

CEN 205 MASS AND ENERGY BALANCES

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BALANCES ON REACTIVE PROCESSES:

Reactive processes can be analyzed by using three different approaches:

- 1. Molecular species balance**
- 2. Atomic species balance**
- 3. Extents of reaction**

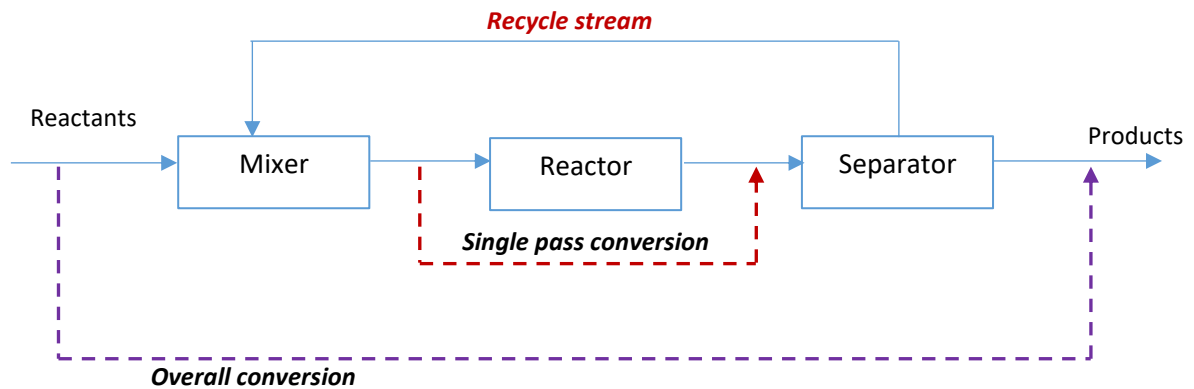
Molecular species balances are the method used for nonreactive processes as well. Generation and consumption term for each species must be added.

Atomic species balances is in a simple form $\text{input} = \text{output}$

Extent of reaction approach is convenient for equilibrium reactions.

PRODUCT SEPARATION AND RECYCLE

When unconsumed reactants are recycled and there is a product separation in the process, there are two important definitions in the analysis of the chemical reactors: Overall conversion and Single-pass conversion.



$$\text{Overall Conversion} = \frac{\text{reactant input to process} - \text{reactant output from process}}{\text{reactant input to process}}$$

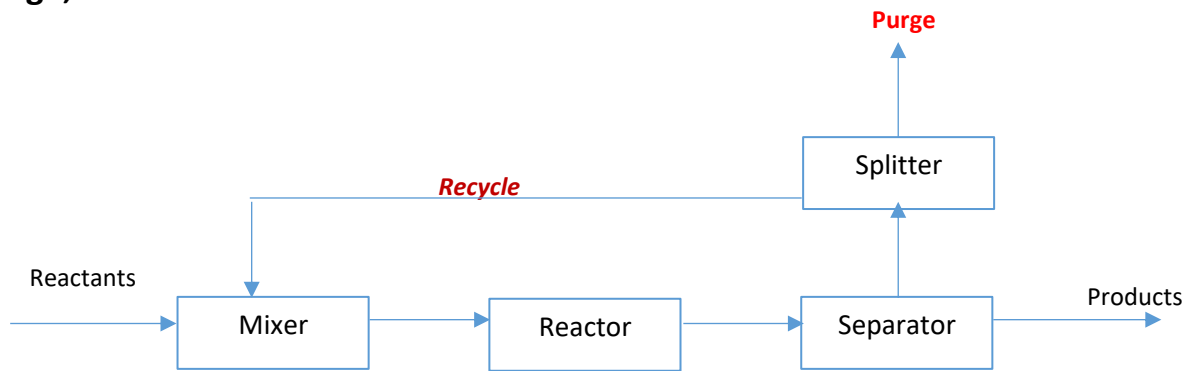
Single – Pass Conversion

$$= \frac{\text{reactant input to reactor} - \text{reactant output from reactor}}{\text{reactant input to reactor}}$$

PURGING:

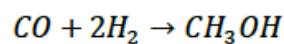
In processes involving recycle, accumulation of a certain substance may cause problems. Assume, a substance is entering the process in the feed and remains entirely in the process during the recycle rather than being carried out in a product stream. The accumulation of this substance may destroy the steady state conditions. To avoid any build up in the system, a portion of the recycle stream is separated as PURGE stream.

Purge;



YOUR TURN:

CO and H₂ can be combined to yield methanol (CH₃OH) according to the following equation



Steady state process for the production of methanol is given in the figure. The stream flows are in moles and all of the compositions are mole fractions or percent.

CH₄ enters the process but does not participate in the reaction (inert). The product stream contains only CH₃OH. A purge stream is used to maintain the CH₄ concentration in the exit of the separator at 3 mole % and prevent H₂ build up in the process. Single pass conversion of the CO is 18%. Calculate

- moles of recycle
- moles of purge
- purge gas composition

