

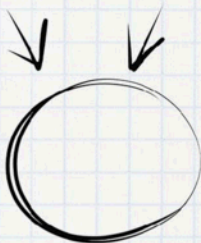


# Imagínate aprobando el examen

## Necesitas tiempo y concentración

Planes	 PLAN TURBO	 PLAN PRO	 PLAN PRO+
 Descargas sin publi al mes	10 🟡	40 🟡	80 🟡
 Elimina el video entre descargas	✓	✓	✓
 Descarga carpetas	✗	✓	✓
 Descarga archivos grandes	✗	✓	✓
 Visualiza apuntes online sin publi	✗	✓	✓
 Elimina toda la publi web	✗	✗	✓
 Precios <small>ANUAL</small>	0,99 € / mes	3,99 € / mes	7,99 € / mes

Ahora que puedes conseguirlo,  
¿Qué nota vas a sacar?



# WUOLAH

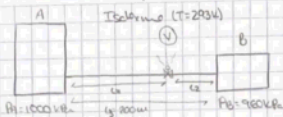
$$= 14 \cdot \frac{P_{04}}{P_{01}} \cdot 2,4012 = \frac{6000000}{P_{04}} \rightarrow P_{04} = 2133883 \text{ Pa}$$

- Calcular el trabajo de los compresores de 4 etapas

$$W = \frac{n}{n-1} \cdot \frac{R \cdot T_{01}}{M} \left[ \left( \frac{P_{04}}{P_{01}} \right)^{\frac{n-1}{n}} - 1 \right] + 0 \cdot \left( \frac{1}{2} \frac{V_{04}}{V_{01}} \left( \frac{P_{04}}{P_{01}} \right)^{\frac{n-1}{n}} - 1 \right) + 0 \cdot \left( \frac{1}{2} \frac{V_{03}}{V_{02}} \left( \frac{P_{03}}{P_{02}} \right)^{\frac{n-1}{n}} - 1 \right) + \rightarrow$$

$$\rightarrow 0 \cdot \left( \frac{1}{2} \frac{V_{04}}{V_{01}} \left( \frac{P_{04}}{P_{02}} \right)^{\frac{n-1}{n}} - 1 \right) \rightarrow W = 276934,8 \text{ J/kg}$$

$$N = m \cdot W = 1000 \frac{\text{kg}}{\text{s}} \cdot \frac{1}{3600} \frac{\text{h}}{\text{s}} \cdot 276934,8 \text{ J/kg} \rightarrow \boxed{N = 76937,4 \text{ W}}$$



Tubería  $\begin{cases} L=200m \\ D=0.05m \end{cases}$   
 $M=300 \text{ kg/m}^3$   
 $\mu=10^{-4} \text{ kg/m s}$

$M_A=300 \text{ kg/m}^3$   $M_B=600 \text{ kg/m}^3$

(a) Calcular el punto de la conducción donde se encuentra la válvula

Se sabe que  $u_1 = u_2 = u_3 \rightarrow 700 = 600 + u_3 \rightarrow u_3 = 100 \text{ m/s}$  *paradoja*

- Suponemos Weissenberg  $A \rightarrow V$  ( $V < 35 \text{ m/s}$ )

$$P_1 - P_2 = \frac{4 \mu L}{D} \cdot \frac{u_1}{D} \cdot \frac{L}{D}$$

$$\rightarrow G = \frac{u_1}{L} = \frac{700}{20} = \frac{1}{20} \rightarrow G = 99.03 \text{ kg/m}^2 \text{ s}$$

$$\rightarrow f = 0.316 \cdot Re^{-1/4} = 0.316 \cdot 4951500^{-1/4} \rightarrow f = 6.6989 \cdot 10^{-3}$$

$$\rightarrow Re = \frac{G \cdot D}{\mu} = \frac{99.03 \cdot 0.05}{10^{-4}} \rightarrow Re = 4951500$$

$$1000000^2 \cdot P_1^2 = \frac{4 \cdot 8314 \cdot 293}{20} \cdot 6.6989 \cdot 10^{-3} \cdot 99.03^2 \cdot \frac{L}{0.05} \quad [Ec. 1]$$

