OLOGBOSERE ANTHONIA
MECHATRONICS
18/ENG05/049
ENG 214

1. $d_1 = 0.3m$, $d_2 = 0.15m$, $S.g_{Hg} = 13.6$, $S.g_{oil} = 0.9$, $y = 0.25m$

— $A_1 = \frac{\pi \times 0.3^2}{4} = 0.0707m^2$

— $A_2 = \frac{\pi \times 0.15^2}{4} = 0.0177m^2$

— $h = y\left[\frac{S.g_{Hg}}{S.g_{oil}} - 1\right]$

$h = 0.25\left[\frac{13.6}{0.9} - 1\right]$

$h = 3.53m$ of oil

a) Discharge of oil, Q

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

$$= \frac{0.98 \times 0.0707 \times 0.0177 \times \sqrt{2 \times 9.81 \times 3.53}}{\sqrt{0.0707^2 - 0.0177^2}}$$

$$= \frac{0.0102}{0.0684}$$

$$= 0.149 m^3/sec$$

b) Pressure Difference, $P_1 - P_2$

$$h = \left[\frac{P_1}{W} - \frac{P_2}{W}\right] + (z_1 - z_2) = y\left[\frac{S.g_{Hg}}{S.g_{oil}} - 1\right]$$

But $h = 3.53$

$\therefore \quad 3.53 = \left[\frac{P_1}{w} - \frac{P_2}{w}\right] + (z_1 - z_2)$

$(z_2 - z_1) = 300\,mm = 0.3\,m$

$3.53 = \left[\frac{P_1 - P_2}{w}\right] - 0.3$

$3.83 = \frac{P_1 - P_2}{w}$

But $w = \rho_{oil} \times g = S.g_{oil} \times 1000 \times g$

$= 0.9 \times 1000 \times 9.81$

$= 8829\,N/m^3$

$\therefore \quad 3.83 = \frac{P_1 - P_2}{8829}$

$P_1 - P_2 = 33,815.07\,N/m^2$

$= 33.8\,kN/m^2$

2. $d_1 = 0.15m$, $d_2 = 0.075m$, $S.g_1 = 0.8$, $Q_{act} = 40l/sec$

$C_{d_1} = 0.96$, $Z_2 - Z_1 = 0.15m$ $\quad Q_{act} = 0.04m^3/sec$

$A_1 = \frac{\pi \times 0.15^2}{4} = 0.0177m^2$

$A_2 = \frac{\pi \times 0.075^2}{4} = 0.0044m^2$

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

$0.04 = \frac{0.96 \times 0.0177 \times 0.0044 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{0.0177^2 - 0.0044^2}}$

$0.04 = \frac{6.7968 \times 10^{-5} \times \sqrt{19.62 \times h}}{0.0171}$

$$6.85 \times 10^{-4} = 3.81 \times 10^{-4} \times \sqrt{h}$$

$$\sqrt{h} = 2.07$$

$$h = 4.292\,m$$

But,

$$h = \left[\frac{P_1}{\omega} - \frac{P_2}{\omega}\right] + (z_1 - z_2)$$

$$4.292 = \left[\frac{P_1 - P_2}{\omega}\right] + (-0.15)$$

$$4.442 = \frac{P_1 - P_2}{\omega}$$

And $\omega = S.g_{oil} \times 1000 \times g$

$= 0.8 \times 1000 \times 9.81$

$= 7848\,N/m^3$

$$4.442 \times 7848 = P_1 - P_2$$

$$P_1 - P_2 = 34,860.816\,N/m^2$$

$$= 34.86\,kN/m^2$$