LIQUID-LEVEL PROCESS WITH CONSTANT-FLOW OUTLET

Ecuacion de balance

$$q_i(t) - \bar{q}_o = A\frac{d[h(t)]}{dt}$$

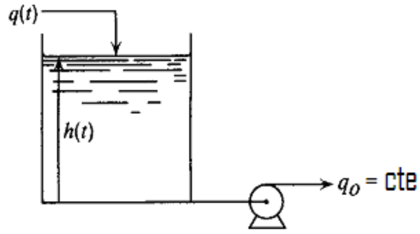
At steady state:

$$\bar{q}_i = \bar{q}_o$$

$$\bar{q}_i - \bar{q}_o = A\frac{d\bar{h}}{dt} = 0$$

Restando a la primera ec:

$$[q_i(t) - \bar{q}_o] - (\bar{q}_i - \bar{q}_o) = \left[A\frac{d[h(t)]}{dt}\right] - \left[A\frac{d[\bar{h}]}{dt}\right]$$



$$\bar{q}_o = cte = q_o$$

$$[q_i(t) - \bar{q}_i] = A\frac{d[h(t) - \bar{h}]}{dt}$$

Definiendo las variables de desviacion:

$$Q = q_i(t) - \bar{q}_i$$

$$H = h(t) - \bar{h}$$

$$[Q] = A\frac{d[H]}{dt}$$

Applying laplace transform:

$$Q(s) = AsH(s)$$

$$\frac{1}{As} = \frac{H(s)}{Q(s)}$$

$$\boxed{\frac{H(s)}{Q(s)} = \frac{1}{A}\frac{1}{s}}$$

Solution is:

$$H(t) = \frac{1}{A}\int_0^t Q(t)\,dt$$

$$h(t) - h_s = \frac{1}{A}\int_0^t Q(t)\,dt \quad h(t) - h_s = \frac{1}{A}\int_0^t [q_i(t) - q_s]\,dt$$

Si $q_i(t) = E_o u(t)$

$$h(t) = h_s + \frac{1}{A}\int_0^t (E_o - q_s)\,dt$$

$$h(t) = h_s + \frac{E_o - q_s}{A}[t]_0^t$$

$$h(t) = h_s + \frac{E_o - q_s}{A}[t - 0]$$

$$\boxed{h(t) = h_s + \frac{E_o - q_s}{A}t}$$

Analizando:

$$E_o = q_s \rightarrow h(t) = h_s$$

$$E_o >> q_s \rightarrow h(t) = h_s + \frac{E_o}{A}t$$

Crece indefinidamente

$$q_o >> E_o \rightarrow h(t) = h_s - \frac{q_s}{A}t$$

En que momento será cero ¿?

$$h_s - \frac{q_s}{A}t = 0$$

$$t = A\frac{h_s}{q_s}\left[m^2\frac{m}{\left(\frac{m^3}{s}\right)}\right]$$

$$t = A\frac{h_s}{q_s}[s]$$

Step response is a ramp function that grows without limit. Such a system that grows without limit for a sustained change in input is said to have nonregulation. Systems that have a limited change in output for a sustained change in input are said to have regulation. An example of a system having regulation is the step response of a first-order system.

$$\boxed{\frac{H(s)}{Q(s)} = \left(\frac{R}{ARs+1}\right)}$$

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