- Suponemos Weissenberg  $V \rightarrow B$  ( $V < 35 \text{ m/s}$ )

$$P_2 - P_3 = \frac{4 \mu L}{D} \cdot \frac{u_2}{D} \cdot \frac{L}{D}$$

$$\rightarrow G = \frac{u_2}{L} = \frac{600}{20} = \frac{1}{20} \rightarrow G = 84.88 \text{ kg/m}^2 \text{ s}$$

$$\rightarrow f = 0.316 \cdot Re^{-1/4} = 0.316 \cdot 4244000^{-1/4} \rightarrow f = 6.9621 \cdot 10^{-3}$$

$$\rightarrow Re = \frac{G \cdot D}{\mu} = \frac{84.88 \cdot 0.05}{10^{-4}} \rightarrow Re = 4244000$$

$$P_2^2 = 980000^2 = \frac{4 \cdot 8314 \cdot 293}{20} \cdot 6.9621 \cdot 10^{-3} \cdot 84.88^2 \cdot \frac{L}{0.05} \quad [Ec. 2]$$

- Las tuberías  $L_3 = L_1 + L_2 \rightarrow 200 = L_1 + L_2 \quad [Ec. 3]$

- Proceso iterativo

$$L_1' \rightarrow Ec. 3 \rightarrow L_2 \rightarrow Ec. 2 \rightarrow P_2 \rightarrow Ec. 1 \rightarrow L_1 \rightarrow \boxed{L_1' = L_1} \rightarrow \text{se repite}$$

$L_1'$	$L_2$	$P_2$	$L_1$
75	125	980935.13	131.11
131.11	68.89	971621.83	131.11

La válvula se encuentra en  $\boxed{131.11m}$  del depósito

\* Comprobamos Weissenberg en el punto de menor presión

$$V = \frac{G}{\rho} = \frac{G}{\rho \cdot \frac{\pi D^2}{4}} = \frac{G \cdot 4}{\rho \cdot \pi D^2} = \frac{84.88 \cdot 4 \cdot 293}{960000 \cdot 20} \rightarrow V = 2.19 \text{ m/s} < 35 \text{ m/s}$$

Se cumple Weissenberg

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



(b) Una vez cerrada la válvula, cuál es el caudal?

Sublinea (1.75M) B

$Q = 3.5 \text{ m}^3/\text{s}$  Sublinea  $Q = 200 \text{ m}^3/\text{s}$

$\mu = 10^{-6} \text{ kg/m} \cdot \text{s}$   $Q = 6.0 \text{ m}^3/\text{s}$

$P_A = 100000 \text{ Pa}$   $P_B = 90000 \text{ Pa}$

Suponemos Weymouth A → B ( $\mu = 35 \text{ mPa}$ )

$$P_A - P_B = \frac{4 \mu L}{\pi R^4} Q$$
$$100000 - 90000 = \frac{4 \cdot 35 \cdot 10^{-3}}{\pi R^4} Q$$

- Recorrido iterativo

$Q \rightarrow R_{eq} \rightarrow f \rightarrow Ec \rightarrow G \rightarrow G = G \rightarrow SS$

Q	Reynolds	$f$	G
SS	1475000	0.0593	94.34
94.34	1475000	0.0593	94.34

$Q = 94.34 \text{ m}^3/\text{s}$

$Q = 3.5$   $Q = \frac{94.34 \cdot 10^6}{1000000} = 94.34$

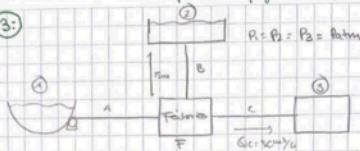
$Q = 0.0593 \text{ m}^3/\text{s}$   $Q = 0.0593 \text{ m}^3/\text{s}$

(c) Taberna!

