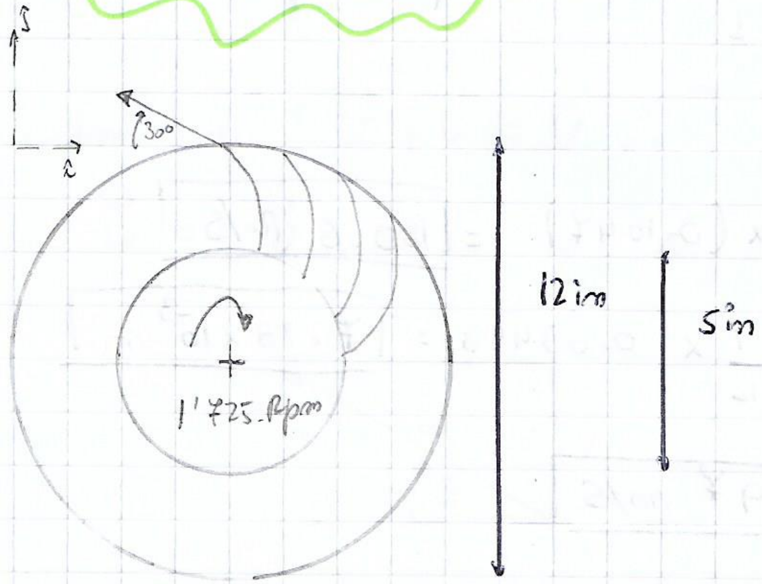
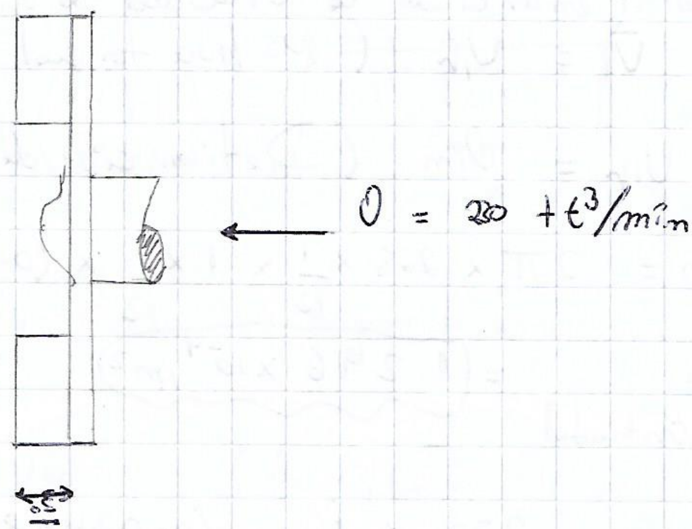
Pauta auxiliar 4

P1)





1° Trastormamo Todas las unidades

1 ft = 12 in = 0.03448 m

1 Rpm = 0.1047 Rad/s

Sea v_1 la Velocidad con la que se mueve la superficie de Control 1

$$v_1 = \omega R_1$$

$$\omega = (1'725) \times (0.1047) = \boxed{180.6 \text{ Rd/S}}$$

$$R_1 = 2.5 \times \frac{1}{12} \times 0.03448 = \boxed{7.18 \times 10^{-3} \text{ m}}$$

$$\therefore \boxed{v_1 = 1.297 \text{ m/S}}$$

Por el enunciado la Velocidad de entrada es solo Radial

$\therefore \quad \vec{V}_1 = V_1 \hat{r}$ (No hace torque)

$A_{in} V_{1r} = Q_{in}$ (Definición de Caudal)

$$A_{in} = 2\pi \times 2.5 \times \frac{1}{12} \times 1 \times \frac{1}{12} \times (0.03448)^2 =$$

$$A_{in} = 1.296 \times 10^{-4} \text{ m}^2$$

(área de Entrada)

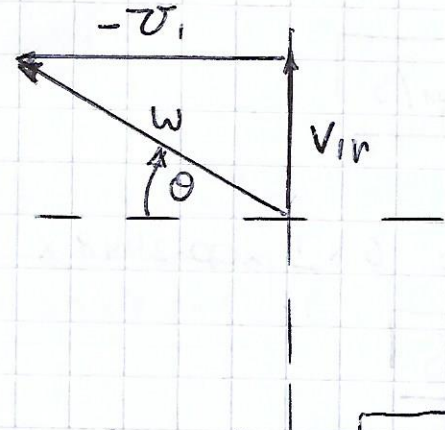
$$Q_{in} = 230 \times \frac{1}{60} \times (0.03448)^3 = \boxed{1.571 \times 10^{-4} \text{ m}^3/\text{s}}$$

$$\boxed{V_{1r} = 1.212 \text{ m/S}}$$

ángulo del aspa?

