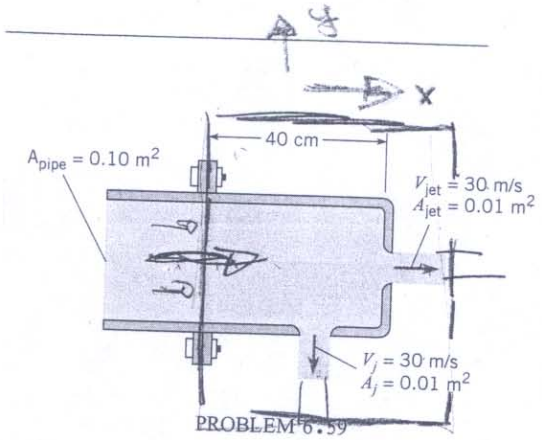
6.59 For this weird nozzle, what force would have to be applied through the bolts in the flange to hold the nozzle in place? Assume irrotational flow. Water is flowing, and the nozzle itself weighs 200 N.



PROBLEM 6.59

$V_{jet} = 30\ m/s$

$Q_{jet} = V_j A_j = 30 \times .01$

$V_j = 30\ m/s$

$Q_j = 30 \times .01$

$$\frac{P_p}{\gamma} + \frac{V_p^2}{2g} = \frac{P_{jet}}{\gamma} + \frac{V_j^2}{2g}$$

$$P_p = (\gamma/2g)(V_j^2 - V_p^2)$$

$$P_p = 500\,(900 - 36) = 432{,}000\ Pa$$

$V_p A_p = \Sigma V_j A_j$ — continuity

$V_p = 2 \times 30 \times .01 / .1$

$V_p = 6\ m/s$

$$\Sigma F_x = \Sigma \rho V_x \underline{V} \cdot \underline{A} = P_p A_p + F_x = \rho V_p(-V_p A_p) + \rho V_{jet}(V_{jet} A_{jet})$$

$$F_x = -1000 \times 6^2 \times .1 + 1000 \times 30^2 \times .01 - 432{,}000 \times .1$$

$$= -37{,}800\ N$$

$$\Sigma F_y = \Sigma \rho V_y \underline{V} \cdot \underline{A} = F_y = \rho V_j (V_j A_j) = 1000(-30)(30 \times .01)$$

$$= -9000\ N$$

$$\Sigma F_z = 0 = -200 - \gamma \forall + F_z$$

$$F_z = 200 + 9810 \times .1 \times .4$$

$$= 592\ N$$

$$\underline{F} = -37.8\hat{i} - 9\hat{j} + .59\hat{k}\ kN$$