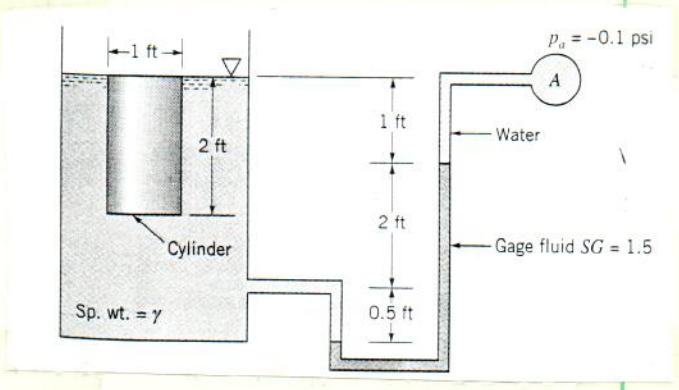
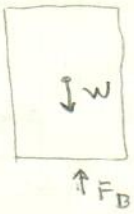
munson 3rd Ed

Hydrostatic Pressure + Buoyancy

(2.89) A 1-ft diameter, 2 ft long cylinder floats in an open tank containing a liquid having a specific weight γ_f. A U-tube manometer is connected to the tank as shown. When the pressure in pipe A is 0.1 psi below atmospheric pressure, the various fluid levels are as shown. With this info, determine the weight of the cylinder



A FBD on the cylinder gives



$$W - F_B = 0$$

or $$W = F_B = \gamma_f V_d$$

(V_d = volume displaced (full vol of cylinder))

here $$V_d = \frac{\pi}{4} D^2 H$$

$$= \frac{\pi}{4}(1)^2(2) = \frac{\pi}{2}\ ft^3$$

$$\therefore \boxed{W = \gamma_f \left(\frac{\pi}{2}\right)}$$

Now, for the manometer, we start at the free surface of the fluid, or

$$P_{atm} + \gamma_f (3.5) - (1.5)\gamma_w (2.5) - \gamma_w (1) = P_A$$

($P_{atm} \to 0$; $P_A = -0.1$ psig (given))

For $\gamma_w = 62.4$ lbf/ft^3, this becomes

$$\gamma_f = \frac{\left(-0.1 \frac{lbf}{in^2}\right)\left(\frac{144\ in^2}{ft^2}\right) + \left(62.4 \frac{lbf}{ft^3}\right)\left(1 + 3.75\right) ft}{3.5\ ft}$$

$$= \frac{-14.4 + 296.4}{3.5} = \frac{282}{3.5} = \boxed{80.6 \frac{lbf}{ft^3}}$$

give this

thus $$W = \left(80.6 \frac{lbf}{ft^3}\right)\left(\frac{\pi}{2}\ ft^3\right) = \boxed{126.6\ lbf}$$