ENAYORU PROSPER SEROMU
CHEMICAL ENGINEERING
19/ENG01/018
FLUID MECHANICS

1) Relative density = 0.8

$d_1 = 150mm = 0.15m$

$d_2 = 75mm = 0.075m$

$Z_2 - Z_1 = 150mm = 0.15m$

$Q = 40 \text{ litres/second} = 0.04 m^3/s$

$cd = 0.96$

Pressure difference $P_1 - P_2$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi \times 0.75^2}{4} = 0.01767 m^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi \times 0.075^2}{4} = 0.00442 m^2$

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

$$0.04 = \frac{0.96 \times 0.1767 \times 0.00442 \times \sqrt{2 \times 9.81 \times h}}{\sqrt{0.017672^2 - 0.00442^2}}$$

$$0.04 = 0.96 \times 0.004505 \times 4.429\sqrt{h}$$

$$4.429\sqrt{h} = \frac{0.04}{0.96 \times 0.004656}$$

$$h = \left(\frac{0.04}{0.96 \times 0.004656}\right)^2 / 4.429$$

$h = 4.247m$

$$h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right)$$

$$h = \frac{P_1}{w} - \frac{P_2}{w} + Z_1 - Z_2$$

$$4.247 = \left(\frac{P_1 - P_2}{Pg}\right) - 0.15$$

$$P_1 - P_2/Pg = 4.247 + 0.15$$

$$P_1 - P_2 = (4.397)Pg$$

$$P_1 - P_2 = (4.397) \times 0.8 \times 1000 \times 9.81$$

$$P_1 - P_2 = 34.51 kN/m^2$$

2) $d_1 = 300mm = 0.3m$ Sg of oil $= 0.9$

$d_2 = 150mm = 0.15m$ Sg of $= 13.6$

Reading of different manometer

$y = 250mm = 0.25m$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi \times (0.3)^2}{4} = 0.0707 m^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi \times (0.15)^2}{4} = 0.017$

$h = \left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right)$

$= y\left(\frac{S.g_m}{S.g_l} - 1\right) = 0.25\left(\frac{13.6}{0.9} - 1\right)$

$h = 3.53m$

i) Discharge of oil, Q

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

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

$Q = 0.1489 m^3/s$

ii) $P_1 - P_2 = ?$ $Cd = 0.98$

$S.g = 13.6$ $Z_2 - Z_1 = 300mm - 20.3m$

$\left(\frac{P_1}{w} - \frac{P_2}{w}\right) + (Z_1 - Z_2) = h$

$\left(\frac{P_1}{w} + Z_1\right) - \left(\frac{P_2}{w} + Z_2\right)$

$\frac{P_1 - P_2}{w} = 3 = 3.53$

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

$P_1 - P_2 = 3.83 \times 0.9 \times 9.81$

$= 33.82 KN/m^2$