

$$S_c = 20 \text{ cm}^2 = 0,002 \text{ m}^2$$

$$\gamma = 1,4$$

$$M = 2,95 \text{ m/s}$$

$$R = 8,31 \text{ J/mol K}$$

$$P_1 = 1500 \text{ kPa} \rightarrow P_2 = 200 \text{ kPa}$$

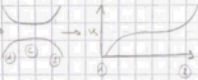
$$T_1 = 35^\circ \text{C} = 308 \text{ K}$$

• Relaciones isentrópicas: $P_1 T_1^{\frac{\gamma}{1-\gamma}} = P_2 T_2^{\frac{\gamma}{1-\gamma}}$ $1500000 \cdot 308^{\frac{1,4}{1-1,4}} = 200000 \cdot T_2^{\frac{1,4}{1-1,4}}$
 $T_2 = 132,19 \text{ K}$

• Usamos la razón de área para ver el tipo de flujo.

$$\left(\frac{P_2}{P_1}\right)_c = \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} \rightarrow P_{2c} = P_1 \left(\frac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}} = 1500000 \cdot \left(\frac{2}{1,4+1}\right)^{\frac{1,4}{1-1,4}} = P_{2c} = 792422,68 \text{ Pa}$$

$P_{2c} > P_2 \rightarrow$ Flujo supsonico



$$V_2 \gg V_1$$

• E.C.E.T. que relaciona P con V .

$$V_2^2 - V_1^2 = 2 \cdot \frac{\gamma}{\gamma-1} \cdot R \cdot T_1 \left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}} \right]$$

$$\rightarrow \rho = \frac{P \cdot M}{R \cdot T} = \frac{1500000 \cdot 29}{8314 \cdot 308} = \rho = 16,99 \text{ kg/m}^3$$

$$\rho = \frac{\gamma}{V} \rightarrow \gamma = 0,0589 \text{ m}^3/\text{kg}$$

$$V_2^2 - 0^2 = 2 \cdot \frac{1,4}{1,4-1} \cdot 1500000 \cdot 0,0589 \cdot \left[1 - \left(\frac{1500000}{792422,68}\right)^{\frac{1,4-1}{1,4}} \right] = V_2 = 520,13 \text{ m/s}$$

$$m_1 = m_c = m_2$$

$$\frac{G}{m} = \frac{V \cdot \rho}{m} \rightarrow m_c = m_2 \rightarrow V_c \cdot \rho_c \cdot S_c = V_2 \cdot \rho_2 \cdot S_2$$

$$\hookrightarrow V_c \cdot V_c^2 = \gamma \cdot \frac{P_c}{\rho_c} = 1,4 \cdot \frac{792422,68}{16,99} = V_c = 320,95 \text{ m/s}$$

$$\hookrightarrow \rho_c = \frac{P_c \cdot M}{R \cdot T_c} = \frac{792422,68 \cdot 29}{8314 \cdot 250,66} = \rho_c = 10,77 \text{ kg/m}^3$$

$$\hookrightarrow T_c = P_c \cdot T_1 \cdot \frac{P_1^{\frac{\gamma-1}{\gamma}}}{P_2^{\frac{\gamma-1}{\gamma}}} = P_2 \cdot T_2 \cdot \frac{P_1^{\frac{\gamma-1}{\gamma}}}{P_2^{\frac{\gamma-1}{\gamma}}} = 792422,68 \cdot T_c^{\frac{1,4}{1-1,4}} = 200000 \cdot T_c^{\frac{1,4}{1-1,4}}$$

$$T_c = 250,66 \text{ K}$$

$$\hookrightarrow \rho_2 = \frac{P_2 \cdot M}{R \cdot T_2} = \frac{200000 \cdot 29}{8314 \cdot 132,19} = \rho_2 = 4,0281 \text{ kg/m}^3$$

$$320,95 \cdot 10,77 \cdot 0,002 = 520,13 \cdot 4,0281 \cdot S_2 \rightarrow S_2 = 3,2997 \cdot 10^{-3}$$

Toberas → Adiabático

(6) de las hojas



$$Y=1.4 \quad P_1=100000 \text{ Pa} \rightarrow P_2=100000 \text{ Pa}$$

$$T_1=40^\circ\text{C}=313\text{K}$$

$$V_1 \rightarrow \text{mucha}$$

$$A_{\text{noe}} \rightarrow M=29.51 \text{ mol}$$

(a) V_2 ?

