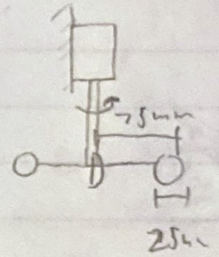
MET330 Homework 2.2

17.11 Knowing that area and distance to moment will help give required torque value, but isn't there a force value calculated by the hemispherical cup shape?



$C_D = 1.35$

Drag force equation: $F_D = \text{drag} = C_D(\rho v^2/2)A$

C_D = coefficient of drag ★ in tables

ρ = density

v = velocity

velocity: $V = \omega \times r$ $\quad \omega = \text{rad/s} = \frac{\text{rev}}{\text{min}}\left(\frac{2\pi \text{ rad}}{1 \text{ rev}}\right)\left(\frac{1 \text{ min}}{60 \text{ s}}\right)$

r = radius

Torque: Force × distance (N·m)

$A = \pi\left(\frac{0.025}{2}\right)^2 = 4.909 \cdot 10^{-4} \text{ m}^2$

$\frac{20 \text{ rotations}}{1 \text{ min}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} \cdot \frac{2\pi \text{ rad}}{1 \text{ rotation}} = 2.0943 \text{ rad/s}$

$V = \omega \cdot r = 2.0943 \cdot 0.075 \text{ m} = 0.157 \text{ m/s}$

$F_D = C_D(\rho V^2/2)A = 1.35(1.225 \text{ kg/m}^3 \cdot 0.157 \text{ m/s}^2/2) \cdot 4.909 \cdot 10^{-4} \text{ m}^2$

$\underline{F_D = 1.00048 \cdot 10^{-5} \text{ N}\cdot\text{m}}$

16.6 $\rho_{H_2O} @ 180°F = 60.546\ lbs/ft^3$

A = constant $= 2.95 in^2 = 0.02044 ft^2$

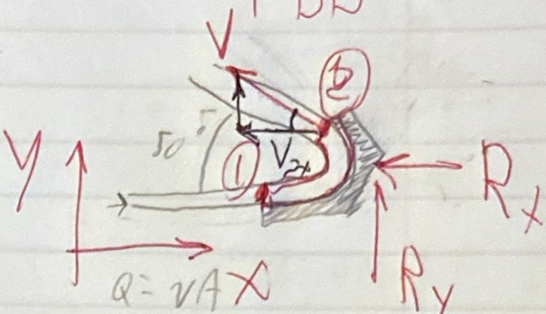
$V = 22.0 ft/s,\ \theta = 50°$

$\Sigma F_x = \rho Q \Delta V_x = \rho Q (V_{2x} - V_{1x})$

$\Sigma F_y = \rho Q \Delta V_y = \rho Q (V_{2y} - V_{1y})$

SOHCAHTOA

FBD



$R_x = P_1 A_1 + \rho \frac{Q^2}{A}$

$R_y = \rho \frac{Q^2}{A_2} + w + P_2 A_2$

$Q = vA$

$Q = 22\ ft/s \cdot 0.02044 ft^2$

$Q = 0.45056\ ft^3/s$

If I have entrance velocity, shouldn't I be able to find exit velocity? or did they give me working velocity. what do I use for pressure? the book used 1000 but I don't know why.

$V_{2x} = (\cos 50) \cdot 22 = 14.14$

$V_{2y} = (\sin 50) \cdot 22 =$

$-R_x = \rho Q (V_{2x} - V_{1x})$

$-R_x = 60.586\ lbs/ft^3 \cdot 0.45056\ ft^3/s\ (14.14 - 22)$

$-R_x = -214.578$

$R_x = 214.578$

$R_y = \rho Q (V_{2y} - V_{1y}) + w$

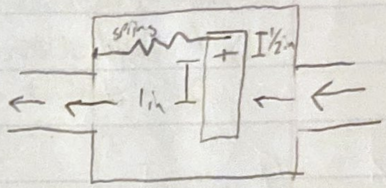
$R_y = 60.586\ lbs/ft^3 \cdot 0.45056\ ft^3/s\ (\quad - 0)$

$R_y =$

16.11 $Q = 100 \text{ gal/min} = .223 \text{ ft}^3/\text{s}$

1in Schedule 40 pipe $= 1.049 \text{in} = 0.0874 \text{ft}$

$A = \pi(0.0437\,\text{ft})^2 = 0.006001 \text{ft}^2$



$\rho = 62.4 \text{ lb/ft}^3$

$Q = VA \rightarrow V = Q/A = \dfrac{.223 \text{ ft}^3/\text{s}}{0.006001 \text{ft}^2}$

$V = 37.15 \text{ ft/s}$

$F = \rho Q \Delta V = 62.4 \text{ lb/ft}^3 \cdot .223 \text{ ft}^3/\text{s} \cdot 37.15 \text{ ft/s}$

$F = 516.949 \text{ ft}\cdot\text{lb/s}^2 \text{ (lbf)}$

$M_A = 0.0416_{ft} \cdot F_s - 0.0833_{ft} \cdot 516.949 \text{ lbf} = 0$

$F_s = \dfrac{0.0833 \cdot 516.944}{0.0416} = 1035.14 \text{ lbf}$