Homework Solutions
10/19/2007

Ch. 9 Problems

47. Using flow rate to find the velocity and calculating the absolute pressure in the large and small diameters allows us to substitute into Bernoulli's equation and solve for the velocity in the constriction and then the diameter of the constriction. Since the height of the constriction is the same as the large diameter we only have pressure and velocity so deal with.

$$R = 1.80 \bullet 10^{-4}\ \frac{m^3}{s}$$

$$R = A_{l\arg ediameter}\, v_{l\arg ediameter} = \left(\pi\left(.025\,m\right)^2\right)$$

$$v_{l\arg ediameter} = \frac{1.80 \bullet 10^{-4}\ \frac{m^3}{s}}{\pi\left(.0125\,m\right)^2} = 0.367\ \frac{m}{s}$$

$$P_{l\arg e} = P_0 + \rho g h = P_0 + \rho g\left(0.10\,m\right)$$

$$P_{constricti\ on} = P_0 + \rho g\left(0.050\,m\right)$$

$$P_{l\arg e} + \frac{1}{2}\rho v^2_{l\arg e} + \rho g h_{l\arg e} = P_{constricti\ on} + \frac{1}{2}\rho v^2_{constricti\ on} + \rho g h_{constricti\ on}$$

$$P_{l\arg e} + \frac{1}{2}\rho v^2_{l\arg e} = P_{constricti\ on} + \frac{1}{2}\rho v^2_{constricti\ on}$$

$$P_0 + \rho g\left(0.10\,m\right) + \frac{1}{2}\rho v^2_{l\arg e} = P_0 + \rho g\left(0.050\,m\right) + \frac{1}{2}\rho v^2_{constricti\ on}$$

$$\rho g\left(0.10\,m\right) + \frac{1}{2}\rho v^2_{l\arg e} = \rho g\left(0.050\,m\right) + \frac{1}{2}\rho v^2_{constricti\ on}$$

$$g(0.10m)+\frac{1}{2}v_{l\arg e}^2=g(0.050m)+\frac{1}{2}v_{constriction}^2$$

$$v_{constriction}=\sqrt{2g(0.10m)-2g(0.050m)+v_{l\arg e}^2}$$

$$v_{constriction}=\sqrt{2\left(9.80\frac{m}{s^2}\right)(0.05m)+\left(0.367\frac{m}{s}\right)^2}=1.06\frac{m}{s}$$

$$A_{constriction}=\frac{R}{v_{constriction}}=\frac{1.80\bullet 10^{-4}\frac{m^3}{s}}{1.06\frac{m}{s}}=1.71\bullet 10^{-4}m^2$$

$$r_{constriction}=\sqrt{\frac{A_{constriction}}{\pi}}=\sqrt{\frac{1.71\bullet 10^{-4}m^2}{\pi}}=7.37\bullet 10^{-3}m$$

$$d_{constriction}=2r_{constriction}=2(7.37\bullet 10^{-3}m)=1.47\bullet 10^{-2}m=1.47cm$$

80. a.

$$P_0+\rho_w g(L-h)=P_0+\rho_{oil}gL$$

$$\rho_w g(L-h)=\rho_{oil}gL$$

$$\rho_w gL-\rho_{oil}gL=\rho_w gh$$

$$L(\rho_w-\rho_{oil})=\rho_w h$$

$$h=\frac{L(\rho_w-\rho_{oil})}{\rho_w}=L\left(1-\frac{\rho_{oil}}{\rho_w}\right)=(5.00cm)\left(1-\frac{750\frac{kg}{m^3}}{1000\frac{kg}{m^3}}\right)=1.25cm$$

b. Considering the left tube A and the right tube B let's look at the air above the tubes.

$$P_A + \frac{1}{2}\rho v_a^2 + \rho g h_A = P_B + \frac{1}{2}\rho v_B^2 + \rho g h_B$$

$$h_A = h_B$$

$$v_b = 0\frac{m}{s}$$

$$P_A + \frac{1}{2}\rho v_a^2 = P_B$$

$$P_B - P_A = \frac{1}{2}\rho_{air} v_a^2$$

Now, let's look at the fluids in the left and right tubes using the air pressure above the tubes that we just solved for.

$$P_L + \frac{1}{2}\rho_w v_L^2 + \rho_w g h_L = P_R + \frac{1}{2}\rho_{oil} v_R^2 + \rho_{oil} g h_R$$

$$P_A + \rho_w g h_L = P_B + \rho_{oil} g h_R$$

$$P_A + \rho_w g L = P_B + \rho_{oil} g L$$

$$P_B - P_A = \rho_w g L - \rho_{oil} g L$$

$$\frac{1}{2}\rho_{air} v_a^2 = Lg(\rho_w - \rho_{oil})$$

$$v_a = \sqrt{\frac{2Lg(\rho_w - \rho_{oil})}{\rho_{air}}} = \sqrt{\frac{2(.05m)\left(9.80\frac{m}{s^2}\right)\left(1000\frac{kg}{m^3} - 750\frac{kg}{m^3}\right)}{1.29\frac{kg}{m^3}}}$$

$$v_a = 13.8\frac{m}{s}$$

Ch. 10 Conceptual Questions

4. This is good advice. The coolant is pressurized which allows the coolant to remain in the liquid phase well above the boiling point of water. Opening the radiator cap could result in explosive release of this pressure and boiling of the coolant. This would splash all over and cause severe burns to anyone standing nearby.