Relaciones termodinámicas $P_1 T_1^{\frac{\gamma}{\gamma-1}} = P_2 T_2^{\frac{\gamma}{\gamma-1}}$; $100000 \cdot 313^{\frac{1.4}{1.4-1}} = 100000 T_2^{\frac{1.4}{1.4-1}}$

$$T_2 = 162.12 \text{ K}$$

Relación de densidad para ver el tipo de tobera

$$\frac{P_2}{P_1} = \left(\frac{T_2}{T_1} \right)^{\frac{\gamma}{\gamma-1}} \rightarrow P_2 = P_1 \left(\frac{T_2}{T_1} \right)^{\frac{\gamma}{\gamma-1}} = 100000 \left(\frac{162.12}{313} \right)^{\frac{1.4}{1.4-1}} \rightarrow P_2 = 528281.79 \text{ Pa}$$

Como $P_2 > P_1 \rightarrow$ la boquilla es convergente

→ una tobera porque $V_2 > 0$



Para calcular V_2 usamos BET que relaciona P con V

$$V_2^2 V_1^2 = 2 \frac{\gamma}{\gamma-1} P_1 \left(1 - \left(\frac{P_2}{P_1} \right)^{\frac{\gamma-1}{\gamma}} \right)$$

$$\left. \begin{aligned} \gamma &= 1.4 \\ \gamma &= \frac{c_p}{c_v} \end{aligned} \right\} \rightarrow V_1 = \frac{2T}{P_1} = \frac{83.14 \cdot 313}{100000 \cdot 29} \rightarrow \gamma = 0.0293 \text{ m}^2/\text{kg}$$

$$V_2^2 - 0^2 = 2 \frac{1.4}{1.4-1} 100000 \cdot 0.0293 \left(1 - \left(\frac{528281.79}{100000} \right)^{\frac{1.4-1}{1.4}} \right) \rightarrow V_2 = 550.27 \text{ m/s}$$

(b) dT_2 ?

Calculo de densidad $T_2 = 162.12 \text{ K}$



$$\begin{aligned} Y &= 1.4 \\ M &= 240 \text{ m/s} \\ W &= 240 \text{ kg/s} \\ \rho &= 1143 \text{ kg/m}^3 \end{aligned}$$

There

$$P_1 = 1500000 \text{ Pa} \rightarrow P_2 = 700000 \text{ Pa}$$

$$c_1/c_2 = 3$$

(a) Tipo de tobera.

$$\text{Razón de cavidad } \left(\frac{P_2}{P_1} \right)_c = \left(\frac{2}{Y+1} \right)^{\frac{Y}{Y-1}} \rightarrow P_{2c} = P_1 \left(\frac{2}{Y+1} \right)^{\frac{Y}{Y-1}} = 1500000 \left(\frac{2}{1.4+1} \right)^{\frac{1.4}{1.4-1}}$$

$$P_{2c} = 792472.68 \text{ Pa}$$

Como $P_2 > P_{2c} \rightarrow$ la tobera es análoga



(b) Valores de las secciones de entrada y salida.