WUOLAH

# Problema Incompresible rugoso. Página 120\*

(3.)



$$D_A = 0.154 \text{ m}$$

$$L_A = 3500 \text{ m}$$

$$D_C = 0.102 \text{ m}$$

$$L_C = 100 \text{ m}$$

$$D_C = 0.102 \text{ m}$$

$$L_C = 200 \text{ m}$$

$$\text{Burgos}$$

$$\Sigma = C$$

(a) ¿cuáles el caudal de agua que pasa por B?

$$\bullet \text{ Bernoulli } 1 \rightarrow 2 \quad \frac{1}{2} \left( \frac{V_1^2}{\alpha_1} - \frac{V_2^2}{\alpha_2} \right) + g(z_1 - z_2) = \frac{P_1 - P_2}{\rho} + \Sigma F_{1-2} = W$$

$$\bullet V_1 = 0$$

$$\bullet \alpha_1 = 1$$

$$\frac{1}{2} \left( \frac{V_2^2}{\alpha_2} \right) + \frac{P_2 - P_1}{\rho} + 2 f_A V_1^2 \frac{L_A}{D_A} = W$$

$$\bullet \text{ Bernoulli } 2 \rightarrow 3 \quad \frac{1}{2} \left( \frac{V_2^2}{\alpha_2} - \frac{V_3^2}{\alpha_3} \right) + g(z_2 - z_3) = \frac{P_2 - P_3}{\rho} + \Sigma F_{2-3} = W$$

$$\bullet V_3 = 0$$

$$\bullet W = 0 \rightarrow \text{No hay bombeo}$$

$$\frac{1}{2} \left( \frac{V_2^2}{\alpha_2} \right) + g(z_2 - z_3) = \frac{P_2 - P_3}{\rho} + 2 f_B V_2^2 \frac{L_B}{D_B} = 0$$

$$\bullet \text{ Bernoulli } 1 \rightarrow 3 \quad \frac{1}{2} \left( \frac{V_1^2}{\alpha_1} - \frac{V_3^2}{\alpha_3} \right) + g(z_1 - z_3) = \frac{P_1 - P_3}{\rho} + \Sigma F_{1-3} = W$$

$$\bullet V_3 = 0$$

$$\bullet W = 0 \rightarrow \text{No hay bombeo}$$

$$\bullet \alpha_2 = 1$$

$$\frac{1}{2} \left( \frac{V_2^2}{\alpha_2} \right) + \frac{P_2 - P_1}{\rho} + 2 f_A V_1^2 \frac{L_A}{D_A} = 0$$

- Considerando  $1 \rightarrow 2 \rightarrow 3$

$$\frac{1}{2} \left( \frac{V_2^2}{\alpha_2} \right) + \frac{P_2 - P_1}{\rho} + 2 f_A V_1^2 \frac{L_A}{D_A} + \frac{1}{2} \left( \frac{V_2^2}{\alpha_2} \right) + g(z_2 - z_3) = \frac{P_2 - P_3}{\rho} + 2 f_B V_2^2 \frac{L_B}{D_B} = W$$

$$g(z_2 - z_3) = \frac{P_2 - P_3}{\rho} + 2 f_A V_1^2 \frac{L_A}{D_A} + 2 f_B V_2^2 \frac{L_B}{D_B} = W \rightarrow P_2 = P_1 \rightarrow P_{atm}$$

$$g(z_2 - z_3) + 2 f_A V_1^2 \frac{L_A}{D_A} + 2 f_B V_2^2 \frac{L_B}{D_B} = W \quad [E: 1]$$

- Considerando  $1 \rightarrow 2 \rightarrow 3$

$$\frac{1}{2} \left( \frac{V_2^2}{\alpha_2} \right) + \frac{P_2 - P_1}{\rho} + 2 f_A V_1^2 \frac{L_A}{D_A} + \frac{1}{2} \left( \frac{V_2^2}{\alpha_2} \right) + \frac{P_2 - P_3}{\rho} + 2 f_B V_2^2 \frac{L_B}{D_B} = W \rightarrow P_1 = P_2$$

$$2 f_A V_1^2 \frac{L_A}{D_A} + 2 f_B V_2^2 \frac{L_B}{D_B} = W \quad [E: 2]$$

- Se sabe que  $Q_c = 36 \text{ m}^3/\text{s} = 0,0139 \text{ m}^3/\text{s}$

$$Q_c \cdot V_c \rightarrow 0,0139 \cdot V_c \cdot \frac{\pi}{4} \cdot 0,078^2 \rightarrow V_c = 2,91 \text{ m/s}$$

$$Q_{\text{neu}} \rightarrow f_c = 3,3175 \cdot 10^{-3}$$

$$[E_2] \quad 2 f_n V_n' \cdot \frac{3500}{0,154} + 2 \cdot 3,3175 \cdot 10^{-3} \cdot 2,91^2 \cdot \frac{200}{0,078} = W$$

