Team 4

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HW 2.2

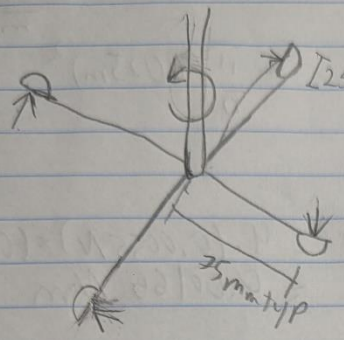
This week we discussed new material dealing with Chapter 16, Forces Due to Fluids in Motion. This topic discusses when a fluid stream deflected its initial direction, and its velocity is changed with the deflection. We discussed how a force is required to make those changes in direction and velocity, and we must be able to calculate the magnitude and direction of those forces for engineering designs. Those calculations are important to make an efficient design, also the forces are sometimes used in to aid the motion of other objects, so that needs to be considered.

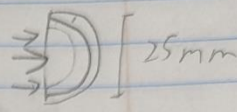
When solving a problem dealing with the forces due to fluids, or really forces in general, drawing a Free Body Diagram (FBD) is crucial in understanding and working out the problem. The Free Body Diagram helps us understand all of the forces on the system and how they are acting/reacting on the system. Understanding how forces are acting on the systems helps us know how to apply the force to help us solve the problem.

Aiden Pham

HW 2.2

Ch 17 #11




a) air at 30°C, b) gasoline at 20°C

$(1.164\ kg/m^3)$ $\approx 680\ kg/m^3$

Torque required to maintain 20RPM of the motor rotate the cup, air but the open front

$\therefore C_D = 1.35$ from Table 17.1

Find velocity each of the cup is to achieve 20RPM:

$$V = \frac{20\ Rev}{min} \cdot \frac{1\ min}{60s} \cdot \frac{2\pi}{1\ Rev} \cdot 75mm = \frac{1m}{1000mm} = 0.157\ m/s$$

calculate Drags:

$$F_D = \frac{C_D \cdot \rho v^2 A}{2} = \frac{1.35 \cdot 1.164\ kg/m^3 \cdot \frac{\pi}{4}(0.025m)^2 \cdot (0.157\ m/s)^2}{2}$$

$$F_D = 9.51E\text{-}6\ kg\ m/s^2 = [N]$$

Torque is 4 cups of area of Drag

$$T = 4F_D \cdot (0.075m) = 4.9518E\text{-}6\ N \cdot 0.075m =$$

$$T = \boxed{2.85E\text{-}6\ Nm}$$

b) Repeat above process

$$F_D = \frac{C_D \cdot \rho v^2 A}{2} = 0.5 \times 1.35 \times 680 \frac{kg}{m^3} \times \left(0.157 \frac{m}{s}\right)^2 \times \frac{\pi}{5}(0.0025m)^2$$

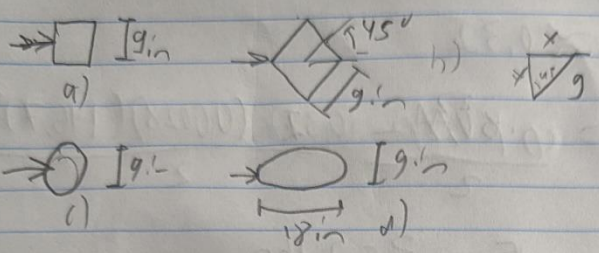
$$F_D \approx 0.0055N$$

$$T = 4F_D(0.075) = 4 \cdot (0.0055N) \times (0.075m)$$
$$= 0.00166\ N \cdot m$$

$a^2+b^2=c^2 \quad 2(a^2)=c^2$

**17.16** $F_D = ?$ @ $v = 100$ mph and air at $-20°F$

$L = 60$ in, $w = 9$ in




$\rho = 2.80 \times 10^{-3}$ slugs/ft$^3$ $\quad v = 100 \frac{\text{miles}}{\text{hour}} = 146.7 \frac{\text{ft}}{\text{second}}$

For a) $F_D = \frac{c_D \rho v^2 A}{2} = 1.20 \times 0.00280 \frac{\text{slugs}}{\text{ft}^3} \cdot \left(146.7 \frac{\text{ft}}{\text{s}}\right)^2 \cdot \left(\frac{9}{12}\text{ft} \times \frac{60}{12}\text{ft}\right) \times 0.50$

$F_D = 135.6 \frac{\text{slug} \cdot \text{ft}}{\text{s}^2} = 135.6 \text{ lbf}$

b) $R_e = \frac{VL}{\nu} = \frac{146.7 \frac{\text{ft}}{\text{s}} \cdot 6.36 \text{ ft}}{1.17 \times 10^{-4} \frac{\text{ft}^2}{\text{s}}} = 64438$

$F_D = 1.66 \times 0.00280 \cdot (146.7)^2 \cdot \left(\frac{6.36}{12} \cdot \frac{60}{12}\right) \cdot 0.5$

$= 255.5 \text{ lbf}$

c) $F_D = \frac{c_D \rho v^2 A}{2} = 1.12 \times 0.00280 \times (146.7)^2 \times \left(0.75 \times \frac{5}{12}\right)$