$$\begin{aligned} \text{Sabemos que } W_1 &= W_2 = 240 \text{ kg/s} \\ W_1 &= \rho_1 V_1 S_1 = 240 \text{ kg/s} \quad [\text{Ec. 1}] \\ W_2 &= \rho_2 V_2 S_2 = 240 \text{ kg/s} \quad [\text{Ec. 2}] \end{aligned}$$

$$\text{Calculamos } \rho_2 = \frac{P_2}{R T_2} \rightarrow \text{Temperatura } T_2 \text{ y } T_1$$

$$\text{Relaciones termodinámicas } \frac{P_2}{P_1} = \left(\frac{T_2}{T_1} \right)^{\frac{\gamma}{\gamma-1}}$$

$$\rho_1 = \frac{1}{0.1} \rightarrow \rho_1 = 10 \text{ kg/m}^3$$

$$\frac{\rho_2}{\rho_1} = \left(\frac{P_2}{P_1} \right)^{\frac{1}{\gamma}} = \frac{10}{\rho_2} = \left(\frac{700000}{1500000} \right)^{\frac{1}{1.4}} \rightarrow \rho_2 = 6.38 \text{ kg/m}^3$$

$$\text{Plantamos Ec. 1 y Ec. 2 } V_1^2 V_2^2 = 2 \frac{P_1}{\rho_1} \left(1 - \left(\frac{P_2}{P_1} \right)^{\frac{1}{\gamma}} \right)$$

$$V_2^2 V_1^2 = 2 \frac{1.4}{1.4-1} = 1500000 \frac{1}{10} \left(1 - \left(\frac{700000}{1500000} \right)^{\frac{1.4-1}{1.4}} \right) \quad [\text{Ec. 3}]$$

$$\text{En el enunciado indicaron que } c_1/c_2 = 3 \quad [\text{Ec. 4}]$$

Procedo a resolver

$$V_1 \rightarrow \text{Ec. 1 } S_1 \rightarrow \text{Ec. 4 } S_2 \rightarrow \text{Ec. 2 } V_2 \rightarrow \text{Ec. 3 } V_1 \rightarrow V_1 = V_1$$

V_1	$S_1 \cdot 10^{-3}$	$S_2 \cdot 10^{-3}$	V_2	V_1
50	3.6341	1.2121	258.62	\rightarrow No sale
100	1.8172	6.0606	517.06	85.19
85.19	2.1342	2.1140	440.5	85.19

$$S_1 = 2.1342 \cdot 10^{-3} \text{ m}^2$$

$$S_2 = 2.1140 \cdot 10^{-3} \text{ m}^2$$

(c) Energía comunicada a la turbina.

$$E_c = \frac{1}{2} W (V_2^2 - V_1^2) = \frac{1}{2} \cdot 240 \text{ kg/s} \cdot (440.5^2 - 85.19^2) \frac{\text{m}^2}{\text{s}^2} \rightarrow E_c = 196782.75 \text{ W}$$

$$\frac{V_2}{V_1} = \frac{W_2}{W_1} = \frac{W_2}{S_2} = \frac{W_1}{S_1} \rightarrow \frac{W_2}{S_2} = \frac{W_1}{S_1}$$



Aprueba tus asignaturas de la URJC con nosotros

Clases de refuerzo para estudiantes de la URJC. Apoyo personalizado en todas las asignaturas para ayudarte a aprobar con éxito

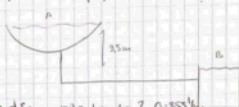
LA COOPERATIVA

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Problemas fluidos.

Ej del libro página 54



Tubería: $\rho = 1000 \text{ kg/m}^3$
 $D = 10 \text{ cm}$
 $L = 600 \text{ m}$
 $Q = 355 \text{ l/min} = 0,005917 \text{ m}^3/\text{s}$

• ¿Se necesita bomba? $Q = 355 \text{ l/min}$

Bernoulli (A \rightarrow B)

$$\frac{1}{2}(\rho V_A^2 - \rho V_B^2) + \rho g(z_A - z_B) = \frac{\rho \Delta P}{L} + \rho f L$$

• $V_A = 0$ y $V_B = 0$ (Válida que hay un nivel en el tanque de A (comienza))

