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18/ENG05/003
MECHATRONICS
ENG 214

ASSIGNMENT

1) $d_1 = 0.3m$

$d_2 = 0.15m$

$s.g_{Hg} = 13.6$

$s.g_{oil} = 0.9$

$y = 0.25m$

$A_1 = \frac{\pi \times 0.3^2}{4} = 0.0707 m^2$ $\quad A_2 = \frac{\pi \times 0.15^2}{4} = 0.0177 m^2$

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

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

$h = 3.53m$ 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 $h = 3.53$

$$3.53 = \left[\frac{P_1}{w} - \frac{P_2}{w}\right] + (Z_1 + (Z_1 - Z_2)$$

$$(Z_2 - Z_1) = \frac{300mm}{1000} = 0.3m$$

$$3.58 = \left[\frac{P_1 - P_2}{w}\right] - 0.3$$

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

~~3.58~~

$$3.83 = \left[\frac{P_1 - P_2}{w}\right]$$

But $w = \rho_{oil} \times g = S.g_{oil} \times 1000 \times 9.81$

$= 0.9 \times 1000 \times 9.81 = 8829\ N/m^3$

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

$P_1 - P_2 = 33815.07\ N/m^2$

$= 33.8\ kN/m^2$

2) $d_1 = 0.15m$ $d_2 = 0.75m$ $Q_{act} = 40l/sec = 0.04m^3/sec$ @ $Cd = 0.96$

$z_2 - z_1 = 0.15m$ $S_g = 0.8$

$A_1 = \frac{\pi \times 0.15^2}{4} = 0.0177m^2$ $A_2 = \frac{\pi \times 0.75^2}{4} = 0.0044m^2$

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

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

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

$\sqrt{h} = 2.07$

$h = 4.292m$

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

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

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

And $w = S.g_{oil} \times 1000 \times g = 0.8 \times 1000 \times 9.81 = 7848\ N/m^3$

$4.442 \times 7848 = P_1 - P_2$

$P_1 - P_2 = 34860.816\ N/m^2$

$= 34.86 kN/m^2$