\ m$ of oil

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

$= \frac{0.64 \times 0.0176 \times 0.0706}{\sqrt{(0.0176^2) - (0.0706^2)}}$

$\times \sqrt{2 \times 9.81 \times 7.05}$

$Q = 2 \times 2.33 \times 10^{-3} m^3/s.$

(4) Axis = 15 m

diff. mercury = 170 mm

= 0.17 m

S.G = 13.6 (mercury)

S.G = 1.026 (sea water)

v = ?

$$h = y\left(\frac{S.G_{mercury}}{S.G_{seawater}} - 1\right)$$

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

h = 2.083 m.

$$v = \sqrt{2gh}$$

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

v = 6.39 m/s.

(5) Q = ~~0.05~~ 5 dm³/min

$$= \frac{0.05}{60}$$

$= 8.33 \times 10^{-5}$ m³/s

Δp = 15 bar = 15×10^5

speed rotation = 1700 rev/min

displacement = 10 cm³/rev

= 0.001 m³/rev

torque input = 15 Nm.

(a) Volumetric efficiency

$$= \frac{\text{Actual flowrate}}{\text{Ideal flowrate}} \times 100$$

$$= \frac{8.33 \times 10^{-5}}{2.83 \times 10^{-4}} \times 100$$

= ~~29.45%~~

= 29.45%

(b) fluid power

$P_f = Q \times \Delta p$

$= 8.33 \times 10^{-4} \times 15 \times 10^5$

= 124.95 watts

(c) shaft power

$T \times \omega$

$\omega = 2 \times \pi \times$ speed of rotation

$\omega = 2 \times \pi \times 28.3$

ω = 177.81 rad/sec

Shaft power = $T \times \omega$

= 15 × 177.81

= 2667.2 watts

(d) Overall Efficiency

$$= \frac{\text{fluid power}}{\text{shaft power}} \times 100$$

$$= \frac{124.95}{2667.2} \times 100$$

= ~~4.65%~~ 4.65%

= ~~46.5%~~