

Road Map

DOF for Reacting Systems (Finish Ch. 4)

Non-Ideal Gases (Ch. 5)

Multiple Phases (Vapor-Liquid) (Ch. 6)

Exam 2

Energy Balances (Ch. 7-9)

Exam 3

Class 14

Multiple Reactions, Multiple Units

- Extent of Reaction (Review)
- Recommendations & Cautions (repeat)
- Definitions
 - Recycle
 - Purge
- Examples

Extent of Reaction

- Moles reacted for a given reaction (normalized)
- Example: Carbon Tetrachloride Production

$\text{CS}_2 + 3\text{Cl}_2$	$\rightarrow \text{S}_2\text{Cl}_2 + \text{CCl}_4$	ξ_1
$\text{CS}_2 + \text{S}_2\text{Cl}_2$	$\rightarrow 6\text{S} + \text{CCl}_4$	ξ_2
$6\text{S} + 3\text{C}$	$\rightarrow 3\text{CS}_2$	ξ_3
- Write expressions for n_{CCl_4} , n_{Cl_2} , and n_{CS_2} in terms of ξ 's

$$n_{\text{CCl}_4} = n_{\text{CCl}_4,0} + \xi_1 + \xi_2$$

$$n_{\text{Cl}_2} = n_{\text{Cl}_2,0} - 3\xi_1$$

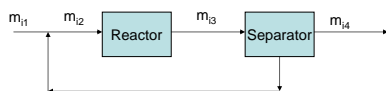
$$n_{\text{CS}_2} = n_{\text{CS}_2,0} - \xi_1 - \xi_2 + 3\xi_3$$

Cautions

- If no reactions occur in the subunit, use the DOF for non-reacting systems
- If reactions occur in the block, you must use the DOF for reacting systems

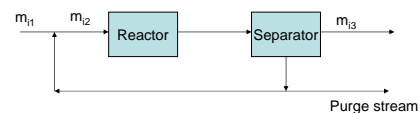
Definitions - Recycle

- Overall Conversion = $(m_{i1} - m_{i4})/m_{i1}$
- Single Pass Conversion = $(m_{i2} - m_{i3})/m_{i2}$



Definitions - Purge

- Recycle can result in buildup of unwanted species
- Purge streams are used to release a small portion of the recycle stream
- Unwanted species therefore have a path for release




Examples

- A. Multiple Species, Elements
- B. Multiple Units

Problem 4-52 (Multiple Reactions, Elements)

Ore
Basis: $m_1 = 100$ kg dissolved ore
 $x_{\text{CaF}_2} = 0.96$
 $x_{\text{SiO}_2} = 0.04$

Aq. Sulfuric Acid
 $m_2 = ?$
 $x_{\text{H}_2\text{SO}_4} = 0.93$
 $x_{\text{H}_2\text{O}} = 0.07$

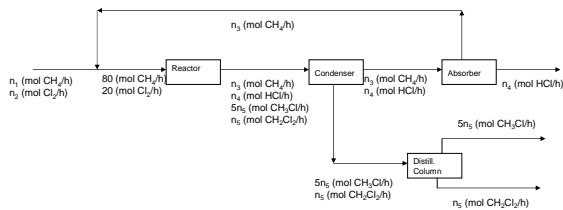


$\text{CaF}_2(\text{s}) + \text{H}_2\text{SO}_4(\text{l}) \Rightarrow \text{CaSO}_4(\text{diss}) + 2\text{HF}(\text{l})$
 $6\text{HF}(\text{l}) + \text{SiO}_2(\text{aq}) \Rightarrow \text{H}_2\text{SiF}_6(\text{s}) + 2\text{H}_2\text{O}(\text{l})$

15% excess Aq. Sulfuric Acid
100% of dissolved ore reacts

Find all unknowns, and check

DOF Practice (Problem 4-58)



Do the DOF on each subunit

Extent of Reaction

- Moles reacted for a given reaction (normalized)
- Example: Chloroform Production
 - $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{HCl} \quad \xi_1$
 - $\text{CH}_3\text{Cl} + \text{Cl}_2 \rightarrow \text{CH}_2\text{Cl}_2 + \text{HCl} \quad \xi_2$
 - $\text{CH}_2\text{Cl}_2 + \text{Cl}_2 \rightarrow \text{CHCl}_3 + \text{HCl} \quad \xi_3$
- Write expressions for $n_{\text{CH}_3\text{Cl}}$ and n_{HCl} in terms of ξ 's

$$n_{\text{CH}_3\text{Cl}} = n_{\text{CH}_3\text{Cl},0} + \xi_1 - \xi_2$$

$$n_{\text{HCl}} = n_{\text{HCl},0} + \xi_1 + \xi_2 + \xi_3$$