• $P_A = P_B = P_{atm}$

$$\rho g(z_A - z_B) + \rho f L = 0 \rightarrow \text{si } f = 0 \text{ no se necesita bomba}$$

$$\rho g(z_A - z_B) + \rho f L = 0 \rightarrow \text{si } f > 0 \text{ se necesita bomba}$$

$$\rho g(z_A - z_B) = 2 f L \cdot \frac{Q}{A} = W$$

$$f = \frac{W}{2 L \cdot \frac{Q}{A}} = \frac{W}{2 L \cdot \frac{Q}{\pi D^2/4}} = \frac{W \cdot \pi D^2}{4 L Q}$$

$$f = \frac{W \cdot \pi D^2}{4 L Q} = \frac{W \cdot \pi (0,1)^2}{4 \cdot 600 \cdot 0,005917} \rightarrow W = 1,293 \text{ m}^3/\text{s}$$

$$\rho g(z_A - z_B) = 2 f L \cdot \frac{Q}{A} = W \rightarrow W = 1,293 \text{ m}^3/\text{s}$$

• Si no fuera necesaria la bomba, ¿Cuál sería Q_{max} ? ¿Se necesita una bomba?

$$\text{Reserva (bomba)}: Q = V \cdot t \rightarrow \text{si } Q_{max} = V_{max} \cdot t \rightarrow (1,62 \cdot 10^{-3})^3$$

• Se usa el mismo Bernoulli: $\rho g(z_A - z_B) + \rho f L = 0 \rightarrow W = 0$

$$\rho g(z_A - z_B) = 2 f L \cdot \frac{Q}{A} = 0 \rightarrow f = 0$$

- Otro caso: iterativo

$$V \rightarrow \text{Caudal } Q \rightarrow \text{Fr } f \rightarrow V_{max} \rightarrow \frac{V_{max}}{L} \rightarrow \text{SE}$$

$$\begin{array}{l} V = 1,62 \cdot 10^{-3} \\ S = 0,005917 \\ 0,005917 \cdot 1,62 \cdot 10^{-3} \end{array} \rightarrow V_{max} = 0,013 \text{ m}^3/\text{s}$$

$$Q_{max} = 0,013 \cdot \frac{\pi (0,1)^2}{4} \rightarrow Q_{max} = 0,0028 \text{ m}^3/\text{s}$$

- Se abre la compuerta C? si su caudal es de 100 l/min y se coloca en paralelo.



Tuberías

$$\begin{aligned} \textcircled{1} & \left\{ \begin{array}{l} Q_1 = 355 \text{ l/min} \\ L_1 = 600 \text{ m} \\ D_1 = 7,62 \text{ cm} \end{array} \right. \\ \textcircled{2} & \left\{ \begin{array}{l} Q_2 = 100 \text{ l/min} \\ L_2 = 600 \text{ m} \\ D_2 = 7 \end{array} \right. \end{aligned}$$

Bernoulli A \rightarrow B (por 2)

$$100 \text{ l/min} = 0,00167 \text{ m}^3/\text{s}$$

$$\frac{1}{2} \rho (V_2^2 - V_1^2) + \rho g (z_1 - z_2) + \frac{P_2 - P_1}{\rho} + \Sigma F_2 = W$$

$$\hookrightarrow V_2 = 0 \text{ y } V_1 = 0$$

$$\hookrightarrow W = 0 \rightarrow \text{No hay trabajo}$$

$$\hookrightarrow P_2 = P_1 = P_{\text{atm}}$$

$$\rho g (z_1 - z_2) + \Sigma F_2 = 0$$

$$9,8 (2,5 - 0) + 2 f_2 V_2^2 \frac{L_2}{D_2} = 0 \quad [\text{Ec. 1}]$$

$$\hookrightarrow f_2 \text{ Cheu} \rightarrow \text{velocidad de } D_2, V_2$$

$$\hookrightarrow V_2 = V_1 \rightarrow 0,00167 = V_2 \frac{\pi}{4} D_2^2 \quad [\text{Ec. 2}]$$

