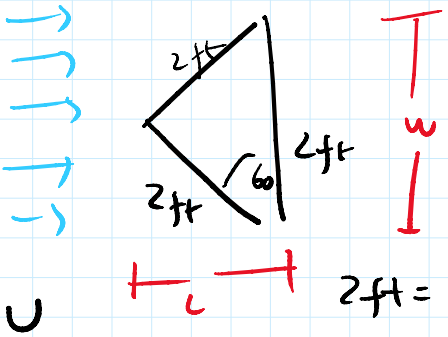
Problema 1 :

Aire @ 70° F

↳ $\rho = 1.2 \ kg/m^3$

↳ $\mu = 1.82 \times 10^{-5} \ Pa \cdot s$



$2ft = 0.6096 \ m$

$L = \sin(60°) \cdot 0.6096$

$L = 0.527 \ m$

$$Re_L = \frac{\rho V L}{\mu}$$

$Re_L = 1.6 \times 10^5$ ← laminar //

$$F_D = \int \tau_w \, dA = \int_0^L \tau_w \cdot 2\pi r(x) \, dx$$

$x = 0 \rightarrow w = 0$

$x = L \rightarrow w = W$

$$w - 0 = \frac{W - 0}{L - 0}(x - 0)$$

$$\rightarrow x = W\frac{x}{L}$$

Adicionales :

$$C_f = \frac{\tau_w}{\frac{1}{2}\rho U^2}$$

y para flujo laminar

$$C_f = \frac{0.730}{Re_x^{0.5}}$$

$$\hookrightarrow \tau_w = \frac{1}{2}\rho U^2 \cdot \frac{0.730}{Re_x^{0.5}}$$

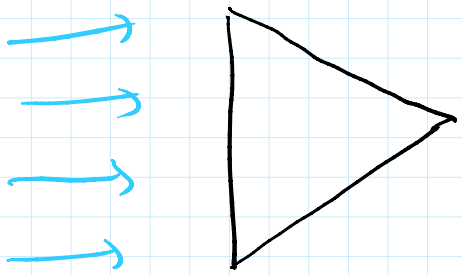
$$\Rightarrow F_D = \int_0^L \frac{1}{2}\rho U^2 \frac{0.730}{\left(\frac{\rho U x}{\mu}\right)^{0.5}} \cdot W \frac{x}{L} \, dx$$

$$F_D = \underbrace{\frac{0.730}{2} \rho^{0.5} U^{3/2} \cdot W \cdot \mu^{0.5}}_{\Phi} \int_0^L \frac{1}{x^{0.5}} \frac{x}{L} \, dx$$

$$F_D = \Phi \int_0^L \frac{x^{0.5}}{L} \, dx$$

$$F_D = \Phi \, \frac{2}{3} \frac{x^{1.5}}{L} \Big|_0^L = \frac{2}{3} \Phi \frac{L^{1.5}}{L} = \frac{2}{3} \Phi L^{0.5}$$

D)



$x = 0 \rightarrow w = W$

$x = L \rightarrow w = 0$

$$w - W = \frac{0 - W}{L - 0}(x - 0)$$

$$w = -\frac{W}{L}x + W$$

$$w = W\left(1 - \frac{x}{L}\right)$$

$$\Rightarrow F_D = \int_0^L \frac{1}{2}\rho U^2 \frac{0.730}{\left(\frac{\rho U x}{\mu}\right)^{0.5}} \cdot W\left(1 - \frac{x}{L}\right) dx$$

$$F_D = \underbrace{\frac{0.730}{2}\rho^{0.5} U^{3/2} \cdot W \cdot \mu^{0.5}}_{\bar{\Phi}} \int_0^L \frac{1}{x^{0.5}}\left(1 - \frac{x}{L}\right) dx$$

$$F_D = \bar{\Phi} \int_0^L x^{-0.5} - \frac{1}{L} x^{0.5}\, dx$$

$$F_D = \Phi \left[2x^{0.5} - \frac{1}{L} \cdot \left(\frac{2}{3} x^{1.5} \right) \right] \Bigg|_0^L$$