$= 253 \text{ lbf}$

d) Ellipse 2:1

$$Re = \frac{VL}{\nu} = \frac{146.7 \cdot 2ft}{1.17E-4} = 2507692$$

$$c_D \approx 0.32$$

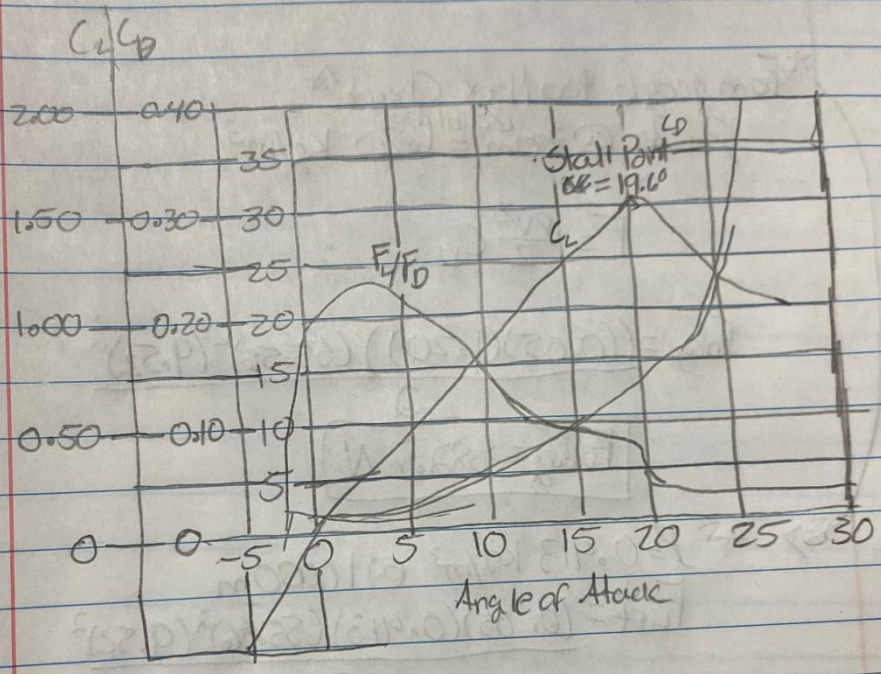
$$F_D = \frac{c_D \cdot \rho V^2 A}{2} = \frac{(0.32)(0.0028)(146.7)^2 (0.75 \times 5)}{2}$$

$$F_D = 36.2\ lbf$$

Met 330 Homework 2.2

- 17.30

Fig 17.11 Airfoil Performance Curve




Given:

$C = 1.4m$ ← Cord Length

Span of Airfoil $= 6.8m$

$V = 200$ km/h $\rightarrow 200(0.278) = 55.6$ m/s

$\alpha = 10°$ angle of attack

$A = (1.4)(6.8) = 9.52\ m^2$ ← Area

*from performance curve Fig 17.11*

$C = 0.05$

$C_L = 0.9$

*From google tool box Chart*

Rho Air @ 200m altitude $= 1.20\ kg/m^3$

$$F = \frac{\rho V^2}{2} C_D$$

$$F_{drag} = \frac{((0.05)(1.20))(55.56)^2(9.52)}{2}$$

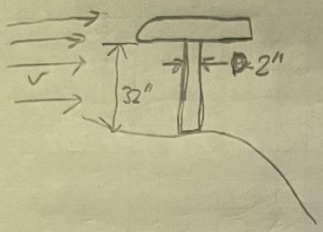
$$\boxed{F_{Drag} = 882.7\ N}$$

> * $\rho = 0.413\ kg/m^3$ @ 16000m

$$F_{Lift} = \frac{(0.05)(0.413)(55.56)^2(9.52)^2}{2}$$

$$\boxed{F_{Lift} = 5,466.3\ N}$$

17.14)




$L = 32'' \rightarrow 2.67'$ $D = 2'' \rightarrow .167'$

$T = -20°F$ $V = 150 mph \rightarrow 220 ft/s$

$F_D = C_D(\rho v^2/2) \cdot A$

$N_R = \frac{VD}{\nu} \rightarrow N_R = \frac{220 \cdot (.167)}{1.17 \cdot 10^{-4}}$

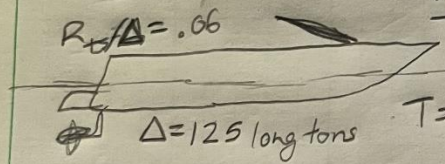
$N_R = 3.14 \times 10^5 \rightarrow C_D = .80$

$A = (D \cdot L)2 \rightarrow (.167) \times (2.67) \times 2 = .892 ft^2$ $\rho @ -20°F = 2.8 \times 10^{-3}$

$F_D = \frac{(.80)(2.8 \times 10^{-3})(220)^2(.892)}{2} = 48.34 lb$

$F_D = 48.34 lb$

17.26)




$\Delta = 125 long tons \rightarrow 2.8 \times 10^5 lb$

$R_{ts}/\Delta = .06 \rightarrow R_{ts} = .06 \cdot 2.8 \times 10^5 \rightarrow R_{ts} = 16,800 lb$

$P = R_{ts} \cdot V = 16800 \times 50 = 8.4 \times 10^5 \frac{lb \cdot ft}{s} \rightarrow 1527 hp$

$R_{ts} = 16,800 lb$ ; $P = 1527 hp$