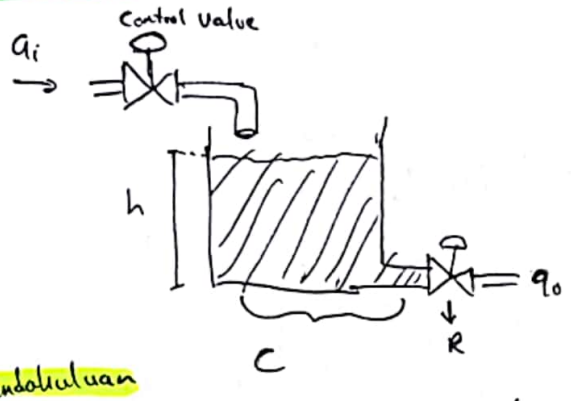
# Modeling of Liquid Level

## ✱ 1 Tank




$q_i$ = debit / laju aliran masuk ($m^3/s$)

$q_o$ = " / " " keluar ($m^3/s$)

h = tinggi air (m)

C = kapasitansi ($m^2$)

R = Hambatan

**Pendahuluan**

$Q = \frac{V}{t} = Av$ ; V = volume ($m^3$) v = kecepatan fluida (m/s)

A = Luar penampang ($m^2$)

$$C = \frac{\text{Perubahan jumlah liquid } (m^3)}{\text{Perubahan ketinggian } (m)}$$

$$R = \frac{\text{Perubahan pada perbedaan level 2 tank } (m)}{\text{Perubahan laju aliran } m^3/s} = \frac{h}{q_o}$$

**Hk. Kekekalan**

perubahan massa di dalam tangki = rate of mass in − rate of mass out

$$\frac{d(\text{massa})}{dt} = \frac{d(\rho \cdot \text{Volume tanki})}{dt} = \rho q_i - \rho q_i$$

Asumsi V tanki = C * h (linier)

V tanki = $C \cdot \sqrt{h}$ (tdk linier)

$\rho = \frac{m}{V}$ ↑ massa jenis / kepadatan / density

$$\frac{d(\rho . c . h)}{dt} = \rho . c . \frac{dh}{dt} = \rho q_i - \rho q_o$$

$$c \cdot \frac{dh}{dt} = q_i - q_o \quad ; \text{ dimana } R = \frac{h}{q_o} \rightarrow q_o = \frac{h}{R} \rightarrow h = Rq_o$$

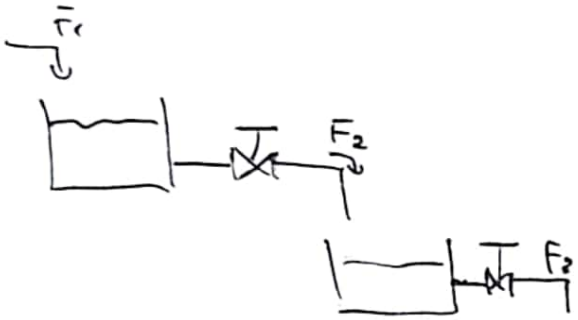
$$c \cdot \frac{dh}{dt} = q_i - \frac{h}{R}$$

$$\frac{dh}{dt} = \frac{q_i}{c} - \frac{h}{Rc}$$

atau:

$$C \cdot R \frac{dq_o}{dt} = q_i - q_o$$

$$\frac{dq_o}{dt} = \frac{q_i - q_o}{RC}$$




$$V = A \cdot h$$

$$\frac{d}{dt}(A_1 h_1) = F_1 - F_2$$

$$\frac{d}{dt}(A_2 h_2) = F_2 - F_3$$

$F_2 = \frac{h_1}{K_1}$ katakanlah liquid

$F_3 = \frac{h_2}{K_2}$

$$\frac{d(h_1)}{dt} = -\frac{h_1}{K_1 \cdot A_1} + \frac{F_1}{A_1}$$

$$\vdots$$

$$\frac{d}{dt}\begin{bmatrix} h_1(t) \\ h_2(t) \end{bmatrix} = \underbrace{\begin{bmatrix} -\frac{1}{A_1 \cdot K_1} & 0 \\ \frac{1}{A_2 K_1} & -\frac{1}{A_2 K_2} \end{bmatrix}}_{A} \begin{bmatrix} h_1 \\ h_2 \end{bmatrix} + \underbrace{\begin{bmatrix} \frac{1}{A_1} \\ 0 \end{bmatrix}}_{B} F_1$$

$$\begin{bmatrix} F_2 \\ F_3 \end{bmatrix} = \underbrace{\begin{bmatrix} \frac{1}{K_1} & 0 \\ 0 & \frac{1}{K_2} \end{bmatrix}}_{C} \begin{bmatrix} h_1 \\ h_2 \end{bmatrix} + \underbrace{\begin{bmatrix} 0 \\ 0 \end{bmatrix}}_{D} F_1$$

Ruang keadaan

$$\dot{h} = A \cdot h + B \cdot F_1$$

$\dot{h}$: output keluaran; $B \cdot F_1$: input aliran

$$y(t) = Ch + DF_1$$

$y(t)$: output aliran yg diinginkan; $DF_1$: input aliran