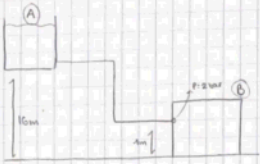
- Proceso iterativo

$$D_2' \rightarrow \text{Ec. 2 } V_2 \rightarrow \text{Cheu } f_2 \rightarrow \text{Ec. 1 } D_2 \rightarrow \boxed{D_2, D_2'} \rightarrow \text{etc}$$

D_2'	V_2	$f_2 \cdot 10^{-2}$	D_2
0,05	0,2428	6,1130	0,0628
0,0628	0,5235	6,7207	0,0628

$$\rightarrow \boxed{D_2 = 0,0628 \text{ m}}$$

Problema de examen Incompresible.



Tubería $\left\{ \begin{array}{l} D = 9 \text{ cm} \\ L = 200 \text{ m} \end{array} \right.$
 $\epsilon = 0,046 \text{ mm} = 4,6 \cdot 10^{-5} \text{ m}$
 $P_B = 2 \text{ bar} = 200000 \text{ Pa}$

- ¿Qué caudal puede obtenerse?

- Ec. Bernoulli (A \rightarrow B)

$$\frac{1}{2} \left(\frac{V_A^2}{\alpha_A} - \frac{V_B^2}{\alpha_B} \right) + g(z_A - z_B) + \frac{P_B - P_A}{\rho} + \Sigma F = W$$

$\frac{1}{2} V_A^2 \approx 0$ y $V_B \approx 0$ (despreciables)
 \rightarrow W < 0 (se vaen hacia abajo)

$$g(z_A - z_B) = \frac{P_B - P_A}{\rho} + 2 f \frac{V^2 L}{D} = 0$$

$$9,8 (16 - 2) = \frac{200000 - 101325}{1000} + 2 f \frac{V^2 \cdot 200}{0,09} = 0 \quad [E. 1]$$

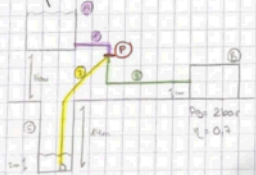
- Procedo iterativo



$V \in [0,2]$
 $f \in [0,05]$
 $1,485 \rightarrow 1,485 \rightarrow V = 1,485 \text{ m/s} \rightarrow Q = V \cdot S = 1,485 \cdot \frac{\pi}{4} \cdot 0,09^2$
 $1,485 \rightarrow 1,485 \rightarrow 1,485$

$$Q = 9,45 \cdot 10^{-3} \text{ m}^3/\text{s}$$

- Ampliación de la instalación. ¿a.c./a.m. y/o ¿Pérdida?



Tuberías $\left\{ \begin{array}{l} 1. L = 20 \text{ m} \\ D_1 = 9 \text{ cm} \\ 2. L = 15 \text{ m} \rightarrow \text{2 m emergente} \\ D_2 = 10 \text{ cm} \rightarrow \text{15 m sumergida} \\ 3. L = 120 \text{ m} \\ D_3 = 20 \text{ cm} \end{array} \right.$

Ec. Bernoulli (A \rightarrow C) $\frac{1}{2} \left(\frac{V_A^2}{\alpha_A} - \frac{V_C^2}{\alpha_C} \right) + g(z_A - z_C) + \frac{P_C - P_A}{\rho} + \Sigma F = W \rightarrow V_A = V_C$

(C \rightarrow P) $\frac{1}{2} \left(\frac{V_C^2}{\alpha_C} - \frac{V_P^2}{\alpha_P} \right) + g(z_C - z_P) + \frac{P_P - P_C}{\rho} + \Sigma F = W \rightarrow V_C = V_P$

(P \rightarrow B) $\frac{1}{2} \left(\frac{V_P^2}{\alpha_P} - \frac{V_B^2}{\alpha_B} \right) + g(z_P - z_B) + \frac{P_B - P_P}{\rho} + \Sigma F = W \rightarrow V_P = V_B$

Importante

Puedo eliminar la publi de este documento con 1 coin

¿Cómo consigo coins? → Plan Turbo: barato
→ Planes pro: más coins

perdo
espacio



Necesito
concentración

ali ali ooh
esto con 1 coin me
lo quito yo...