$$F_D = \Phi \left[2L^{0.5} - \frac{2}{3} L^{0.5} \right] = \frac{4}{3} \Phi L^{0.5}$$

$$\Rightarrow \quad \frac{F_{D,A}}{F_{D,B}} = \frac{\frac{2}{3} \Phi L^{0.5}}{\frac{4}{3} \Phi L^{0.5}} = \frac{1}{2}$$

$$\Phi = \frac{0.730}{2} \rho^{0.5} U^{3/2} \cdot W \cdot \mu^{0.5}$$

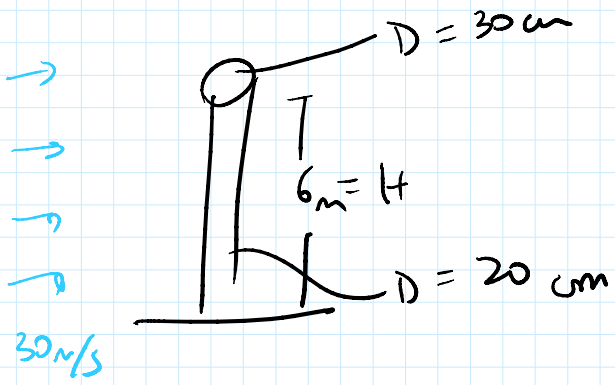
ρ: $1.2\ kg/m^3$ — U: $15\ ft/s$ — W: $2\ ft$ — μ: $1.82 \times 10^{-5}\ Pa \cdot s$

$$\Phi = 2.04 \times 10^{-3}\ N/m^{0.5}$$

$$F_{D,A} = 9.9 \times 10^{-4}\ N$$

$$F_{D,B} = 1.98 \times 10^{-3}\ N$$

Problema 2



$$FD_E = C_{D_E} \cdot \left(\frac{1}{2} \rho_{aire} \cdot U^2 \cdot A_{T_E}\right)$$

1.2 kg/m³ · 30 m/s · $\frac{\pi D^2}{4}$

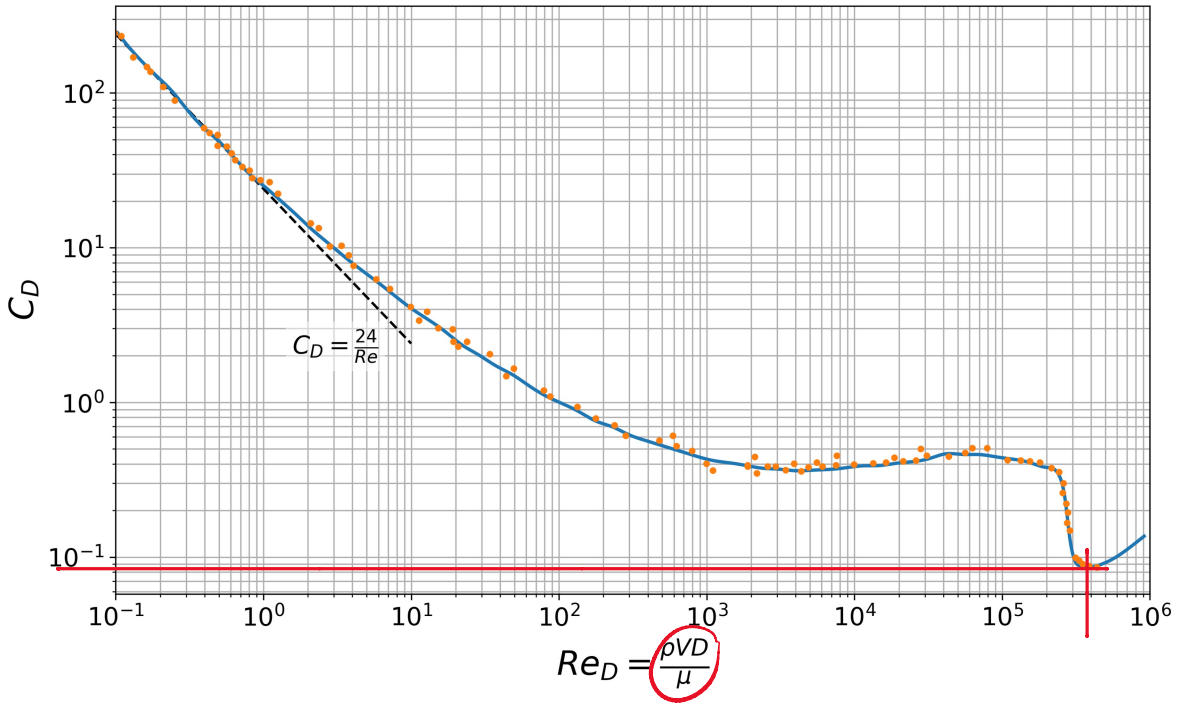
$$FD_C = C_{D_C} \left(\frac{1}{2} \rho_{aire} U^2 \cdot A_{T_C}\right)$$

