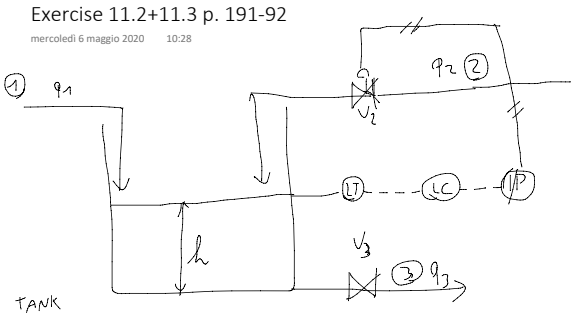
Exercise 11.2+11.3 p. 191-92

mercoledì 6 maggio 2020 10:28



$d = 1\,m$

VALVOLA 2

V_2 : equiv% $f(l) = 3\,0^{l-1}$ AIR-TO-OPEN

INLET: 3-15 psig , NO DINAMICA ATTUATORE ⇒ GUADAGNO PURO

$f(l) = 1 \Rightarrow q_{max} = 0{,}2\ m^3/min$

NOMINAL

OUTLET: $0-0{,}2\ \frac{m^3}{min}$

$f(l) = 0{,}5 \Rightarrow q_{nom}$

VALVOLA 3

linear resistance $R = 6{,}37\ \frac{min}{m^2}$

CONTROLLORE : P only (K_c)

INLET: 0-100 % TO

OUTLET: 0-100 % CO

SENSOR/TRANS

SPAN 0,5 m

OUTLET: 0-100 % TO

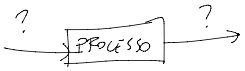
TRANSDUCER I/P

INLET : 0-100 % CO

OUTLET : 3-15 psig

CLTF > UNIT STEP CHANGE IN SET-POINT

$K_c = 1 ; 2 ; 5$?



① TF IN ANELLO APERTO

$$q_3 = \frac{\text{DRIVING FORCE}}{\text{RESISTANCE}} = \frac{h}{R} = \frac{h}{6{,}37} = 0{,}157\,\frac{h\,[m]}{\left[\frac{min}{m^2}\right]} \Rightarrow \left[\frac{m^3}{min}\right]$$

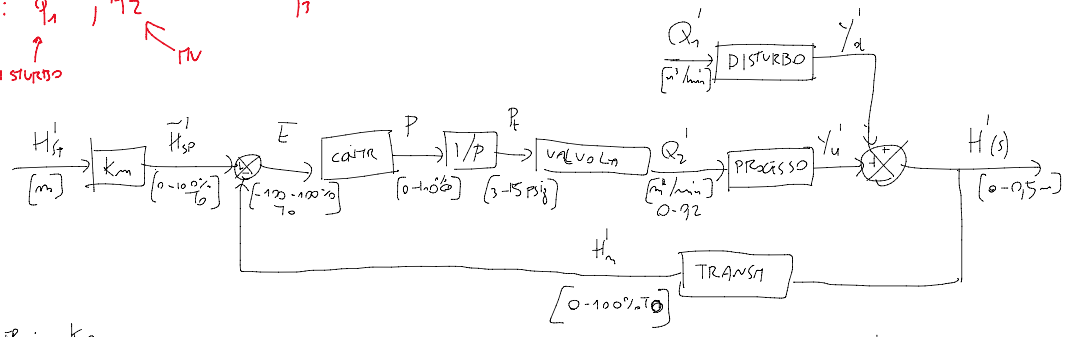
OUTPUT : h ~~q_3~~

INPUT : q_1 , q_2

q_1 → DISTURBO

q_2 → MV

q_3 NON È NÈ INPUT NÈ OUTPUT



TRANSMITTER : K_m

CONTR : K_c

I/P : K_{IP}

VALVE : K_v'

$$CLTF_{SP} = \frac{Y(s)}{Y_{sp}(s)} = \frac{H'(s)}{H'_{sp}(s)} = \frac{\text{FORWARD}}{1 + CL} = \frac{K_m K_c K_{IP} K_v' G_P}{1 + K_m K_c K_{IP} K_v' G_P}$$

G_P ?

$$\frac{dM}{dt} = \rho q_1 + \rho q_2 - \rho q_3 \qquad M = \rho V = \rho h A$$

$$A\,dh = q_1 + q_2 - q_3 \Rightarrow A\frac{dh}{dt} = q_1 + q_2 - 0{,}157\,h$$

$$\frac{d(\rho h A)}{dt} = \rho q_1 + \rho q_2 - \rho q_3 \qquad A\frac{dh}{dt} = q_1 + q_2 - q_3 \Rightarrow A\frac{dh}{dt} = q_1 + q_2 - 0{,}137\,h$$

$$\tau_p = RA = 6{,}37 \cdot \pi \frac{d^2}{4} = 6{,}37 \cdot 9{,}7854 = 5{,}0\ min$$

$$R = k_p$$

[....] $$H'(s) = \frac{R}{(RA)s+1} \cdot Q_1'(s) + \frac{R}{(RA)s+1} Q_2'(s)$$

$$\boxed{H'(s) = \frac{k_p}{\tau_p s + 1} Q_1'(s) + \frac{k_p}{\tau_p s + 1} Q_2'(s)}$$

