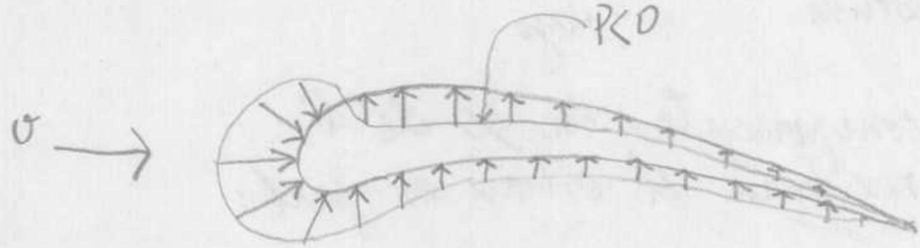
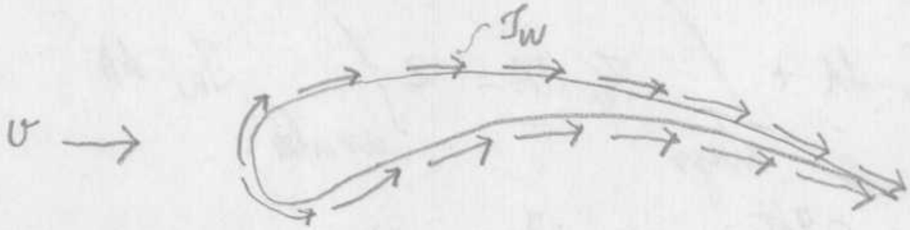
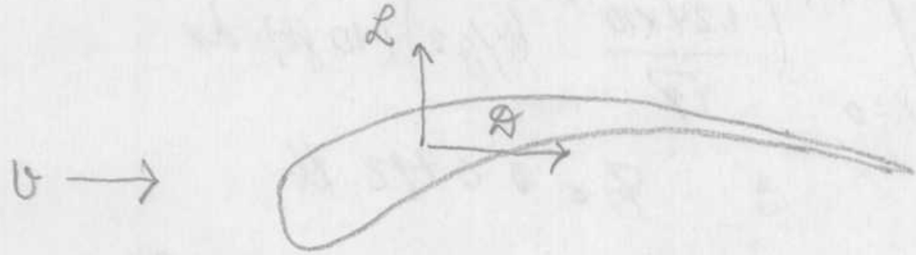
Flujo sobre cuerpos sumergidos-







$\mathcal{L}$ levante
$\mathcal{D}$ arrastre

$$\mathcal{D} = \int dF_x = \int P\cos\theta \, dA + \int \tau_w \cdot \sin\theta \, dA$$

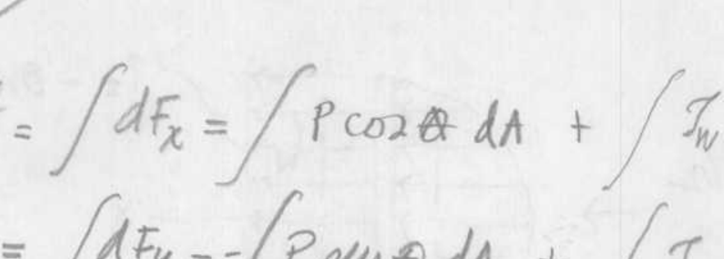
$$\mathcal{L} = \int dF_y = -\int P \sin\theta \, dA + \int \tau_w \cdot \cos\theta \, dA$$

Ejemplo:
Aire a condiciones estandar pasa a través de un plato plano paralelo a la corriente. Encuentre $\mathcal{L}$ y $\mathcal{D}$.

a)

$v = 25$ ft/s
$P = 0$ (man)