D · H

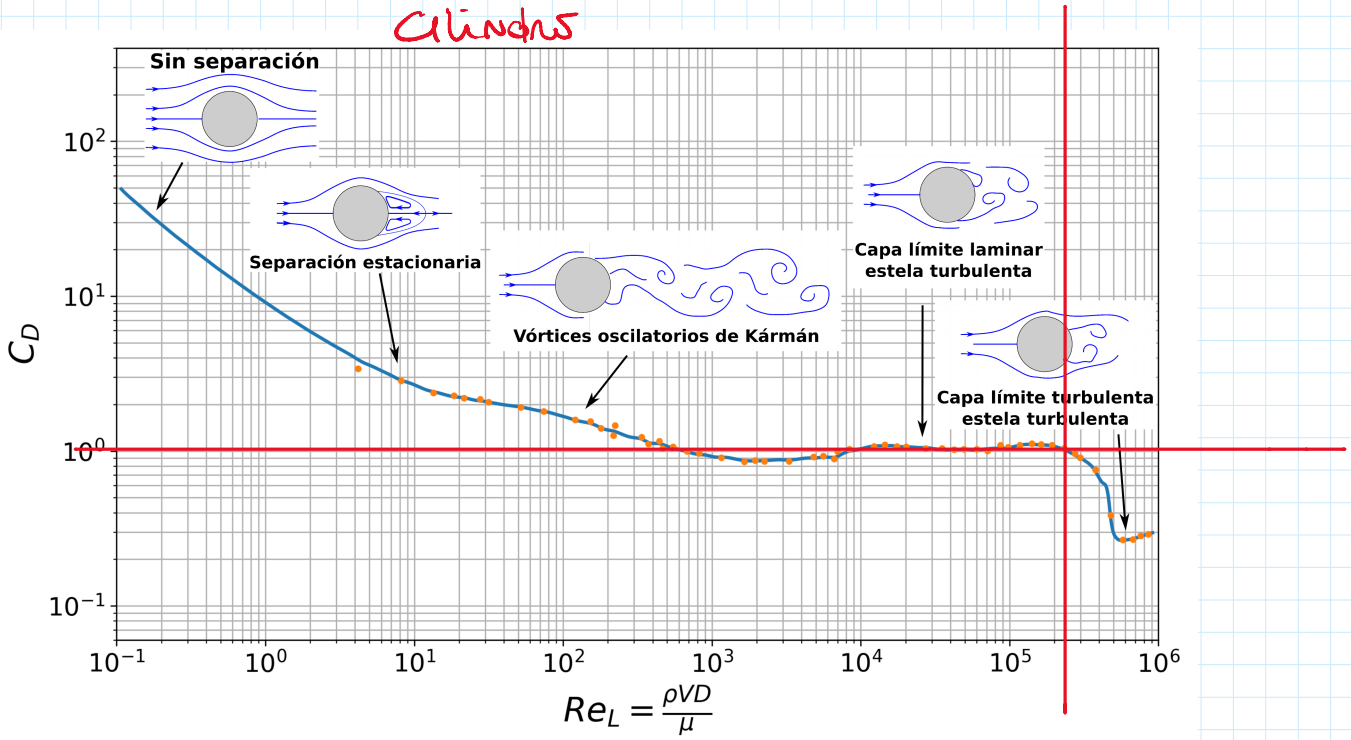
$$Re_E = \frac{1.2\ kg/m^3 \cdot 30\ m/s \cdot 0.3\ m}{1.82 \times 10^{-5}\ Pa \cdot s} = 4 \times 10^5 \Rightarrow C_{D_E} = 0.085$$

$$Re_C = \frac{1.2\ kg/m^3 \cdot 30\ m/s \cdot 0.2\ m}{1.82 \times 10^{-5}\ Pa \cdot s} = 2.6 \times 10^5 \Rightarrow C_{D_C} = 1$$