Recordemos que $\vec{v} + \vec{w} = \vec{V}$ ∴ (Ec de Velocidad aparente)

$$\vec{w} = \vec{V} - \vec{v}$$



a) ∴ $\theta_{max} = \arctan\left(\frac{|V_{1r}|}{|v_1|}\right) = \boxed{43.06°}$

Para calcular la Potencia Requerida usaremos:

$$(-\dot{m}_{in})(\pm v_{in} V_{\theta in}) + (\dot{m}_{out})(\pm v_{out} V_{\theta out}) = \dot{W}_{eje}$$

(0)

Notamos que $V_{\theta in} = 0$, pues por enunciado No tenemos Velocidad tangencial en t rante (Solo Radial)

Conservación del Caudal

$\dot{m}_{in} = \dot{m}_{out}$.

Como ρ No cambia $\Rightarrow$ $\boxed{Q_{in} = Q_{out}}$

luego $\dot{m}_{out} = \rho \times \dot{Q}_{in} = (1'000) \times (1.571 \times 10^{-4}\ m^3/s)$

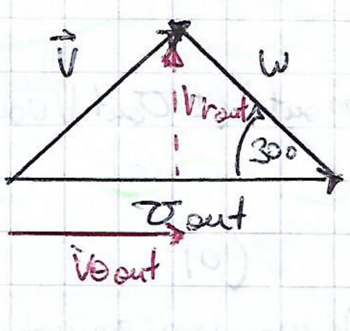
$$\boxed{\dot{m}_{out} = 0.1571\ Kgr/s}$$

$$v_{out} = r_2 \times w = 6 \times \frac{1}{12} \times 0.0.3448 \times 180.6$$

$$\boxed{v_{out} = 3.113\ m/s}$$

$V_{\theta out}$? $\longrightarrow$ usaremos Velocidad aparente.

$$\vec{V} = \vec{w} + \vec{v}$$



luego Por trigonometrie

$$|V_{\theta out}| = |v_{out}| - \frac{|V_{r\,out}|}{tg 30}$$

(*)

Pero por conservación del caudal.

$$Q_{out} = Q_{in} = A_{out} \times V_{r\,out}$$

luego $A_{out} = 2\pi r_2 h = 2\pi \times 6 \times \frac{1}{12} \times 1 \times \frac{1}{12} \times (0.03448)^2$

~~$A_{out} = 0.021\ m^2$~~

$$\Rightarrow A_{out} = 3.1124 \times 10^{-4}\ m^2$$

$\therefore$ $\boxed{V_{r\,out} = 0.5047\ m/s}$

$\therefore$ Reemplazando lo anterior en $(*)$

$$\boxed{V_{\theta\,out} = 2.238\ m/s}$$

luego reemplazamos todo en (0)

$$\boxed{\dot{W}_{eje} = 1.0948\ Watts}$$

P2)

$$1 hp = 745.7 \text{ watts}$$

$$R = 0.287 \left[\frac{kPa\, m^3}{kgr\, K}\right]$$

$$C_p = 1.012 \, [kJ/kgr\, K]$$

1°, escribimos la 1° Ley de la Termodinámica:

$$\dot{Q} + \dot{W} = \sum_i \dot{m}_i (h_i + V_i^2/2 + gz_i)_{out} - \sum_j \dot{m}_j (h_j + V_j^2/2 + gz_j)_{in}$$