$b = 10$ ft
$a = 4$ ft



$$\tau_w = \tau_w(x) = \frac{(1.24\times 10^{-3})}{\sqrt{x}} \ \text{lb/ft}^2$$

ya que $\theta = 90°$ arriba
$\theta = 270°$ abajo

$$\mathcal{L} = -\int_{arriba} P dA + \int_{abajo} P dA = 0 .$$

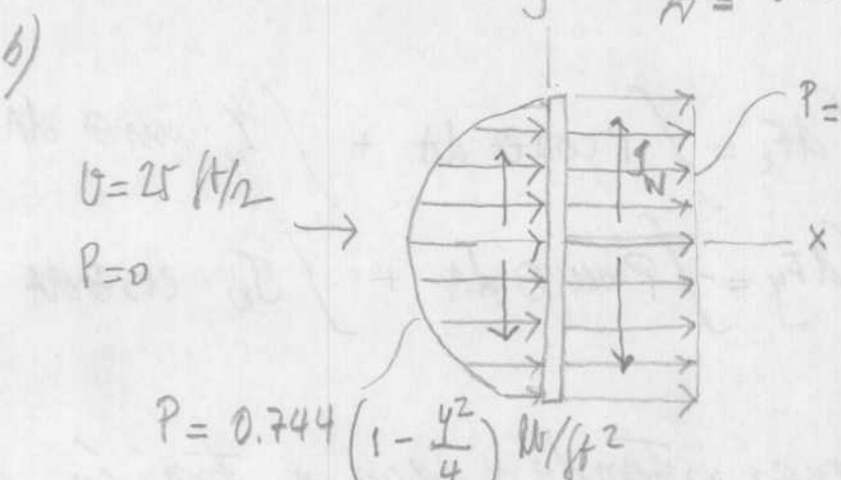
no hay componentes en x de P.
por simetría el estrés es igual:

$$\mathcal{D} = \int_{arriba} \tau_w \cdot dA + \int_{abajo} \tau_w \cdot dA = 2\int_{arriba} \tau_w \cdot dA$$

$$\mathcal{D} = 2\int_{x=0}^{4ft} \left(\frac{1.24\times10^{-3}}{\sqrt{x}} \; lb/ft^2 \right)(10\,ft) \cdot dx$$

$$\mathcal{D} = 0.0992 \; lb$$

b)



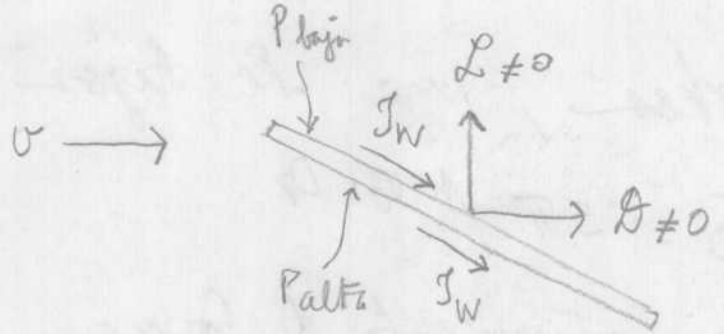
$$\tau_w(y) = -\tau_w(-y)$$

$$\mathcal{L} = \int_{frente} \tau_w \cdot dA - \int_{atras} \tau_w \cdot dA = 0$$

$$\mathcal{D} = \int_{frente} P dA - \int_{atras} P dA$$

$$= \int_{y=-2}^{y=2} \left[0.744\left(1 - \frac{y^2}{4}\right) lb/ft^2 - (0.893)\; lb/ft^2 \right](10\,ft)\,dy$$