- Como hay interacción del canal

$$Q_A = Q_B + Q_c \quad V_A \cdot \frac{\pi}{4} \cdot 0,154^2 = V_B \cdot \frac{\pi}{4} \cdot 0,102^2 + 0,0139 \quad [E_3]$$

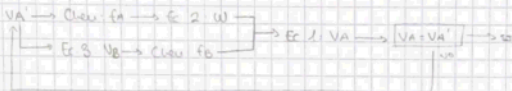
- Ecuaciones

$$[E_1] \quad 9,8 \cdot (15 - 0) + 2 f_n V_n' \cdot \frac{3500}{0,154} + 2 f_B V_B^2 \cdot \frac{200}{0,102} = W$$

$$[E_2] \quad 2 f_n V_n' \cdot \frac{3500}{0,154} + 2 \cdot 3,3175 \cdot 10^{-3} \cdot 2,91^2 \cdot \frac{200}{0,078} = W$$

$$[E_3] \quad V_A \cdot \frac{\pi}{4} \cdot 0,154^2 = V_B \cdot \frac{\pi}{4} \cdot 0,102^2 + 0,0139$$

- Procedo a resolver



$V_A'$	$f_A \cdot 10^{-3}$	$W$	$V_B$	$f_B \cdot 10^{-3}$	$V_n$
5	3047,3	2628,22	9,6898	2,1177	1,4075
1,4075	3350,9	512,2	1,5089	4,1267	1,4075

$$Q_B = V_B \cdot C_c = 1,5089 \cdot \frac{\pi}{4} \cdot 0,102^2 \rightarrow 0,0124 \text{ m}^3/\text{s}$$

(b) ¿Cuál es la potencia de bombas reversa?

$$\left. \begin{array}{l} N = 14075 \text{ W} \\ N = 512,2 \text{ W} \end{array} \right\} N = V_A \cdot \frac{\pi}{4} \cdot 0,154^2 \cdot W = 14075 \cdot \frac{\pi}{4} \cdot 0,154^2 \cdot 1000 \cdot 512,2$$

$$N = 13478,25 \text{ W}$$

(c) ¿Cuál es la distancia mínima del puente a la que se produce colapso?





# Aprueba tus asignaturas de la URJC con nosotros

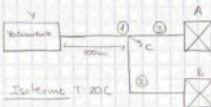
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## Problema compresible reexpansión 2021



$M^* = 1.3$  kg/kg  
 $L_1 = 200$  mm  
 $D_1 = D_2 = D_3 = D_4 = 10$  mm  
 $P_1 = 200000$  Pa  
 $P_0 = 200000$  Pa  
 $M = 27.0$  g/mol  
 $\mu = 10^{-4}$  kg/m·s  
 $f = 0.001 + 0.125 Re^{-0.32} \rightarrow L_{eq}$



Supongamos Weymouth:  $Y \rightarrow A$  ( $V = 35$  m/s)

$$P_1^2 - P_A^2 = \frac{4RT}{\pi} f_1 G_1^2 \frac{L_1}{D_1^5} \quad P_1^2 = 200000^2 \quad \frac{4 \cdot 8314 \cdot 293}{2.2} \quad f_1 \quad G_1^2 \frac{200000}{0.125^5}$$

$$\hookrightarrow G_1 = \frac{W_1}{S_1} = \frac{1.3}{\frac{\pi}{4} \cdot 0.01^2} \quad \hookrightarrow G_1 = 52.36 \text{ kg/m}^2 \cdot \text{s}$$

$$\hookrightarrow f_1 = 0.001 + 0.125 Re^{-0.32} = 0.001 + 0.125 \left( \frac{52.36}{10^{-4}} \right)^{-0.32} \quad \hookrightarrow f_1 = 0.00294$$

$$\hookrightarrow Re = \frac{G_1 D_1}{\mu} = \frac{52.36 \cdot 0.01}{10^{-4}} \quad \hookrightarrow Re = 5236 \quad \hookrightarrow \text{turbulencia}$$

$$P_1^2 = 200000^2 \quad \frac{4 \cdot 8314 \cdot 293}{2.2} \quad 0.00294 \quad 52.36^2 \frac{200000}{0.125^5} \quad \hookrightarrow P_1 = 2015029 \text{ Pa}$$