(*)

$$\dot{W} = 150 \times (0.745) = 113.4 \text{ K watts}$$

$$h_i = C_p T_i$$

$$h_1 = (1.012) \times (70 + 273) = 347.1 \text{ kJ/kgr}$$
$$h_2 = (1.012) \times (100 + 273) = 377.48 \text{ kJ/kgr}$$
$$h_3 = (1.012) \times (200 + 273) = 478.68 \text{ kJ/kgr}$$

usamos la aprox de gas ideal

$$P = \rho R T \rightsquigarrow \quad \rho_1 = 10.16$$
$$\rho_2 = 18.68$$

$$\boxed{\rho_3 = \frac{P_3}{(0.287) \times (200 + 273)}}$$

ahora usaremos continuidad:

$$\dot{m}_1 = \dot{m}_2 + \dot{m}_3$$

$$Q_1 \rho_1 = Q_2 \rho_2 + Q_3 \rho_3$$

$$\boxed{\rho_3 = 5.37 \ kg/m^3}$$

$$\Rightarrow \boxed{P_3 = 729.06 \ kPa}$$

finalmente,

$$V_1 = \frac{Q_1}{A_1} = 12.5$$

$$V_2 = \frac{Q_2}{A_2} = 2$$

$$V_3 = \frac{Q_3}{A_3} = 10$$

Reemplazando Todo en (*) Tenemos

$$\boxed{\dot{Q} = 2575.61 \ Kwatts}$$

P3) 1° Recordaremos que $\rho_{aire} = 1.23\ Kg/m^3$.

luego Planteamos:

$$\frac{P_{out}}{\rho} + \frac{\alpha_{out}\,\overline{V}_{out}^2}{2} + \cancel{g z_{out}} = \frac{P_{in}}{\rho} + \frac{\alpha_{in}\,\overline{V}_{in}^2}{2} + \cancel{g z_{in}} + w - loss$$

$$z_{out} = z_{in}$$

$$P_{out} - P_{in} = 0.1\ kPa\ , \quad w = \frac{\dot{W}}{\dot{m}} = \frac{0.14}{(0.1)\times(1/60)} = \boxed{84\ Nm/Kg}$$

$$\overline{V}_1 = \frac{\dot{m}}{\rho A_1} = \frac{(0.1)\times(1/60)}{(1.23)\times(A1)} = \boxed{0.479\ m/s}$$

$$\overline{V}_2 = \frac{\dot{m}}{\rho A_2} = \boxed{1.92\ m/s}$$

esto sale de la conservación del caudal masico

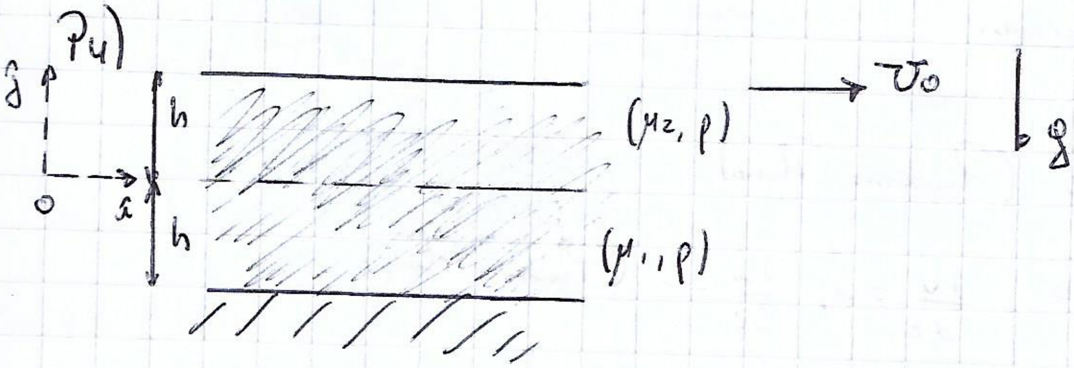
$$\dot{m}_{in} = \dot{m}_{out} \Rightarrow \dot{m}_{in} = \dot{m}_{out} = \dot{m}$$

luego si $\alpha_{out} = \alpha_{in} = 1$

$loss_1 = 0.975\ Nm/Kg$.

Si $\alpha_{out} = 2 \wedge \alpha_{in} = 1.008$

$loss_2 = 0.940\ Nm/Kg$.