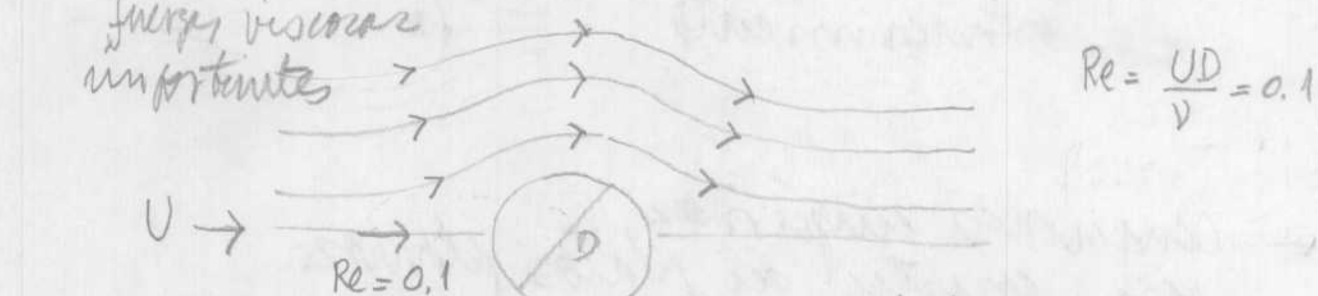
$$\mathcal{D} = 55.6 \; lb$$

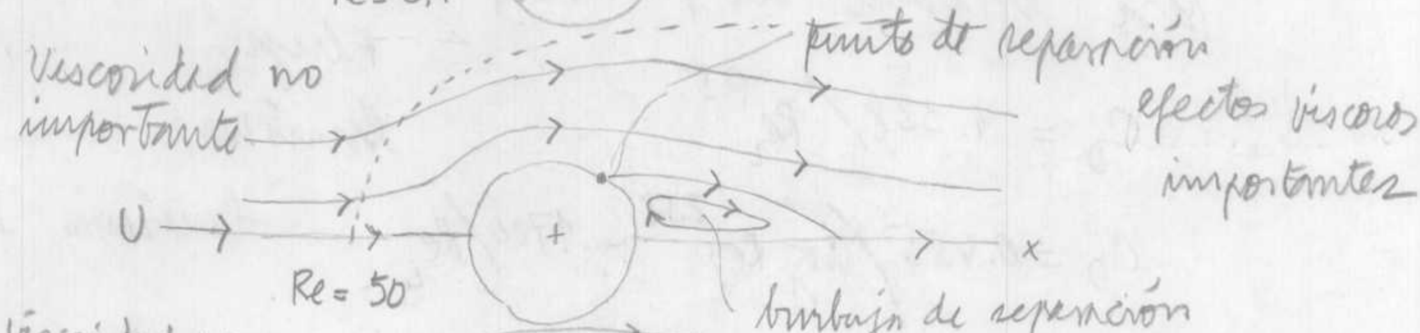


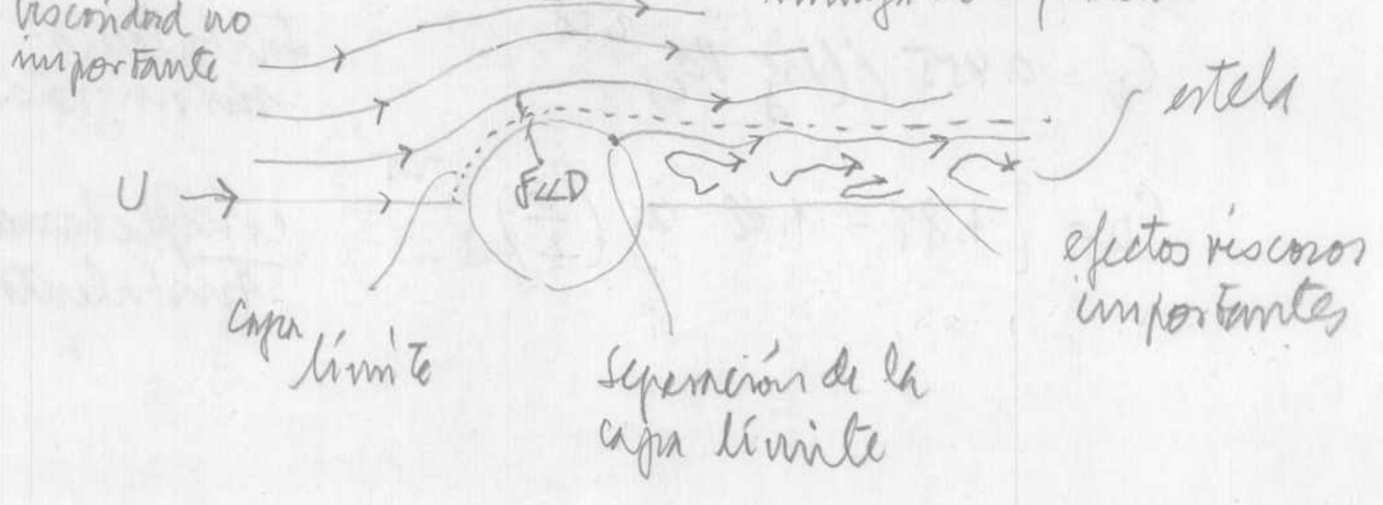
Coeficiente de impulso $\qquad C_L = \dfrac{\mathcal{L}}{\frac{1}{2}\rho v^2 A}$

