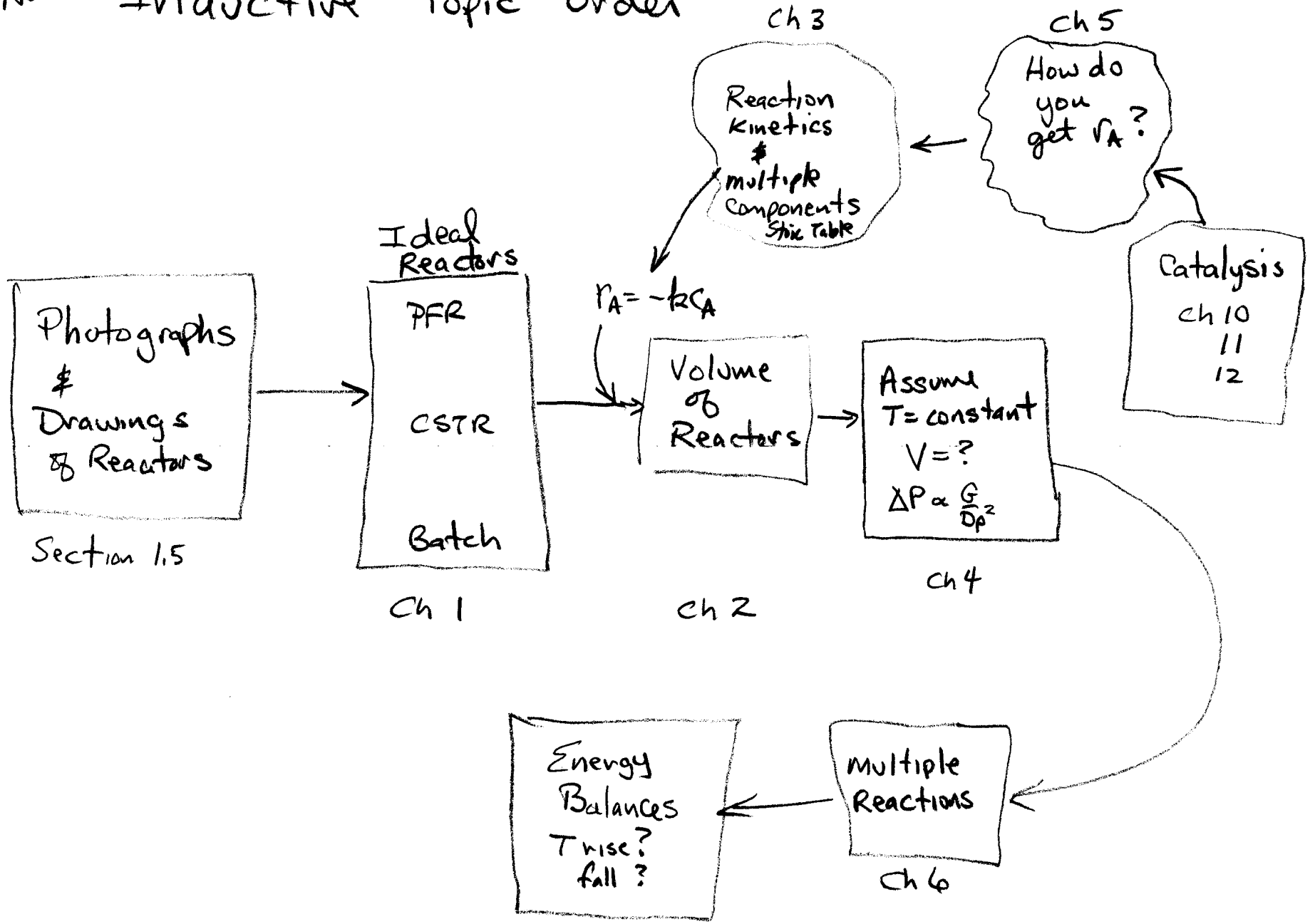
1/22/02

"Newly" Inductive Topic Order

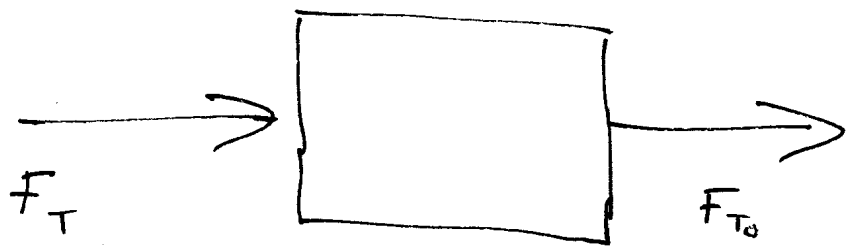


Objectives

1. Give the definition of Conversion for a flow System

2. Construct a stoichiometric table.

In CRE we use <u>moles</u>



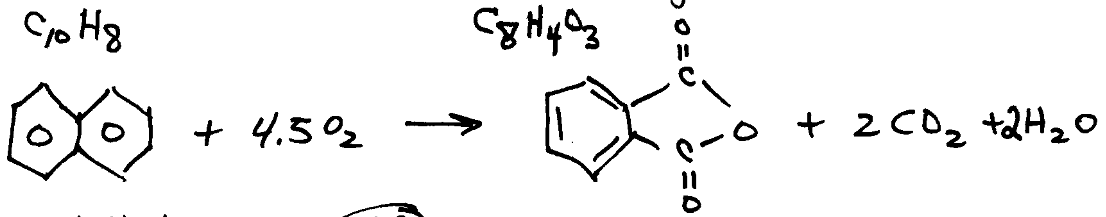
$\frac{mol}{s}$ $\frac{mol}{s}$

Help for Reactor Design Project

memo 1

See Section 3.6 in Fogler

Formation of phthalic anhydride (GAS PHASE)



