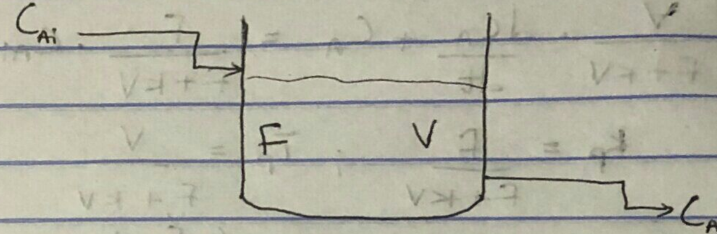
Name: ASIWAJU, Oluwatodimu Adekunle

Matric No: 14/ENG01/002

CHE 532: Process Dynamics and Control II

For a first order rxn



$$A \xrightarrow{k} B$$

$$-r_A = kC_A$$

$$\therefore r_A = -kC_A$$

Taking overall mass balance

ACCUMULATION = IN + GENERATION − OUT

$$\frac{dm}{dt} = \dot{m}_{in} + r_A V - \dot{m}_{out}$$

We know $\dot{m} = FC_A$

and $m = C_A V$

$$\frac{dm}{dt} = FC_{Ai} - FC_A + r_A V$$

$$\frac{dm}{dt} = FC_{Ai} - FC_A - kC_A V$$

$$\frac{d(C_A V)}{dt} = FC_{Ai} - FC_A - kC_A V$$

Constant volume

$$V\frac{dC_A}{dt} = FC_{Ai} - FC_A - kC_A V$$

Divide through by F

$$\frac{V}{F}\frac{dC_A}{dt} = C_{Ai} - C_A - \frac{kC_A V}{F}$$

$$\frac{V}{F}\frac{dC_A}{dt} = C_{Ai} - \frac{kC_A V}{F} - C_A$$

$$\frac{V}{F}\frac{dC_A}{dt} = C_{Ai} + \left(-\frac{kC_A V - FC_A}{F}\right)$$

$$\frac{V}{F}\frac{dC_A}{dt} + \frac{FC_A + kC_A V}{F} = C_{Ai}$$

$$\frac{V}{F}\frac{dC_A}{dt} + C_A\left(\frac{F+kV}{F}\right) = C_{Ai}$$

Divide through by $\left(\frac{F+kV}{F}\right)$

standard form

$$\frac{V}{F+kV}\cdot\frac{dC_A}{dt} + C_A = \frac{F}{F+kV}\cdot C_{Ai}$$

$$k_p = \frac{f}{f+kV} \quad ; \quad \tau_p = \frac{V}{F+kV}$$

$$G_p(s) = \frac{k_p}{\tau_p s+1} = \frac{\left(\frac{F}{F+kV}\right)}{\left(\frac{V}{F+kV}\right)s+1}$$

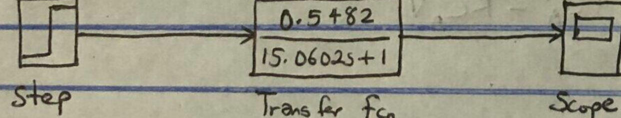
$V = 2.5\,m^3$; $f = 0.091\,m^3/min$; $k = 0.03\,min^{-1}$

$$k_p = \frac{0.091}{0.091+(0.03\times 2.5)} = \frac{0.091}{0.166} = 0.5482$$

$$\tau_p = \frac{2.5}{0.091+(0.03\times 2.5)} = \frac{2.5}{0.166} = 15.0602$$

$$G_p(s) = \frac{0.5482}{(15.0602)s+1}$$

Open loop



Closed loop