Sistemas Hidráulicos:

Variables dependientes:

$$Q,\ caudal\ \left(\frac{m^3}{s}\right)$$

$$V,\ volumen\ (m^3)$$

$$h, altura\ (m)$$

$$p,\ presión\ \left(\frac{N}{m^2} = Pa\right)$$

Elementos pasivos (parámetros):

$$Q_C = C_f \frac{dP_{1r}}{dt}, Q_c = C_f \frac{dh_{1r}}{dt}, C_f \longrightarrow capacitancia\ hidráulica$$

$$P_{12} = I\frac{dQ_I}{dt}, h_{12} = I\frac{dQ_I}{dt}, I \longrightarrow Inertancia\ hidráulica$$

$$P_{12} = R_f Q_R,\ h_{12} = R_f Q_R, R_f \longrightarrow Resistencia\ hidráulica$$

Leyes:

Ley de Continuidad:

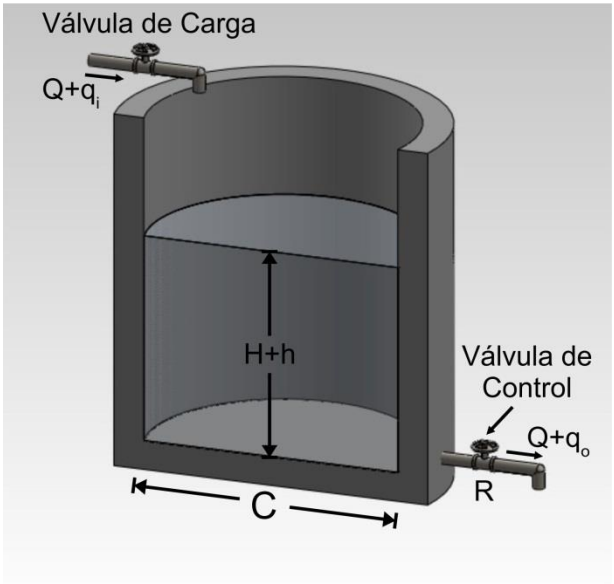
$$Q_A + Q_B + Q_C = 0$$

Ley de Compatibilidad:

$$P_{r1} + P_{12} + P_{2r} = 0$$

Ejemplos

Ejemplo 1: Llenado de un tanque



$$\boldsymbol{H_s(s) = \frac{Q_o(s)}{Q_i(s)} = ?}$$

$$q_i = C\frac{dh}{dt} + q_o$$

$$q_o = \frac{h}{R} \longrightarrow h = q_o R \longrightarrow \frac{dh}{dt} = R\frac{dq_o}{dt}$$

