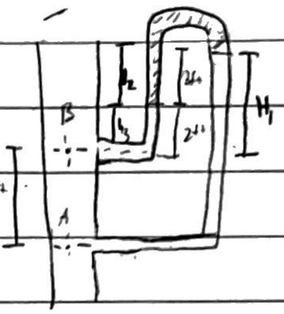
Fluid Mechanics Test 1 Hunter Young

Problem 1. The purpose of this question is to determine the height change necessary for a manometer if it were to change the oil for gasoline




$h_1 = h_2 + h_3$

$h_1 - h_3 = h_2$

$h_1 - h_2 = h_3$

$Sg_o = .90$ , $\Delta P = 2.7177 Psi = 18.737 kPa$

$Sg_o = \rho_o / \rho_{H_2O} \rightarrow .90 = \rho_o / 1000 kg/m^3$

$\rho_o = 900 \ kg/m^3$

$\gamma_o = \rho_o \cdot g = 900 kg/m^3 \cdot 9.81 m/s^2 = 8829 N/m^3 = 8.83 \ kN/m^3$

$Sg_g = .68$

$\rho_g = 680 \ kg/m^3$

$\gamma_g = 6.67 \ kN/m^3$

$\Delta P = \gamma h$

$\Delta P = (\gamma_{H_2O} \cdot 11ft) - (\gamma_{oil} \cdot 3ft) - (\gamma_{H_2O} \cdot 2ft)$

$18.737 kPa = (9.81 \ kN/m^3 \cdot 3.35m) - (\gamma_g \cdot h) - (9.81 \ kN/m^3 \cdot .6096)$

New height is 4ft

$\gamma_g \cdot h = 8.14$

$h = 1.22m = 4ft =$ new deflection

this result makes sense because gasoline had a smaller specific gravity, meaning it is less dense and thus more is needed

Fluid Mechanics test continued Hunter Young

Problem 2 $Sg_c = \rho_c / \rho_{H_2O}$ $\gamma_c = 920 kg/m^3 \cdot 9.807 m/s^2$

$.92 = \rho_c / 1000 kg/m^3$ $\gamma_c = 9022.44 N/m^3 = 9.02 kN/m^3$

$\rho_c = 920 kg/m^3$

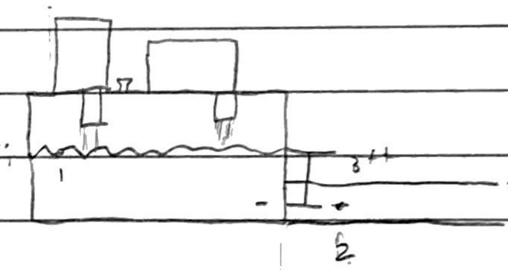
dynamic viscosity: $3.6 \cdot 10^{-5} lbs/ft^2$

Kinematic viscosity $= dv/\rho = .000176 kg/m^2 / 920 kg/m^3 = 1.934 \cdot 10^{-7}$

Reynolds $= (V_2/D)$ / Kinematic viscosity

$$h_a + \cancel{\frac{P_1}{\gamma_c}} + \cancel{\frac{V_1^2}{2g}} + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + \cancel{Z_2} + \cancel{h_R} + h_L$$

$$h_a + Z_1 = \frac{P_2}{\gamma} + \frac{V_2^2}{2g} + h_L$$




Reynolds $= \left(\frac{2.84 m/s}{.04115 m}\right) / 1.934 \cdot 10^{-8}$

$Re = 356710833 = 3.57 \cdot 10^{8}$

Relative roughness $= \frac{.015 mm}{41.15 mm} = 3.645 \cdot 10^{-4}$

$f \approx 0.016$

$Q = VA \rightarrow 60 gpm = V_2 \cdot (A$ of $1\frac{1}{4}$ in pipe$)$

$.0037855 m^3/s = V_2 \cdot \left(\pi \left(\frac{.04115}{2}\right)^2\right)$

$V_2 = 2.84 m/s$

$$h_L = f \cdot \frac{L}{D} \cdot \frac{V^2}{2g}$$

$$h_L = .016 \cdot \frac{3.048 m}{.04115 m} \cdot \frac{(2.84 m/s)^2}{2(9.81 m/s^2)}$$

$h_L = .487$

$P_2 = \gamma_c \cdot h = 9.02 kN/m^3 \cdot 3 ft$

$P_2 = 9.02 kN/m^3 \cdot .9144 m$

$P_2 = 8.25 kPa$

$$h_a + .9144 m = \frac{8.25 kPa}{9.02 kN/m^3} + \frac{2.84^2}{2(9.81)} + .487$$

$\boxed{h_a = .901 N \cdot m/N}$

Power $= \gamma Q h$

$= 9022 N/m^3 \cdot .0037855 m^3/s \cdot .901 N \cdot m/N$

$= 30.76$ watts

Pressure at Pump inlet $= \gamma_c \cdot h = 9.02 kN/m^3 \cdot 9 ft$

$= 9.02 kN/m^3 \cdot 2.743 m = 24.74 kPa$