Comprimos Weymouth:  $V_1 \frac{G_1}{S_1} \rightarrow V_1 = \frac{52.36}{5206.2} \quad \hookrightarrow V_1 = 28.99 \text{ m/s} \approx 35 \text{ m/s}$

$$\hookrightarrow f_2 = \frac{PM}{RS} = \frac{200000 \cdot 27}{8314 \cdot 293} \quad \hookrightarrow f_2 = 1.5062 \text{ kg/m}^2 \cdot \text{s}$$

Altera con el sistema general

$m^*$  no se puede usar en la bitricción ya que se cambia de sistema.

Conservación de materia:  $M_1 = M_2 = M_3$   
 $G_1 = G_2 + G_3$  [Ec 1]

Supones Weymouth en los tramos:



$$\textcircled{1} P_1^2 - P_1^2 = \frac{4RT}{\pi} f_1 G_1^2 \frac{L_1}{D_1^5} \quad 2015029^2 - P_1^2 = \frac{4 \cdot 8314 \cdot 293}{2.2} \quad f_1 \quad G_1^2 \frac{100000}{0.125^5} \quad \text{[Ec 2]}$$

$$\hookrightarrow f_1 = 0.001 + 0.125 Re^{-0.32} \quad \hookrightarrow f_1 = 0.001 + 0.125 \left( \frac{G_1 \cdot 0.01}{10^{-4}} \right)^{-0.32} \quad \text{[Ec 3]}$$

$$\hookrightarrow Re = \frac{G_1 D_1}{\mu}$$

$$\textcircled{2} P_2^2 - P_A^2 = \frac{4RT}{\pi} f_2 G_2^2 \frac{L_2}{D_2^5} \quad P_2^2 = 200000^2 \quad \frac{4 \cdot 8314 \cdot 293}{2.2} \quad f_2 \quad G_2^2 \frac{100000}{0.125^5} \quad \text{[Ec 4]}$$

$$\hookrightarrow f_2 = 0.001 + 0.125 Re^{-0.32} \quad \hookrightarrow f_2 = 0.001 + 0.125 \left( \frac{G_2 \cdot 0.01}{10^{-4}} \right)^{-0.32} \quad \text{[Ec 5]}$$

$$\hookrightarrow Re = \frac{G_2 D_2}{\mu}$$



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$$\textcircled{3} P_1^2 - P_0^2 = \frac{4.8314 \cdot 293}{22} f_3 G_3^2 \frac{L_3}{D_3} \quad P_1^2 - 200000 = \frac{4.8314 \cdot 293}{22} f_3 G_3^2 \frac{100000}{0.1238}$$

$$\hookrightarrow f_3 = 0.0014 + 0.125 P_1^{-0.32} \quad \text{Ec. 6}$$

$$\hookrightarrow P_1 = \frac{G_3 D_3}{N} \quad \left\{ \begin{array}{l} f_3 = 0.0014 + 0.125 \left( \frac{G_3 \cdot 0.1238}{10^5} \right)^{-0.32} \quad \text{Ec. 7} \end{array} \right.$$

$$\text{Ec. 1} \quad G_1 = G_2 + G_3 \rightarrow G_1 = 2G_2$$

$$\text{Ec. 2} \quad 2013029^2 - P_1^2 = \frac{4.8314 \cdot 293}{22} f_1 G_1^2 \frac{100000}{0.1238}$$

$$\text{Ec. 3} \quad f_1 = 0.0014 + 0.125 \left( \frac{G_1 \cdot 0.1238}{10^5} \right)^{-0.32}$$

$$\text{Ec. 4} \quad P_1^2 - 200000^2 = \frac{4.8314 \cdot 293}{22} f_2 G_2^2 \frac{100000}{0.1238}$$

$$\text{Ec. 5} \quad f_2 = 0.0014 + 0.125 \left( \frac{G_2 \cdot 0.1238}{10^5} \right)^{-0.32}$$

$$\text{Ec. 6} \quad P_1^2 - 200000^2 = \frac{4.8314 \cdot 293}{22} f_3 G_3^2 \frac{100000}{0.1238}$$

$$\text{Ec. 7} \quad f_3 = 0.0014 + 0.125 \left( \frac{G_3 \cdot 0.1238}{10^5} \right)^{-0.32}$$

$$\text{Ec. 4} = \text{Ec. 6}$$

$$\text{Ec. 5} = \text{Ec. 7}$$

$$G_2 = G_3$$

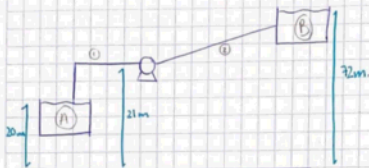
• Proceso iterativo.



