

Ej 4 P1

Datos:

$$V_1 = 200 \text{ m/s}$$

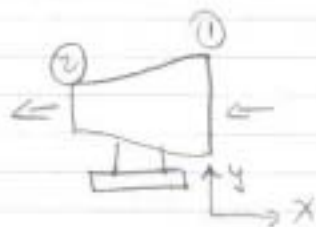
$$V_2 = 500 \text{ m/s}$$

$$A_1 = 1 \text{ m}^2$$

$$T_1 = 268 \text{ K}$$

$$P_1 = -22,5 \text{ kPa}$$

$$P_2 = 0 \text{ kPa}$$



Suponemos flujo permanente $\Rightarrow \frac{\partial}{\partial t} \int_V \rho dV = 0 \Rightarrow \dot{m}_1 = \dot{m}_2$

luego:

Ecuación de estado en 1 $\Rightarrow P_1 = \rho_1 R T_1 \Rightarrow \rho_1 = \frac{P_1}{R T_1}$

$$\rho_1 = 1,007 \left[\frac{\text{kg}}{\text{m}^3} \right]$$

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

$$\dot{m} = \rho_1 A_1 V_1 = 1,007 \cdot 200 \cdot 1 = 201,4 \left[\frac{\text{kg}}{\text{s}} \right]$$

Ecuación de cantidad de movimiento:

$$\sum \vec{F} = \frac{\partial}{\partial t} \int_V \rho \vec{V} dV + \int_{SC} \vec{V} (\rho \vec{V} \cdot d\vec{A})$$

$$R_x - P_1 A_1 + P_2 A_2 = \dot{m} (V_2 - V_1)$$

$$R_x = \dot{m} (V_2 - V_1) - P_1 A_1$$

$$R_x = 37,955 \text{ [kN]}$$

Como $F_e = -R_x \Rightarrow F_e = -37,955 \text{ [kN]}$

nota: un resultado sin unidad es malo!

PAUTA PROBLEMA 2, EJERCICIO 4

$$\dot{W} = -\dot{m} (\pm U_1 V_{\theta,1}) + \dot{m} (\pm U_2 V_{\theta,2})$$

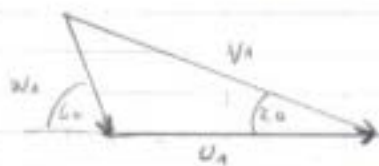
$$\omega = 50 \text{ rpm} = 50 \cdot \frac{2\pi}{60} = 5,24 \frac{\text{rad}}{\text{s}}$$

$$\Rightarrow U_1 = \omega r_1 = 5,24 \cdot 4 = 20,96 \text{ ft/s}$$

$$U_2 = \omega r_2 = 5,24 \cdot 2 = 10,48 \text{ ft/s}$$

$$\dot{m} = \rho \cdot Q = 1,94 \cdot 20 = 38,8 \text{ slug/s}$$

TRIÁNGULO DE VELOCIDADES A LA ENTRADA:



$$\Rightarrow W_1 \cos(60) + U_1 = V_1 \cos(20) \quad (1)$$

$$W_1 \sin(60) = V_1 \sin(20) \quad (2)$$

$$(2) \Rightarrow V_1 = W_1 \frac{\sin(60)}{\sin(20)} \quad \text{REEMPLAZANDO EN (1)}$$

$$\Rightarrow W_1 \cos(60) + U_1 = W_1 \frac{\sin(60)}{\sin(20)} \cos(20) \Rightarrow W_1 \left(\frac{\sin(60)}{\sin(20)} \cos(20) - \cos(60) \right) = U_1 = 20,96$$

$$\Rightarrow \boxed{W_1 = 11,15 \text{ ft/s}} \\ \boxed{V_1 = 28,24 \text{ ft/s}}$$

El caudal que entra en la turbina es $Q = V_{r1} \cdot A_1 = V_1 \sin(20) \cdot 2\pi r_1 \cdot b$

$$\Rightarrow \boxed{b = \frac{Q}{V_1 \sin(20) \cdot 2\pi r_1} = 0,0825 \text{ ft}}$$

Además, $\boxed{V_{\theta,1} = V_1 \cos(20) = 26,54 \text{ ft/s}}$

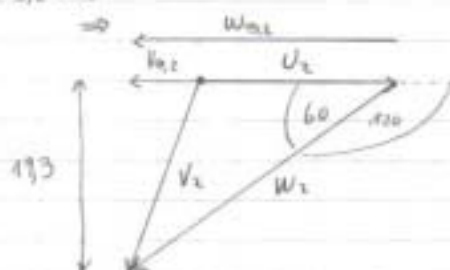
TRIÁNGULO DE VELOCIDADES A LA SALIDA

(b conocido)

$$V_{r,2} = W_{r,2} = \frac{Q}{A_2} = \frac{Q}{2\pi \cdot r_2 \cdot b} = 17,30 \text{ ft/s}$$

$$W_2 = W_{r,2} / \sin(60) = 22,21 \text{ ft/s}$$

$$W_{\theta,2} > U_2$$



$$\Rightarrow V_{\theta,2} = W_{\theta,2} - U_2 = 11,14 - 10,48$$

$$\Rightarrow V_{\theta,2} = 0,66 \text{ ft/s}$$

Además, U_2 y $V_{\theta,2}$ TIENEN \neq SENTIDO \Rightarrow SE UTILIZA EL SIGNO $(-)$ EN LA ECUACIÓN PARA LA POTENCIA

$$\Rightarrow \dot{W} = -\dot{m} (U_1 V_{\theta,1}) + \dot{m} (-U_2 V_{\theta,2}) = -\dot{m} (U_1 V_{\theta,1} + U_2 V_{\theta,2}) \\ = -38,8 (20,96 \cdot 26,54 + 10,48 \cdot 0,66) = -21831,77 \text{ lbf} \cdot \text{ft/s}^2$$

$$\Rightarrow \boxed{\dot{W} = \frac{-21831,77}{550} \text{ hp} = -39,73 \text{ hp}}$$

\therefore LA TURBINA ENTREGA 39,76 hp DE POTENCIA