1º escribimos las Ec de N-S en Coordenadas.

$$\hat{i}: \quad \rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} + w\frac{\partial u}{\partial z}\right) = \mu\left\{\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2}\right\} - \frac{\partial P}{\partial x} + \rho g_x$$

$$\hat{j}: \quad \rho\left(\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + w\frac{\partial v}{\partial z}\right) = \mu\left\{\frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial z^2}\right\} - \frac{\partial P}{\partial y} + \rho g_y$$

Escribimos Continuidad:

$$\frac{\partial \rho}{\partial t} + \frac{\partial u\rho}{\partial x} + \frac{\partial \rho v}{\partial y} + \frac{\partial \rho w}{\partial z} = 0$$

Simplificaciones.

$w = 0$ (Problema Plano)

$\frac{\partial u}{\partial z} = 0$, $\frac{\partial u}{\partial z} = 0$, $\frac{\partial w}{\partial z} = 0$ (Problema Plano)

$\frac{\partial u}{\partial t} = \frac{\partial v}{\partial t} = \frac{\partial \rho}{\partial t} = 0$ (Problema estacionario)

Además, $\vec{V} = u\hat{\imath}$ pues las Placas son infinitas $\therefore$ $v = 0$.

$\therefore$ Escribimos Continuidad

$0 + \frac{\partial u \rho}{\partial x} + 0 + 0 = 0$. Si $\rho \neq 0$

$$\boxed{\frac{\partial u}{\partial x} = 0}$$

$\therefore$ Nos quedan N-S

$$0 = \mu \left\{ \frac{\partial^2 u}{\partial y^2} \right\} - \frac{\partial P}{\partial x} + 0$$

$$0 = -\frac{\partial P}{\partial y} - \rho g$$

ahora separamos esta Ecuación para los dos Fluidos, integrando Tenemos.

$$u_1(y) = \frac{1}{\mu_1}\left(\frac{\partial p}{\partial x}\right)\frac{y^2}{2} + c_1 y + c_2$$

Con $y \in [-h, 0]$

$$u_2(y) = \frac{1}{\mu_2}\left(\frac{\partial p}{\partial x}\right)\frac{y^2}{2} + c_3 y + c_2$$

Con $y \in [0, h]$

del enunciado sabemos que $\frac{\partial p}{\partial x} = 0$

$\therefore$ Tenemos $\begin{cases} u_1(y) = c_1 y + c_2 \\ u_2(y) = c_3 y + c_4 \end{cases}$

Condiciones de borde.

$u_1(-h) = 0 \rightsquigarrow -c_1 h + c_2 = 0$

$u_2(h) = v_0 \rightsquigarrow c_3 h + c_4 = v_0$

$u_1(0) = u_2(0) \rightsquigarrow c_2 = c_4$

$\tau_{xy_1}(0) = \tau_{xy_2}(0)$

$$\boxed{\tau_{xy} = \mu \left\{ \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \right\}}$$

$$\tau_{xy_1} = \mu_1 c_1$$

$$\tau_{xy_2} = \mu_2 c_3$$

$$\therefore \quad \boxed{\mu_1 c_1 = \mu_2 c_3}$$

$$\therefore \quad c_1 = \frac{v_0}{h\left(1 + \frac{\mu_1}{\mu_2}\right)} \quad , \quad c_3 = \frac{v_0}{h\left(1 + \mu_2/\mu_1\right)}$$

$$c_2 = \frac{v_0}{(1 + \mu_1/\mu_2)} \quad , \quad c_4 = \frac{v_0}{(1 + \mu_1/\mu_2)}$$

$$\therefore \quad u_1(y) = \frac{v_0}{(1 + \mu_1/\mu_2)} \frac{y}{h} + \frac{v_0}{(1 + \mu_1/\mu_2)}$$

$$u_2(y) = \frac{v_0}{(1 + \mu_2/\mu_1)} \frac{y}{h} + \frac{v_0}{(1 + \mu_1/\mu_2)}$$

$$\boxed{\text{luego} \quad u_1(0) = u_2(0) = \frac{v_0}{1 + \mu_1/\mu_2}}$$