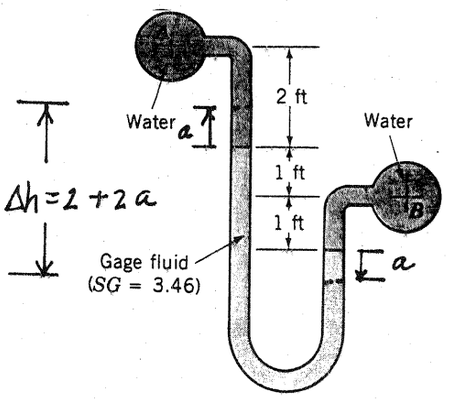
2.42

2.42 The manometer fluid in the manometer of Fig. P2.42 has a specific gravity of 3.46. Pipes *A* and *B* both contain water. If the pressure in pipe *A* is decreased by 1.3 psi and the pressure in pipe *B* increases by 0.9 psi, determine the new differential reading of the manometer.



■ FIGURE P2.42

For the initial configuration:

$$p_A + \gamma_{H_2O}(2) + \gamma_{gf}(2) - \gamma_{H_2O}(1) = p_B \qquad (1)$$

where all lengths are in ft. When p_A decreases to p_A' and p_B increases to p_B' the heights of the fluid columns change as shown on figure. For the final configuration:

$$p_A' + \gamma_{H_2O}(2-a) + \gamma_{gf}(2+2a) - \gamma_{H_2O}(1+a) = p_B' \qquad (2)$$

Subtract Eq. (2) from Eq. (1) to obtain

$$p_A - p_A' + \gamma_{H_2O}(a) - \gamma_{gf}(2a) + \gamma_{H_2O}(a) = p_B - p_B'$$

or

$$a = \frac{(p_B - p_B') - (p_A - p_A')}{2(\gamma_{H_2O} - \gamma_{gf})}$$

Since, $p_A - p_A' = 1.3$ psi, $p_B - p_B' = -0.9$ psi, and $\gamma_{gf} = 3.46\,\gamma_{H_2O}$

$$a = \frac{\left(-0.9 \frac{lb}{in.^2}\right)\left(144 \frac{in.^2}{ft^2}\right) - \left(1.3 \frac{lb}{in.^2}\right)\left(144 \frac{in.^2}{ft^2}\right)}{2\left(62.4 \frac{lb}{ft^3}\right)(1 - 3.46)} = 1.03 \text{ ft}$$

and therefore

$$\Delta h = 2\text{ ft} + 2a = 2\text{ ft} + 2(1.03\text{ ft}) = \underline{\underline{4.06\text{ ft}}}$$