G_d G_p

TRASMETTITORE

$$\xrightarrow[0-0{,}5]{(m)} \boxed{K_m} \xrightarrow[0-100]{[\%\ TO]} \qquad K_m = \frac{100-0\ [\%\ TO]}{0{,}5-0\ [m]} = 200\ \frac{\%\ TO}{m}$$

CONTROLLORE

$$\xrightarrow[(-100-100)]{[\%\ TO]} \boxed{K_c} \xrightarrow[(0-100)]{[\%\ CO]} \qquad K_c = 1;\ 2;\ 5\ \frac{\%\ CO}{\%\ TO}$$

I/P TRANSDUCER + VALVE

$$\xrightarrow[(0-100)]{[\%\ CO]} \boxed{K_{IP}} \xrightarrow[(3-15)]{[psig]} \boxed{G_v'} \xrightarrow[0-0{,}2]{[m^3/min]} \qquad G_v' = K_v' \qquad K_{IP} = \frac{15-3\ [psi]}{100-0\ [\%\ CO]} = 0{,}12\ \frac{psi}{\%\ CO}$$

$$\xrightarrow[0-100]{\%\ CO} \boxed{G_v} \xrightarrow[0-0{,}2]{m^3/min} \qquad G_v = K_{IP} \cdot G_v'$$

$$\xrightarrow[3-15]{(psig)} \boxed{\frac{K_l}{\tau_v s+1}} \xrightarrow[0-1]{f\ [-]} \boxed{K_q} \xrightarrow[0-0{,}2]{[m^3/min]} \qquad G_v' = \frac{K_l}{\tau_v s+1} \cdot K_q \approx K_l \cdot K_q$$

$$K_l \to \frac{\partial l}{\partial P_t} \approx \frac{\Delta l}{\Delta P_t} = \frac{1-0\ [-]}{15-3\ [psi]} = 8{,}33 \cdot 10^{-2}\ psi^{-1}$$

$$K_v = K_{IP} \cdot K_l \cdot K_q = 0{,}12 \cdot 8{,}33 \cdot 10^{-2} \cdot 0{,}2 \cdot 3{,}401 \cdot 30^{l-1} = 6{,}800 \cdot 10^{-3} \cdot 30^{l-1}\ \frac{m^3/min}{\%\ CO}$$

$$l_{max} = 0{,}5 \qquad K_{v_{min}} = 1{,}24 \cdot 10^{-3}\ \frac{m^3/min}{\%\ CO}$$

$$K_q = \frac{\partial q}{\partial l} = \frac{\partial q}{\partial f(l)} \cdot \frac{\partial f(l)}{\partial l} \approx \frac{\Delta q}{\Delta f(l)} \cdot \frac{\partial f(l)}{\partial l} \qquad f(l) = 30^{l-1}$$

$$\frac{\Delta q}{\Delta f} = \frac{q_{max} - q_{min}}{f_{max} - f_{min}} = q_{max} = 0{,}2\ \frac{m^3}{min} \qquad q_{min} \to 0,\ f_{max} \to 1,\ f_{min} \to 0$$

$$\frac{\partial f}{\partial l} = \ln 30 \cdot 30^{l-1} \Leftarrow$$

$$K_q = q_{max} \cdot \ln 30 \cdot 30^{l-1} \Leftarrow$$

CLTF

$$K_1 = \frac{K_{OL}}{1+K_{OL}}$$

$$K_{OL} = 1{,}582\ K_c \qquad \frac{H'(s)}{H'_{SP}(s)} = \frac{K_1}{\tau_1 s + 1}$$

$$K_1 = \frac{1{,}582\ K_c}{1+1{,}582\ K_c}\ [-]\ ; \qquad \tau_1 = \frac{5{,}0}{1+1{,}582\ K_c}\ [min]$$

K_c	K_1	τ_1 [min]
1	0,612	1,94
2	0,76	1,20
5	0,888	0,56

$K_c \uparrow \Rightarrow \tau_1 ? \Rightarrow \tau_1 \downarrow$

$K_c \uparrow \Rightarrow K_1 ? \Rightarrow K_1 \to 1$

$\frac{1}{s}$ SUL SP

$$h'(t) = K_1 M \left(1 - e^{-\frac{t}{\tau_1}}\right)$$