Lawal Teslim
Mechanical Engineering
18/ENG06/038

1 $V_1 = 5ms^{-1}$ PHg smaller end = 2.5m   l = 2.0m
$V_2 = 2ms^{-1}$ $H_L = \frac{(0.35(V_1 - V_2)^2)}{2g}$

PHg lower end = h
$L = Z_1 - Z_2$
$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + h_f$
$\frac{P_2}{w} = \frac{P_1}{w} + \frac{1}{2g}(V_1^2 + V_2^2) + (Z_1 - Z_2)h_f$
$= 2.5 + \frac{5^2 - 2^2}{2 \times 9.81} + 2 - \frac{(0.35(5-2)^2}{2 \times 9.81}$
$= 2.5 + 1.07 + 2 - 0.16055$
$P_2 = 5.407$m of liquid
~~Pressure~~

2 Inlet diameter = 20cm, Inthroat diameter = 10cm
$P_1 = 17.658 N/cm^2$ $C_d = 0.98$
J = 30cm of Mercury = 0.3m of mercury
$A_1 = \frac{\pi d^2}{4} = \frac{(20/100)^2 \times 3.142}{4} = 0.0314m^2$
$A_2 = \frac{\pi d^2}{4} = \frac{(\frac{10}{100})^2 \times 3.142}{4} = 7.855 \times 10^{-3} m^2$
$P_1 = \frac{17.658}{1000} = 1.7658 \times 10^{-2} N/m$
$\frac{P_1}{w} = \frac{1.7658 \times 10^{-2}}{9.81 \times 10^{-1}} = 1.8 \times 10^{-3} m$
$\frac{P_2}{w} = 0.3 \times 13.6 = +4.08$ of H_2O
$h = \frac{P_1}{w} - \frac{P_2}{w} = 1.8 \times 10^{-3} - (-4.08) = 4.08018m$
$Q = 0.98 \times \frac{0.0314 \times 7.855 \times 10^{-3}}{\sqrt{(0.0314)^2 - (7.855 \times 10^{-3})^2}} \times \sqrt{2 \times 9.81 \times 4.08018}$
$Q = 0.0209 m^3/s$

3 $D_1 = 15cm$ $D_2 = 30cm$ S.G = 0.9
Q = x   0.5m of mercury $C_d = 0.64$
$A_1 = \frac{\pi d^2}{4} = \frac{(15/100)^2 \times 3.14}{4} = 0.0177 m^2$
$A_2 = \frac{\pi d^2}{4} = \frac{(30/100)^2 \times 3.14}{4} = 0.0707 m^2$
~~$h_1 = x\left(\frac{13.6}{0.9} - 1\right)$~~ $h_1 = y\left(\frac{Shl}{S0} - 1\right)$
$h = 0.5\left(\frac{13.6}{0.9} - 2\right)$ $Shl = 13.6$, $y = 50 \times 10^{-2}$
$=$ ~~7.05m~~ 6.56m $h = 50 \times 10^{-2}\left(13.6/0.9 - 1\right)$
$= 7.055m$

$Q = \frac{C_d \cdot A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2g \cdot h}$
$Q = \frac{0.64 \times 0.0177 (0.0707)}{\sqrt{(\cancel{0.1766})^2 \times (0.0707)^2}} \times \sqrt{2 \times 9.81 \times \overset{6.56}{\cancel{7.05}}}$
0.0177
$Q =$ ~~7.264~~ $0.137 m^3/s$

4 A = 13m
$y = 170mm$ of Mercury $= 0.17mHg$ v = J
S.G of mercury = 13.6
S.G of sea water = 1.026
$\Delta h = y\left(\frac{S_{Hg}}{S_{sw}} - 1\right)$
$\Delta h = 0.17\left(\frac{13.6}{1.026} - 1\right)$

$h = 2.083m$
$V = \sqrt{2g\Delta h}$
$V = \sqrt{2 \times 9.81 \times 2.083}$
V = 6.39 m/s

5 $Q = 0.05 dm^3/min = 8.33 \times 10^{-5} m^3/s$

Speed of Rotation $= 1700 Rev/min = 28.3 Rev/sec$

Normal Displacement $= 10 cm^3/rev = 10^{-5} m^3/rev$

Torque Input $= 15 N/m$

Pressure change $= 15 bar = 15 \times 10^5 N/m^2$

Ideal flow rate $= 10^{-5} \times 28.3$

$= 2.83 \times 10^{-4} m^3/sec$

a) Volumetric Efficiency $= \frac{\text{Actual flow rate}}{\text{Ideal flow rate}} \times 100$

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

$= 29.45\%$

b fluid Power $P_f = Q \times \Delta P$

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

$= 124.95$ watts

c Shaft Power $= T \times w$

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

$w = 2 \times \pi \times 28.3$

$w = 177.81 rad/sec$

$\therefore$ Shaft power $= 15 \times 177.81$

$= 2667.2$ watts

d Overall efficiency $= \frac{\text{Fluid Power}}{\text{Shaft power}} \times 100$

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

$= 4.68\%$