Pauta Control #3, P

a) i) $Q = \frac{V}{t} = \frac{1512\ m^3}{8\ hrs} = 189\ [m^3/h] = 0{,}0525\ [m^3/s] = 52{,}5\ [lt/s]$

ii) Aplicando Bernoulli entre el lago y la salida:

$$B_L = B_S + \sum \Delta_S + \Delta_f - \Delta B_{bomba} \qquad B_L = Z_L \qquad B_S = Z_S + v^2/2g$$

$$Z_L = \left[Z_S + \frac{v^2}{2g}\right] + (k_e + k_c)\frac{v^2}{2g} + \frac{f L_T}{D}\frac{v^2}{2g} - \Delta B_{bomba} \qquad L_T = L_1 + L_2$$

$$\Rightarrow \Delta B_{bomba} = Z_S - Z_L + \frac{v^2}{2g}\left(1 + k_e + k_c + \frac{f L_T}{D}\right)$$

$Q = 0{,}0525\ m^3/s$, $D = 0{,}2\ m$, $v = \frac{4Q}{\pi D^2} = 1{,}671\ [m/s]$

$Re = \frac{v \cdot D}{\nu} = 3{,}34 \times 10^5$ } transición lisa-rugosa

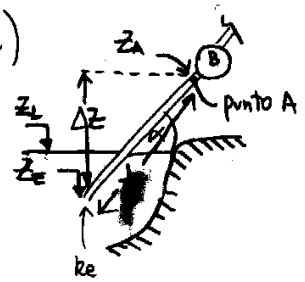
$\varepsilon/D = 0{,}0002$ } $f = 0{,}0161$

$\Rightarrow \Delta B_{bomba} = 15{,}40\ m$

$Pot(hidraulica) = \gamma Q \Delta B = 7926\ [W]$

$Pot\ efectiva = \frac{Pot\ Hid}{\eta} = 8806\ [W]$ $\qquad Energía = Pot \cdot tiempo = 70{,}45\ [kW \cdot h]$

iii)



Bernoulli entre el lago y A:

$$B_L = B_A + k_e \frac{v^2}{2g} + \frac{f \cdot x}{D}\frac{v^2}{2g} \qquad B_L = Z_L \qquad B_A = Z_A + \frac{v^2}{2g} + \frac{p_A}{\gamma}$$

$L_1 \cdot \operatorname{sen}\alpha = Z_S - Z_E \Rightarrow \alpha = 3{,}44°$

$x \cdot \operatorname{sen}\alpha = \Delta Z \Rightarrow Z_A - Z_E + \Delta Z = Z_E + x \operatorname{sen}\alpha$

$$\Rightarrow Z_L = (Z_E + x \operatorname{sen}\alpha) + \frac{v^2}{2g} + \frac{p_A}{\gamma} + k_e\frac{v^2}{2g} + f\frac{x}{D}\frac{v^2}{2g}$$

($\frac{p_A}{\gamma} = -5\ m$)

$$\Rightarrow Z_L - Z_E - \frac{p_A}{\gamma} - \frac{v^2}{2g}(1 + k_e) = x\left(\operatorname{sen}\alpha + \frac{f}{D}\frac{v^2}{2g}\right) \Rightarrow x = 95\ m.$$

b) i) $Q = \frac{V}{t} = \frac{1512\ m^3}{24\ hrs} = 63\ [m^3/h] = 0{,}0175\ [m^3/s] = 17{,}5\ [lt/s]$

ii) Energía eléctrica = 70450 [W·h]

$$\text{Potencia} = \frac{\text{Energía}}{\text{Tiempo}} = 2935\ [W]$$

$$\text{Pot Hid} = \eta\ \text{Pot Elec} = 2642\ [W]$$

iii) Al igual que antes, al aplicar Bernoulli entre el lago y la salida:

$$B_L = B_S + \sum \Delta_S + \Delta_f - \Delta B_{bomba} \qquad B_L = Z_L \qquad B_S = Z_S + \frac{v^2}{2g}$$

$$Z_L = Z_S + \frac{v^2}{2g} + (k_e + k_c)\frac{v^2}{2g} + \frac{f \cdot L}{D}\frac{v^2}{2g} - \Delta B_{bomba} \quad (*)$$

$$\Delta B_{bomba} = \frac{Pot}{\gamma Q} = 15{,}40\ m$$

Como no se conoce D, no se conoce v ni Re ni ε/D $\Rightarrow$ no se conoce f tampoco

Iteración 1: suponiendo $D = 0{,}15\ m$

$Q = 0{,}0175\ m^3/s \Rightarrow v = 0{,}990\ m/s$

$\Rightarrow Re = 1{,}49 \times 10^5$, $\varepsilon/D = 0{,}000267$ } transición liso-rugosa, $f = 0{,}01821$

con todo esto, en (*): $Z_L = 417{,}42\ m \neq 420$

Iteración 2: suponiendo $D = 0{,}12\ m$

$\Rightarrow v = 1{,}547\ m/s \Rightarrow Re = 1{,}86 \times 10^5$, $\varepsilon/D = 0{,}000333$ } transición liso-rugosa, $f = 0{,}01807$

$(*) \Rightarrow Z_L = 423{,}09$

Iteración	D (m)	v (m/s)	f	Z_L	
3	0,135	1,223	0,01812	419,34	
4	0,132	1,279	0,01811	419,90	
5	**0,1315**	1,289	0,01810	420,00	✓