Mass and Energy Balances

Basic Steps in Flowsheet Synthesis

- ✓Gather information about the process chemistry
- ✓Generate flow diagram based on Douglas Hierarchy
- Solve mass and energy balances
- Estimate equipment size based on flow rates from previous step
- Estimate equipment cost based on size from previous step
- Optimize process

Introduction

- We developed a sketch of a process in the previous lecture.
- The next step is to determine the size of each unit, which will help us estimate the cost of each unit.

There are two ways to do this:

1. The Chemist's Approach: Build larger sizes of laboratory equipment and experimentally measure all the process variables.
2. The Engineer's Approach: Develop process models for each unit and solve these equations to estimate the mass and energy flow rates. Use these rates to determine size.

Process Models

A process model is a set of equations, including the necessary input data to solve the equations, that allow us to predict the behavior of a chemical process system.

1. Fundamental Model: Derived from
   - Material and energy balances
   - Physical and Chemical Properties
2. Empirical Model: Obtained by “fitting” data
   - Numerical Methods
   - Statistical Analysis

Types of Process Models

1. Steady state models.
2. Dynamic models.

In this course, we will develop:

- steady state models from first principles.
- approximate models of chemical processes.

Dynamic models will be considered in ECH 4323: Chemical Process Control.

In particular, we will consider the following unit operations:

Mixer and Splitter
Reactor
Flash
Distillation
Absorption

Multicomponent Systems
Linear Balances

Models for other unit operations may be found in:

- *Transport Processes and Separation Process Principles* by Geankoplis
- *Separation Process Principles* by Seader and Henley
- *Elements of Chemical Reaction Engineering* by Fogler