$$q_i = CR\frac{dq_o}{dt} + q_o$$

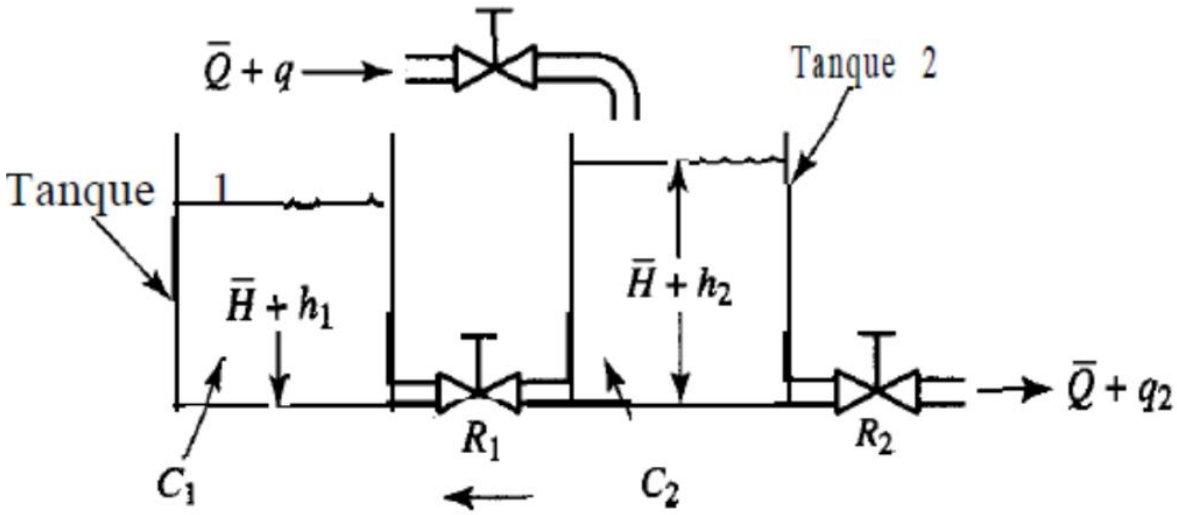
$$Q_i(s) = Q_o(s)(1 + RCs)$$

$$\boxed{\boldsymbol{\frac{Q_o(s)}{Q_i(s)} = \frac{1}{RCs + 1}}}$$

$$\frac{H(s)}{Q_i(s)} = \frac{Q_o(s)R}{Q_i(s)} = \frac{R}{RCs + 1}$$

$$\boxed{\boldsymbol{\frac{H(s)}{Q_i(s)} = \frac{R}{RCs + 1}}}$$

Ejemplo 2: tanques interconectados (Ejercicio 2b del taller de sistemas hidráulicos)



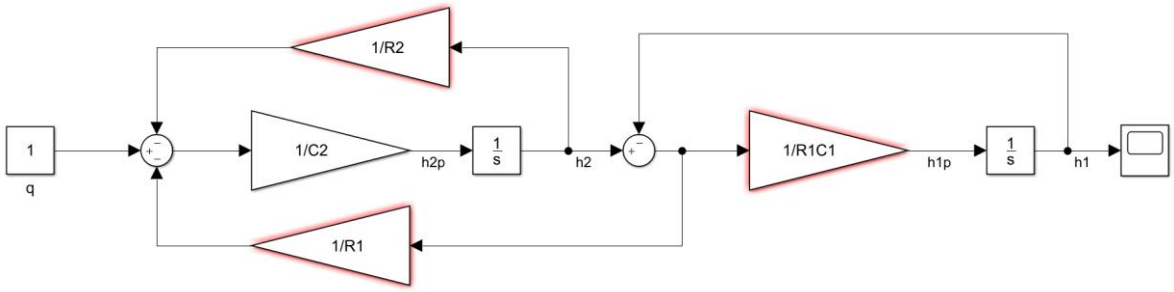
$$\boldsymbol{H(s) = \frac{H_1(s)}{Q(s)} = ?}$$

$$q = C_2\frac{dh_2}{dt} + q_2 + q_{21} \quad Tanque\ 2$$

$$q_{21} = C_1\frac{dh_1}{dt} = \frac{h_2 - h_1}{R_1} \quad Tanque\ 1$$

$$q_2 = \frac{h_2}{R_2}$$

DB:



Simplificando el DB

$$\boldsymbol{H(s) = \frac{H_1(s)}{Q(s)} = \frac{R_2}{R_1R_2C_1C_2s^2 + (C_1R_1 + C_1R_2 + R_2C_2)s + 1}}$$

VE

$$q = C_2\frac{dh_2}{dt} + \frac{h_2}{R_2} + \frac{h_2 - h_1}{R_1}$$

$$C_1\frac{dh_1}{dt} = \frac{h_2 - h_1}{R_1}$$

$$\boxed{\begin{bmatrix}\dot{h}_1 \\ \dot{h}_2\end{bmatrix} = \begin{pmatrix} -\frac{1}{R_1C_1} & \frac{1}{R_1C_1} \\ \frac{1}{R_1C_2} & -\frac{1}{C_2}\left(\frac{1}{R_2} + \frac{1}{R_1}\right)\end{pmatrix}\begin{bmatrix}h_1 \\ h_2\end{bmatrix} + \begin{pmatrix}0 \\ \frac{1}{C_2}\end{pmatrix}[q]}$$

$$\boxed{y = x_1}$$

$$\boxed{y = \begin{pmatrix}1 & 0\end{pmatrix}\begin{bmatrix}h_1 \\ h_2\end{bmatrix}}$$