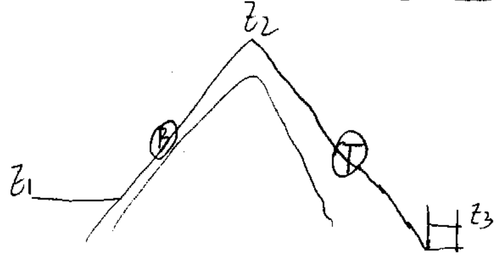
PAUTA P2



a) $B_1 = B_2 + \lambda_f + \lambda_s - \Delta B$

$$z_1 = z_2 + \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + \frac{f_1 L_1}{D}\frac{v^2}{2g} + (K_s+K_c)\frac{v^2}{2g} - \Delta B \quad (0{,}5)$$

El diámetro es el mismo $\Rightarrow V_1 = V_2 = V_3 = V$

$Q = Av \Rightarrow Q = \frac{\pi d^2}{4} v \Rightarrow v^2 = \frac{16Q^2}{(\pi d^2)^2}$ Longitud tramo 1: $L_1 = (z_2 - z_1)\sqrt{2}$

$$\Rightarrow z_1 - z_2 - \frac{P_2}{\gamma} + \Delta B = \frac{v^2}{2g}\left(1 + \frac{f_1(z_2-z_1)\sqrt{2}}{d} + K_s + K_c\right) \Leftrightarrow \frac{\overset{8}{\cancel{16}}\,Q^2}{\pi^2 d^4\, \cancel{2}g}\left(1 + \frac{f_1(z_2-z_1)\sqrt{2}}{d} + K_s + K_c\right) = z_1 - z_2 - \frac{P_2}{\gamma} + \Delta B$$

$$\Rightarrow Q = \pi d^2 \sqrt{\frac{(z_1 - z_2 - P_2/\gamma + \Delta B)g}{8\left(1 + \frac{f_1(z_2-z_1)\sqrt{2}}{d} + K_s + K_c\right)}} \quad (1{,}0) \quad = \pi \cdot 0{,}5^2 \sqrt{\frac{(1.000 - 1.050 - 1 + 60)9{,}8}{8\left(1 + \frac{0{,}017(1.050-1.000)\sqrt{2}}{0{,}5} + 0{,}5 + 0{,}25\right)}} = 1{,}28\,[m^3/s] \quad (0{,}5)$$

b) $B_1 = B_3 + \lambda_f + \lambda_s - \Delta B + \Delta T \Leftrightarrow z_1 = z_3 + \left[\frac{f_1(z_2-z_1)\sqrt{2}}{d} + \frac{f_2(z_2-z_3)\sqrt{2}}{d} + (K_s+K_c+K_e)\right]\frac{v^2}{2g} - \Delta B + \Delta T \quad (0{,}5)$

$$\Rightarrow \Delta T = z_1 - z_3 - \left[\frac{f_1(z_2-z_1)\sqrt{2}}{d} + \frac{f_2(z_2-z_3)\sqrt{2}}{d} + (K_s+K_e+K_c)\right]\frac{8Q^2}{g\pi^2 d^4} + \Delta B; \quad (0{,}5)$$

$$\Rightarrow \Delta T = 1.000 - 990 - \left[\frac{0{,}017(1.050-1.000)\sqrt{2}}{0{,}5} + \frac{0{,}025(1.050-990)\sqrt{2}}{0{,}5} + 0{,}5 + 1 + 0{,}25\right]\frac{8\cdot 1{,}28^2}{9{,}8\pi^2 0{,}5^4} + 60 = 51{,}8\,[m] \quad (0{,}5)$$

$P_{BOMBA} = \gamma Q \Delta B$; $P_{TURBINA} = \gamma Q \Delta T \Rightarrow \frac{P_{TURBINA}}{P_{BOMBA}} = \frac{51{,}8}{60} = 86{,}3\%$ (0,5)

c) La turbina se pone a una distancia X aguas abajo del codo. Ahí se cumple $\frac{P_x}{\gamma} = 50\,[m]$

$$B_1 = B_x + \lambda_f + \lambda_s - \Delta B \Leftrightarrow z_1 = z_x + \frac{P_x}{\gamma} + \left[\frac{f_1(z_2-z_1)\sqrt{2}}{d} + \frac{f_2 X}{d} + (K_s+K_c)\right]\frac{v^2}{2g} - \Delta B \; ; \; z_x = z_2 - \frac{X\sqrt{2}}{2} \quad (0{,}5)$$

$$\Rightarrow z_1 - z_2 - \frac{P_x}{\gamma} - \left[\frac{f_1(z_2-z_1)\sqrt{2}}{d} + K_s + K_c\right]\frac{v^2}{2g} + \Delta B = X\left(\frac{f_2}{d}\frac{v^2}{2g} - \frac{\sqrt{2}}{2}\right) \quad (1{,}0)$$

$$\Rightarrow X = \frac{z_1 - z_2 - P_x/\gamma - \left[\frac{f_1(z_2-z_1)}{d} + K_s + K_c\right]\frac{v^2}{2g} + \Delta B}{\frac{f_2}{d}\frac{v^2}{2g} - \frac{\sqrt{2}}{2}} \; ; \; v = \frac{Q}{A} = \frac{Q}{\frac{\pi d^2}{4}} = \frac{4Q}{\pi d^2} = \frac{4\cdot 1{,}28}{\pi \cdot 0{,}5^2} = 6{,}52$$

$$\Rightarrow X = \frac{1000 - 1.050 - 50 - \left[\frac{0{,}017(1.050-1.000)\sqrt{2}}{0{,}5} + 0{,}5 + 0{,}25\right]\cdot\frac{6{,}52^2}{2\cdot 9{,}8} + 60}{\frac{0{,}025}{0{,}5}\cdot\frac{6{,}52^2}{2\cdot 9{,}8} - \frac{\sqrt{2}}{2}} = 78{,}24\,[m] \quad (0{,}5)$$