ESFERA



Cilindro

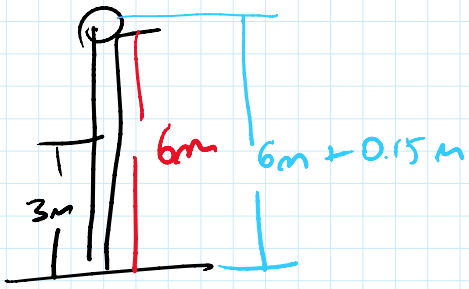


$$F_{D_E} = 0.085 \cdot \left(0.5 \cdot 1.2\ kg/m^3 \cdot (30\ m/s)^2 \cdot \frac{\pi (0.3\ m)^2}{4}\right)$$

$$F_{D_C} = 1 \cdot \left(0.5 \cdot 1.2\ kg/m^3 \cdot (30\ m/s)^2 \cdot (0.2m \cdot 6m)\right)$$

$F_{D_E} = 1.4\ N$

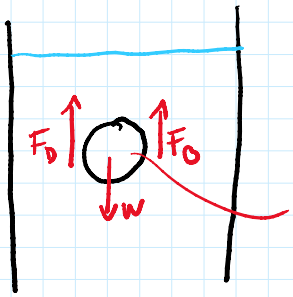
$F_{D_C} = 288\ N$



$$\tau = (3m) \cdot 288N + (6m + 0.15m) \cdot 1.4N$$

$$\tau = 872.6\ Nm$$

Problema 3



Agua @ 20°C

$\mu = 1 \times 10^{-3}$ Pa·s

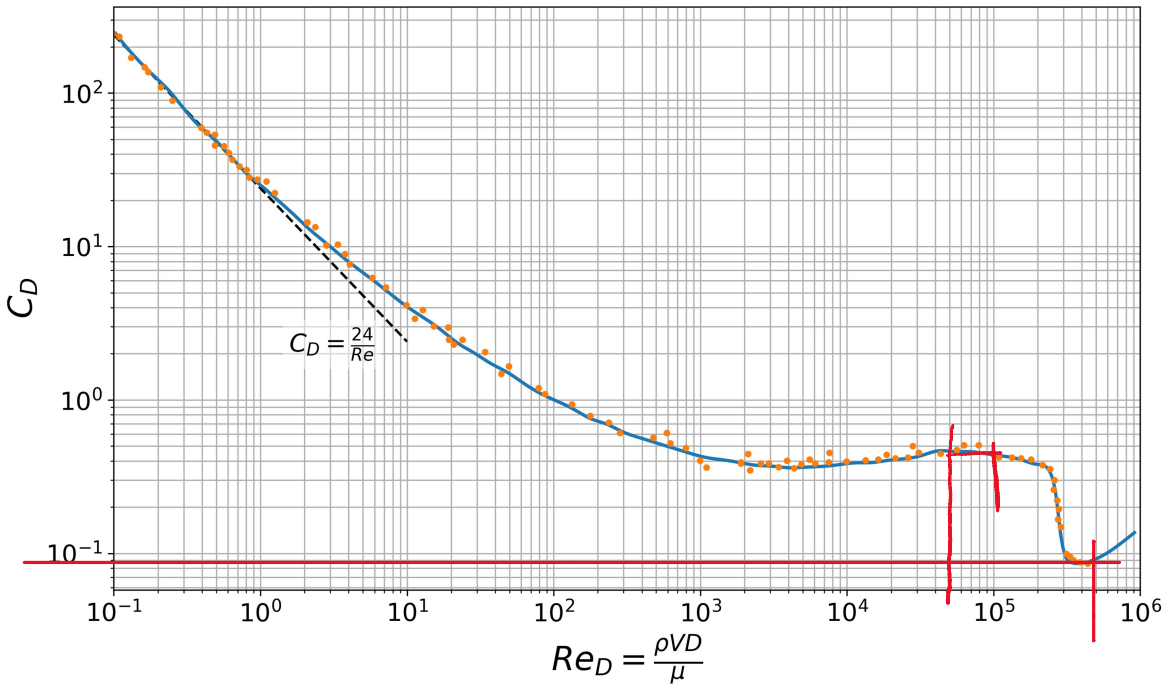
$\rho = 10^3$ kg/m³

$$F_B + F_D = W$$

$$V_e \cdot \gamma_w + C_D \cdot \left(\frac{1}{2} \rho_w U^2 \cdot A_{T/E}\right) = V_e \cdot \gamma_e$$

$$\frac{4}{3}\pi\left(\frac{0.5m}{2}\right)^3 \cdot \left(9.81 \times 10^3 \frac{N}{m^3}\right) + C_D \cdot \frac{1}{2}\left(1000 \frac{kg}{m^3} \cdot U^2 \cdot \frac{\pi D^2}{4}\right) = \frac{4}{3}\pi\left(\frac{0.5m}{2}\right)^3 \cdot 1.05 \cdot 9.8 \times 10^3 \frac{Pa}{m^3}$$

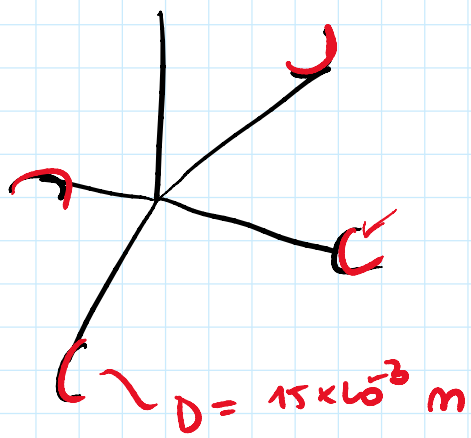
