Olawoyin Sadeeq Babalola
18/ENG05/048
Mechatronics Engineering

1 $d_1 = 300mm = 0.3m$

$d_2 = 150mm = 0.15m$

$A_1 = \frac{\pi d_1^2}{4} = \frac{3.142 \times (0.3)^2}{4} = 0.707m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{3.142 \times (0.15)^2}{4} = 0.0177m^2$

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

$$h = 0.25\left(\frac{13.6}{0.9} - 1\right)$$

$h = 3.53m$ of oil

(a) Discharge of oil (Q)

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

$$= \frac{0.98 \times 0.707 \times 0.0177 \times \sqrt{2 \times 9.81 \times 3.53}}{\sqrt{0.707^2 - 0.0177^2}}$$

$$= 0.149 m^3 s^{-1}$$

(b) Pressure Difference $(P_1 - P_2)$

$$h_1 = \left[\frac{P_1}{wl} - \frac{P_2}{wl}\right] + (Z_1 - Z_2) = y\left[\frac{SG_{Hg}}{SG_{oil}} - 1\right]$$

Since $h = 3.53$

$$\therefore \quad 3.53 = \left[\frac{P_1 - P_2}{wl}\right] + (Z_1 - Z_2) - 0.3$$

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

$wl = \rho_{oil} \times g$

$= 0.9 \times 1000 \times 9.81$

$= 8829 Nm^{-3}$

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

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

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

$$0.04 = \frac{6.85 \times 10^{-9} \times \sqrt{h}}{0.0171}$$

$$6.85 \times 10^{-9} = 3.31 \times 10^{-4} \times \sqrt{h}$$

$$\sqrt{h} = 2.07$$

$$h = 4.292\,m$$

Since

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