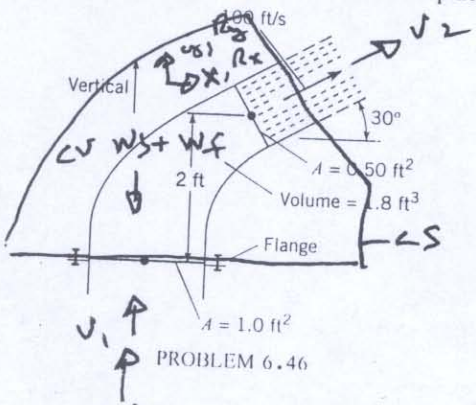
6.46 This nozzle bends the flow from vertically upward to 30° with the horizontal and discharges water (γ = 62.4 lbf/ft^3) at a speed of 100 ft/s. The volume within the nozzle itself is 1.8 ft^3, and the weight of the nozzle is 100 lbf. For these conditions, what *vertical* force must be applied to the nozzle at the flange to hold it in place?



PROBLEM 6.46

V_1 $\quad$ $p_1 A_1$

$\rho_1 A_1 V_1 = \rho_2 A_2 V_2 \Rightarrow V_1 = \dfrac{V_2 A_2}{A_1} = \dfrac{Q}{A_1} = 50$ ft/s — (3)

$Q = 100 \times .5 = 50$ ft^3/s — (2)

$V_2 \quad A_2$

$\Sigma F_y = \Sigma \rho v \underline{V} \cdot \underline{A} = \rho Q (V_{2y} - V_{1y})$

$= R_y + p_1 A_1 - W_s - W_f$ — (1)

$\dfrac{p_1}{\gamma} + \dfrac{V_1^2}{2g} + z_1 = \dfrac{p_2}{\gamma} + \dfrac{V_2^2}{2g} + z_2$ — (4)

$p_1 = \gamma \left[\dfrac{V_2^2}{2g} - \dfrac{V_1^2}{2g} \right] + (z_2 - z_1)\gamma$

$= 62.4 (155.28 + 2 - 38.82) = 7392$ psf

$-W_s - W_f + p_1 A_1 + R_y = 1.94 \times 50 [100 \sin 30° - 50]$ — (5)

$W_s \quad W_f \quad 62.4 \times 1.8 \quad p_1 A_1 \quad 7392 \times 1$

$R_y = -7155$ lbf