WUOLAH

Phora molas Bernoulli

$(A \rightarrow B) \cdot (P \rightarrow B) \cdot \frac{1}{2} \left(\frac{V_A^2}{m_1} - \frac{V_B^2}{m_2} \right) + g \cdot (z_B - z_A) + \frac{P_B - P_A}{\rho} + \sum F_1 + \sum F_2 = 0 \quad (A \rightarrow B)$

$(C \rightarrow P) \cdot (P \rightarrow B) \cdot \frac{1}{2} \left(\frac{V_C^2}{m_1} - \frac{V_B^2}{m_2} \right) + g \cdot (z_B - z_C) + \frac{P_B - P_C}{\rho} + \sum F_1 + \sum F_2 = 0 \quad (C \rightarrow B)$

• Igualación de ecuaciones $G_1 + G_2 = G_3 \rightarrow V_1 \cdot \frac{\rho}{4} \cdot D_1^3 = V_2 \cdot \frac{\rho}{4} \cdot D_2^3 = V_3 \cdot \frac{\rho}{4} \cdot D_3^3$

$V_1 D_1^3 = V_2 D_2^3 = V_3 D_3^3$

$V_1 V_2 \cdot G_1 V_2 \rightarrow 2,04 \cdot V_2 \cdot \frac{\rho}{4} \cdot D_2^3 \rightarrow V_2 = 1,73 \text{ m/s} \rightarrow R_{eq} = 25,5000$

$V_1 \cdot 0,05^3 = V_2 \cdot 0,1^3 = 0,04 \quad (G_1 = 1)$

$(G_1 \rightarrow B) \cdot \frac{1}{2} \left(\frac{V_1^2}{m_1} - \frac{V_2^2}{m_2} \right) + g \cdot (z_B - z_1) + \frac{200000 - 101325}{1000} + \sum F_1 + \sum F_2 = 0$

• Segundo ecuación de balance para la tubería con conductancia 100

$\rightarrow \sum F_1 = 2 \cdot F_1 \cdot V_1 \cdot \frac{20}{0,075}$

$\rightarrow \sum F_2 = 2 \cdot F_2 \cdot V_2 \cdot \frac{10}{0,1}$

$\rightarrow \sum F_3 = 2000 \rightarrow F_3 = 2000 \cdot 10^{-3}$

$\frac{1}{2} \left(V_1^2 - V_2^2 \right) + g \cdot (z_B - z_1) + \frac{200000 - 101325}{1000} + 2 \cdot F_1 \cdot V_1 \cdot \frac{20}{0,075} - 2 \cdot F_2 \cdot V_2 \cdot \frac{10}{0,1} = 0$

$(G_1 = 1)$

$(G_2 \rightarrow B) \cdot \frac{1}{2} \left(\frac{V_2^2}{m_1} - \frac{V_3^2}{m_2} \right) + g \cdot (z_B - z_2) + \frac{200000 - 101325}{1000} + \sum F_1 + \sum F_2 = 0$

$\frac{1}{2} \left(V_2^2 - V_3^2 \right) + g \cdot (z_B - z_2) + \frac{200000 - 101325}{1000} + 2 \cdot F_2 \cdot V_2 \cdot \frac{10}{0,1} - 2 \cdot F_3 \cdot V_3 \cdot \frac{10}{0,1} = 0$