coeficiente de arrastre (frotamiento) $\qquad C_D = \dfrac{\mathcal{D}}{\frac{1}{2}\rho v^2 A}$

A area frontal (o area proyectada)
v velocidad hacia arriba







Ley de Stokes, para Re bajos

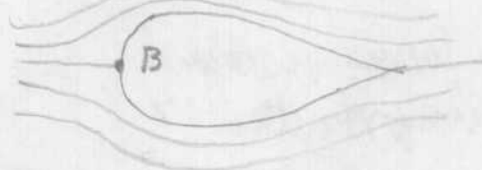
$$F_D = 3\pi \mu v_0 \cdot D_p$$

1/3 frotamiento de forma
2/3 " de pared

$\hookrightarrow$ $C_D = \frac{24}{N_{Re}}$

fig 7.3 C_D vs. $Re_{\text{partícula}}$ | esferas discos cilindros

Propiedades de estancamiento



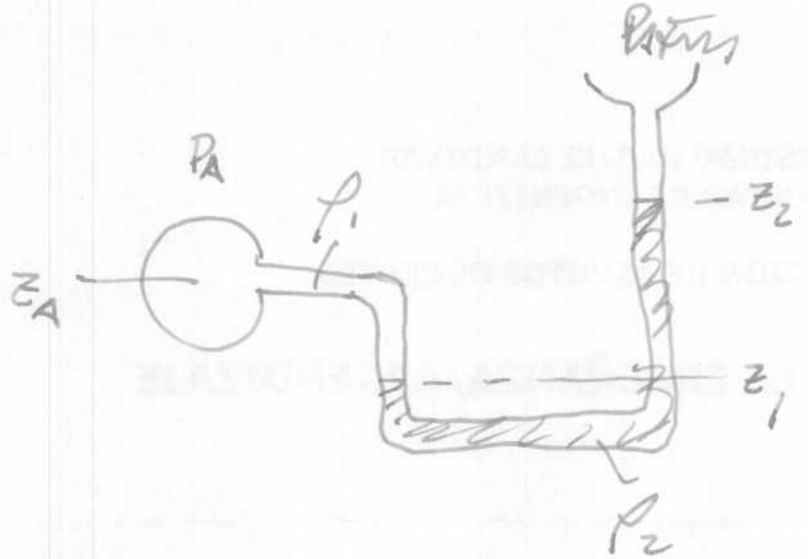
Ecuaciones empíricas para arrastre en platos planos

$C_D = 1.328 / Re_L^{0.5}$ Flujo laminar

$C_D = 0.455 / (\log Re_L)^{2.58} - 1700/Re_L$ transición 5×10^5

$C_D = 0.455 / (\log Re_L)^{2.58}$ turbulento sin rugosidad

$C_D = \left[1.89 - 1.62 \log\left(\frac{\epsilon}{L}\right)\right]^{-2.5}$ completamente turbulento



Hallar P_A si $p_a = 2116$ lbf/ft² $z_A = 7$ in
$z_1 = 4$ in $z_2 = 13$ in R) 2758 lbf/ft²
El fluido 1 es agua y 2 es mercurio
Cual será z_2 y si sustituye el mercurio por glicerina. ES = 78.7 lbf/ft³. S) z_2 = 01 in