Naphthalene (NA) — 5.5 (O_2) — phthalic anhydride (PAN) — (C) (W) +5

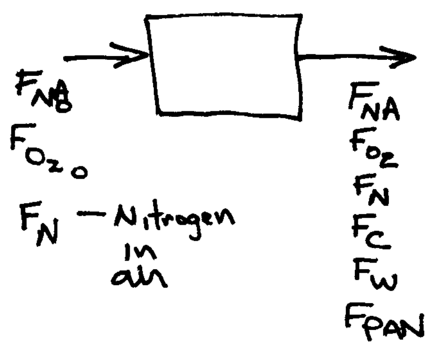
Question: what do you expect for an overall change in total # moles — +0.5 moles

Define Conversion of NA

$$X_{NA} \equiv \frac{F_{NA_0} - F_{NA}}{F_{NA_0}}$$

↑ definition

F_{NA_0} [=] $\frac{\text{mol NA fed to Reactor}}{s}$ — has units



Rearranging

$F_{NA} = F_{NA_0} - F_{NA_0} X_A$

(initial) (change)

Species	Initial	Molar change	Final
NA	F_{NA_0}	$-F_{NA_0} X_{NA}$	$F_{NA} = F_{NA_0} - F_{NA_0} X_A$
O_2	$F_{O_{2}0}$	(?) $F_{NA_0} X_{NA}$	
N	F_{N_0}	(?) $F_{NA_0} X_{NA}$	
C	0	(?) $F_{NA_0} X_{NA}$	
W	0	(?) $F_{NA_0} X_{NA}$	
PAN	0	(?) $F_{NA_0} X_{NA}$	

See Next Page

write next

How do you write F_{O_2} in terms of X_{NA}?

$F_{O_2} = F_{O_{2}0} - \frac{4.5 \text{ mol } O_2}{1 \text{ mol NA}} X_{NA} F_{NA_0}$

Species	Initial	Molar Change	Final
NA	F_{NA_0}	$-F_{NA_0}X_{NA}$	$F_{NA} = F_{NA_0} - F_{NA_0}X_{NA}$
O_2	$F_{O_{2_0}}$	$-\frac{4.5\,mol\,O_2\,\Delta}{1\,mol\,NA\,\Delta} F_{NA_0}X_{NA}$	$F_{O_2} = F_{O_{2_0}} - 4.5F_{NA_0}X_{NA}$
N	F_{N_0}	0	$F_N = F_{N_0}$
C	F_{C_0}	$+\frac{2\,mol\,CO_2\,\Delta}{1\,mol\,NA\,\Delta} F_{NA_0}X_{NA}$	$F_C = F_{C_0} + 2F_{NA_0}X_{NA}$
W	F_{W_0}	$+\frac{2\,mol\,W\,\Delta}{1\,mol\,NA\,\Delta} F_{NA_0}X_{NA}$	$F_W = F_{W_0} + F_{NA_0}X_{NA}$
PAN	F_{PAN_0}	$+\frac{1\,mol\,PAN\,\Delta}{1\,mol\,NA\,\Delta} F_{NA_0}X_{NA}$	$F_{PAN} = F_{PAN_0} + F_{NA_0}X_{NA}$

$mol\,NA_0 \frac{(mol\,NA\,\Delta)}{mol\,NA_0}$

$mol\,O_2\,\Delta$

Examine chart

Species	Initial	Molar change (This column has $F_{i_0}X_i$)	Final
		( ) $F_{NA_0}X_{NA}$	
		( ) $F_{NA_0}X_{NA}$	
		⋮	
		( ) $F_{NA_0}X_{NA}$	

Examine totals

Initial:

$$F_{T_0} = \Sigma F_{i_0} = F_{NA_0} + F_{O_{2_0}} + F_{N_0} + 0 + 0 + 0$$

what is F_{N_0}?

$0.21\ O_2$

$\sim 0.79\ N_2$

$$F_{N_0} = \frac{0.79 \text{ mol } N_2}{0.21 \text{ mol } O_2} F_{O_{2_0}}$$

Final

$$F_T = \Sigma F_i$$

$$F_T = F_{T_0} + \left[-4.5 F_{NA_0} \chi_{NA} - F_{NA_0} \chi_{NA} + 2 F_{NA_0} \chi_{NA} + F_{NA_0} \chi_{NA} + F_{NA_0} \chi_{NA} \right]$$

$$F_T = F_{T_0} + F_{NA_0} \chi_{NA} \left[\underbrace{-1 - 4.5 + 2 + 2 + 1}_{-0.5} \right] = \left(\underbrace{-5.5 + 5}_{-0.5} \right)$$

$$F_T = F_{T_0} - 0.5 F_{NA_0} \chi_A$$