$(G_2 = 2)$

• $V_1 \cdot 0,05^3 = V_2 \cdot 0,1^3 = 0,04$

• Principio de conservación

$V_1 \rightarrow Q_{env} \cdot F_1 \rightarrow G_1 \cdot 2 \cdot V_1 \rightarrow V_1 = V_1 \rightarrow G_1 \cdot 1 \cdot V_2 \rightarrow Q_{env} \cdot F_2 \rightarrow G_2 \cdot 3$

$V_1 = 4,10^3 \quad V_2 = V_2 = 0,1^3 \quad W$

$5 \quad 4,4529 \quad 3,822$

$3,822 \quad 4,4529 \quad 3,822 \quad 4,453 \quad 4,4529 \quad 205,44 \rightarrow Q_1 = 205,44 \text{ J/kg}$

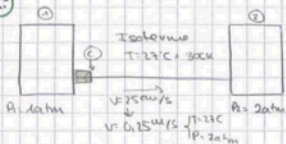
$N^2 = W \cdot W$

$N_2 = \frac{W}{V} \rightarrow N_2 = \frac{m \cdot W}{V} = \frac{15,65 \cdot 205,44}{0,4} \rightarrow N_2 = 7,935 \text{ GJ/W}$

$W = 0,9 \quad G = 0,5 \rightarrow W = V \cdot G \cdot \rho = 1,995 \cdot \frac{\rho}{4} \cdot 0,1^3 \cdot 1000 \rightarrow W = 15,65 \text{ kg/s}$

WUOLAH

2-



$$\eta = 0.9$$

$$\begin{aligned} \mu &= 1.5 \cdot 10^{-2} \text{ cp} \\ L &= 20000 \text{ m} \end{aligned}$$

$$\mu = 1.5 \cdot 10^{-2} \text{ cp} = 1.5 \cdot 10^{-2} \text{ kg/m.s}$$

$$M = 16 \text{ g/mol}$$

$$n = 1.3$$

$$R = 8310$$

- Calcular la potencia.

$$N = m \cdot W$$

↳ calculamos W aunque el flujo sea isotermo, como se dan μ , el compresor es politrópico

Como nos falta la presión de salida del compresor, supongamos $P_2 = 2$

$$P_1 \cdot P_2^n = \frac{\mu R T}{M} \cdot 2 \cdot f \cdot G \cdot \frac{L}{D}$$

$$\text{Porque } V_2 = 0.25 \text{ m/s} \approx 35 \text{ m/s}$$

$$\hookrightarrow G = V \cdot \rho = 0.25 \cdot 1.3 \rightarrow G = 0.325 \text{ kg/m}^2 \cdot \text{s}$$

$$\hookrightarrow \rho = \frac{P \cdot M}{R \cdot T} = \frac{202650 \cdot 16}{8310 \cdot 300} \rightarrow \rho = 1.3 \text{ kg/m}^3$$

$$\hookrightarrow f \cdot Q_{\text{ecu}} \rightarrow f \cdot G \cdot 346 \cdot 10^{-3}$$

$$P_2 = 202650 \rightarrow \frac{4 \cdot 8310 \cdot 300}{G} \cdot 2 \cdot G \cdot 346 \cdot 10^{-3} \cdot 0.325^2 \cdot \frac{20000}{1} \rightarrow P_2 = 202332.92 \text{ Pa}$$

$$P_1 = \frac{P_2}{P_2^n} = \frac{202332.92}{101325} \rightarrow P_1 = 2 \rightarrow \text{el compresor tiene 1 etapa}$$