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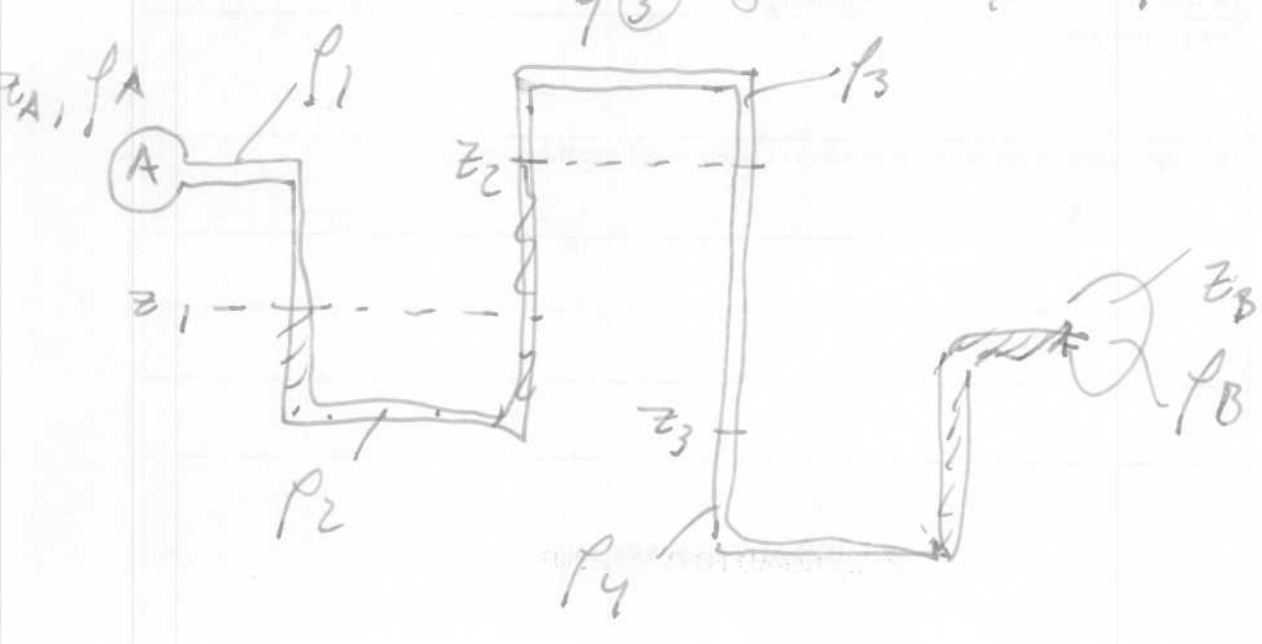
Hallar la diferencia de presión $p_A - p_B$ si
$z_A = 1.6$ m $z_1 = 0.7$ m $z_2 = 2.1$ m $z_3 = 0.9$ m
$z_4 = 1.8$ m Si 1 agua y 3 y 2 y 4 Hg