$G_1$	$f_1 \cdot 10^3$	$P_1$	$G_2$	$G \cdot 10^3$	$P$
30	2.9605	1436136	25	3.3430	959608
66.73	2.9226	959608	33.36	3.1761	959608

$$G_1 = \frac{W_1}{S_1} \rightarrow W_1 = G_1 \cdot S_1 = 66.73 \cdot \frac{\pi}{4} \cdot 0.1238^2 \rightarrow W_1 = 1.65968 \text{ kg/s} \quad (a)$$

$$W_2 = G_2 \cdot S_2 = 33.36 \cdot \frac{\pi}{4} \cdot 0.1238^2 \rightarrow W_2 = 0.8283 \text{ kg/s} \quad (b)$$



Tubería

$$\begin{cases} ① & \begin{cases} D_1 = 0,8 \text{ m} \\ L_1 = 14 \text{ m} \end{cases} & f_1 = 0,02 \\ ② & \begin{cases} D_2 = 0,25 \text{ m} \\ L_2 = 95 \text{ m} \end{cases} & f_2 = 0,02 \end{cases}$$

$$\frac{P_1}{\gamma} = 0,238 \text{ m} @ 20^\circ \text{C}$$

$$\frac{P_0}{\gamma} = 10,33 \text{ m}$$

$$\gamma = 9810 \text{ N/m}^3$$

$$\hookrightarrow P_A = 10,33 \rightarrow P_A = 101234 \text{ Pa}$$

$$P_A = 101234 \text{ Pa}$$

$$P_A = 101234 \text{ Pa}$$

$$H(m) = 60 - 5208 Q^2$$

$$CNPA_f (m) = 5 - 600 Q + 30208 Q^2 \quad (Q \text{ en m}^3/\text{s})$$

$$\eta = 30 Q - 300 Q^2$$

(a) Caudal

Bernoulli A  $\rightarrow$  B

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

Supuestos

$$V_A = V_B \quad \rightarrow \text{se pasan a unidades métricas (m)}$$

$$(z_B - z_A) + \frac{P_B - P_A}{\gamma} + \frac{\sum F}{\gamma} = \frac{W}{\gamma} \quad \rightarrow \quad z_B - z_A + \frac{\sum F}{\gamma} = \frac{W}{\gamma} \quad \rightarrow \quad \frac{\sum F}{\gamma} = \frac{W}{\gamma} - (z_B - z_A)$$

$$(32 - 21) + \frac{2 \cdot 0,02 \cdot V^2 \cdot 14}{9,8 \cdot 0,08} + \frac{2 \cdot 0,02 \cdot V^2 \cdot 95}{9,8 \cdot 0,25} = \frac{101234 - 101234}{9,8 \cdot 1000} = 0 - 5208 Q^2$$

$$② \quad m_1 = m_2 \rightarrow m = Q \cdot \rho \rightarrow \rho = \text{cte} \rightarrow Q_1 = Q_2 = Q$$

$$Q = V \cdot S \rightarrow V = \frac{Q}{S}$$

$$52 \cdot \frac{2 \cdot 0,02 \cdot \left[ \frac{Q}{9,8 \cdot 0,08} \right]^2 \cdot 14}{9,8 \cdot 0,08} + \frac{2 \cdot 0,02 \cdot \left[ \frac{Q}{9,8 \cdot 0,25} \right]^2 \cdot 95}{9,8 \cdot 0,25} = \frac{101234 - 101234}{9,8 \cdot 1000}$$

$$60 - 5208 Q^2$$

$$Q = 1,41 \cdot 10^{-2} \text{ m}^3/\text{s}$$