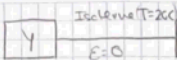
$$W = \frac{\mu}{\mu - 1} \cdot \frac{R T}{M} \left[\left(\frac{P_2}{P_1} \right)^{\frac{\mu - 1}{\mu}} - 1 \right] = \frac{1.3}{1.3 - 1} \cdot \frac{8310 \cdot 300}{16} \left[\left(\frac{202332.92}{101325} \right)^{\frac{1.3 - 1}{1.3}} - 1 \right]$$

$$W = 119192.78 \text{ J/kg}$$

$$N = m \cdot W$$

$$\hookrightarrow m = G \cdot S = 0.325 \cdot 1 \rightarrow m = 0.3253 \text{ kg/s}$$

$$N_R = \frac{N}{L} \rightarrow N_R = \frac{0.3253 \cdot 119192.78}{0.3} \rightarrow N_R = 42334.75 \text{ W}$$



$$m = 1.3 \text{ kg/s}$$

$$P_A = 200000 \text{ Pa}$$

$$L = 200000 \text{ m}$$

$$D = 0.1778 \text{ m}$$

$$\mu = 10^{-3} \text{ Pa.s}$$

$$\rho = 2000 \text{ kg/m}^3$$

(a) Caudal nísico que sale del yacimiento.

- Suponemos Weymouth ($v < 35 \text{ m/s}$)

$$P_1^2 - P_2^2 = \frac{4.81}{M} \cdot f \cdot G^2 \cdot \frac{L}{D}$$

$$G = \frac{m}{s} \cdot \frac{1}{\rho} \cdot \frac{1}{D} \rightarrow G = 52.36 \text{ kg/m}^2 \cdot \text{s}$$

* Veremos si cumple Weymouth.

$$v = \frac{G}{\rho} \rightarrow v = \frac{52.36}{2000} \rightarrow v = 0.02618 \text{ m/s} < 35 \text{ m/s} \rightarrow \text{si vale Weymouth}$$

$$f = \frac{P_1 - P_2}{P_1} \cdot \frac{20}{2310.293} \rightarrow f = 1.6428 \cdot 10^{-3}$$

$$Re = 0.0044 + 0.125 Re^{-0.32}$$

$$Re = \frac{G \cdot D}{\mu} = \frac{52.36 \cdot 0.1778}{10^{-3}} \rightarrow Re = 930960.8$$

$$P_1^2 - 200000^2 = \frac{4.81 \cdot 20}{20} \cdot 2.9336 \cdot 10^{-3} \cdot 52.36^2 \cdot \frac{200000}{0.1778} \rightarrow P_1 = 2109832.04 \text{ Pa}$$



- Suponemos Weymouth ($v < 35 \text{ m/s}$)

$$P_1^2 - P_2^2 = \frac{4.81}{M} \cdot f_1 \cdot G_1^2 \cdot \frac{L_1}{D_1}$$

$$2109832^2 - 200000^2 = \frac{4.81 \cdot 20}{20} \cdot f_1 \cdot G_1^2 \cdot \frac{100000}{0.1778} \quad [\text{Ec. 1}]$$

- Suponemos Weymouth ($v < 35 \text{ m/s}$)

$$P_1^2 - P_2^2 = \frac{4.81}{M} \cdot f_2 \cdot G_2^2 \cdot \frac{L_2}{D_2}$$

$$2109832^2 - 200000^2 = \frac{4.81 \cdot 20}{20} \cdot f_2 \cdot G_2^2 \cdot \frac{100000}{0.1778} \quad [\text{Ec. 2}]$$

- Suponemos Weymouth ($v < 35 \text{ m/s}$)

$$P_1^2 - 200000^2 = \frac{4.81 \cdot 20}{20} \cdot f_3 \cdot G_3^2 \cdot \frac{100000}{0.1778} \quad [\text{Ec. 3}]$$

$$f_1 = f_2 = f_3$$

$$G_1 = G_2 = G_3$$

- En el punto C: $m_1 = m_2 + m_3$ $\left\{ \begin{array}{l} G_1 \cdot S_1 = G_2 \cdot S_2 + G_3 \cdot S_3 \\ S_1 = S_2 = S_3 \\ D_1 = D_2 = D_3 \end{array} \right.$

$$G_1 = G_2 + G_3 \quad [\text{Ec. 4}]$$