$\rho_{H_2O} = 9710 \quad \rho g_{Hg} = 132\,800\ N/m^3$

$P_A - P_1 = -\rho_1 g (z_A - z_1)$

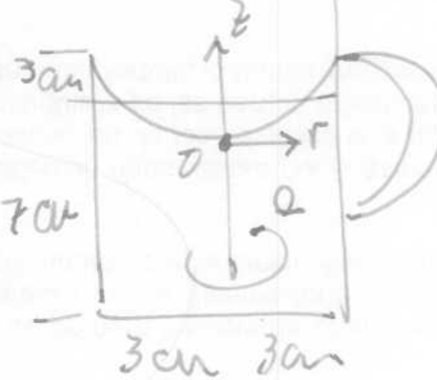
$P_1 - P_2 = -\rho_2 g (z_1 - z_2)$

$P_2 - P_3 = -\rho_3 g (z_2 - z_3)$

$P_3 - P_B = -\rho_4 g (z_3 - z_B)$

$P_A - P_B = 285\ kPa$

Una taza de café gira



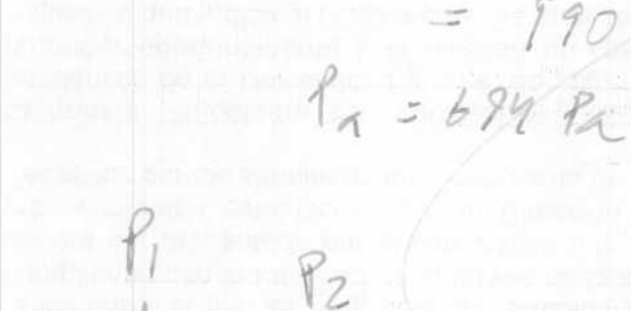
$\frac{h}{2} = 0.03\,m = \frac{\Omega^2 R^2}{4g}$

$\Omega = 345\ RPM = 36.2\ rad/s$

$P_0 = 0 \quad P_A = 0 - (1010\ kg/m^3)(9.81\ m/s^2)(-0.04\,m) + \frac{1}{2}(1010\ kg/m^3)(0.03\,m)^2(1308\ rad^2/s^2)$

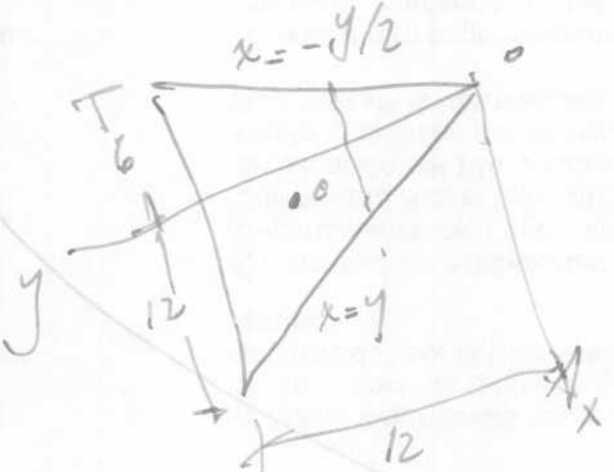
$= 990\ Pa$

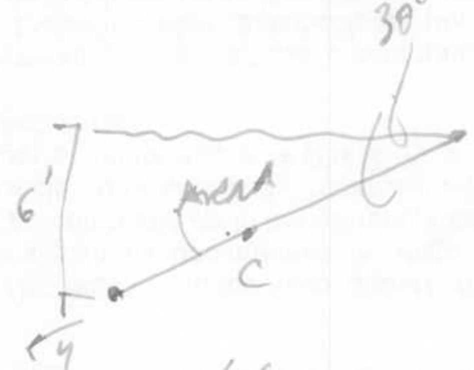
$P_A = 694\ Pa$ en reposo



$v_1 = \frac{1}{(\alpha^4 - 1)^{1/2}} \cdot \left(\frac{2g(P_1 - P_2)}{\rho}\right)^{1/2}$

$\alpha = \frac{d_1}{d_2}$





$$\iint xy\,dA = \int_0^{12} \frac{y}{2}\left(y^2 - \frac{y^2}{4}\right)dy = 1944\ ft^4$$

$$\iint y\,dA = \int_0^{12} y\left(y + \frac{y}{2}\right)dy = 864\ ft^3$$

$$\iint y^2\,dA = \iint y^2\,dx\,dy = 7{,}776\ ft^4$$

$$F = \rho g \sin\theta \iint y\,dA = 27{,}000\ lb$$

$$y_F = \frac{1}{F}\rho g \sin\theta \iint y^2\,dA = \frac{7776}{864} = 9.00\ ft$$

$$x_F = \frac{1}{F}\rho g \sin\theta \iint xy\,dA = \frac{1944}{864} = 2.25\ ft$$