EO : $$0 = \frac{4}{3}\pi\left(\frac{0.5m}{2}\right)^3 \cdot \left(9.81 \times 10^3 \frac{N}{m^3}\right) + C_D \cdot \frac{1}{2}\left(1000 \frac{kg}{m^3} \cdot U^2 \cdot \frac{\pi D^2}{4}\right) - \frac{4}{3}\pi\left(\frac{0.5m}{2}\right)^3 \cdot 1.05 \cdot 9.8 \times 10^3 \frac{Pa}{m^3}$$



U	R_e	C_D	EO
1 m/s	5×10^5	0.45	12.1
5 m/s	2.5×10^6	0.2	458.7
0.1	5×10^4	0.4	-31.6
0.85	4.2×10^5	0.45	-0.18
0.9	4.5×10^5	0.45	3.68

Velocidad Terminal : $U = 0.852$ m/s

Problema 4



a) AIRE @ 30°C

↳ $\rho = 1.16 \ kg/m^3$

↳ $\mu = 1.86 \times 10^{-5} \ Pa \cdot s$

b) gasolina @ 20°C

↳ SG = 0.7

↳ $\mu = 2.9 \times 10^{-4} \ Pa \cdot s$

$$F_{D_i} = C_D \left(\frac{1}{2} \rho U^2 A \right)$$

TABLA → $C_D = 1.2$

$U = \omega \cdot r = 20 \frac{1}{min} \cdot 75 \times 10^{-3} \ m$

$A = \frac{\pi D^2}{4}$

$\rho_{aire} = 1.16 \ kg/m^3$

$\rho_{gasolina} = 0.7 \times 10^3 \ kg/m^3$

$$\tau = 4 \times \left(F_{D_i} \cdot r_{brazo} \right) = 4 \times \left(F_{D_i} \cdot 75 \times 10^{-3} \ m \right)$$

$F_{D_i} = 2.32 \times 10^{-4} \ N$

$\tau = 6.96 \times 10^{-5} \ Nm$