Types of Biochemical Reactors

Teng-Jui Lin
Department of Chemical Engineering, University of Washington
Chemical Reaction Engineering

Chemical processes can be classified as batch, continuous, or semibatch

- **Batch process** - no mass crosses the system boundary

- **Continuous process** - inputs and outputs flow continuously through the system boundary

- **Semibatch process** - neither batch nor continuous

Biochemical reactors can also be classified as batch, continuous, or semibatch

- **Batch reactor** - feed is put into the reactor before $t = 0$, no inlet or outlet during operation
  - Batch process

- **Continuous stirred tank reactor (CSTR, chemostat)** - inlet and outlet flow continuously in and out
  - Continuous process

- **Semibatch reactor** - feed is added to the reactor OR the reactor content is drained
  - Semibatch process

Conservation of mass is the foundation of mass balance

- **Conservation of mass** - no mass is created nor destroyed in physical and chemical processes
- **Mass balance** of a chemical species

$$\text{In} - \text{Out} + \text{Generation} = \text{Accumulation}$$

$$\dot{m}_{i,0} - \dot{m}_i + \tilde{G}_i = \frac{dm_i}{dt}$$

$$\dot{n}_{i,0} - \dot{n}_i + G_i = \frac{dn_i}{dt}$$

- In $\dot{n}_{i,0}$
- Out $\dot{n}_i$
- Generation/Destruction G_i
- Accumulation $\frac{dn_i}{dt}$

Batch reactor mass balance gives its design equation

$$\dot{n}_{i,0} - \dot{n}_i + G_i = \frac{dn_i}{dt}$$

- Assumptions
  - No inlet - $\dot{n}_{i,0} = 0$
  - No outlet - $\dot{n}_i = 0$

Continuous stirred tank reactor (CSTR) mass balance gives its design equation

$$\dot{n}_{i,0} - \dot{n}_i + G_i = \frac{dn_i}{dt}$$

- Assumptions
  - Steady state - $\frac{dn_i}{dt} = 0$

Semibatch reactor mass balance gives its design equation

$$\dot{n}_{i,0} - \dot{n}_i + G_i = \frac{dn_i}{dt}$$

- Assumptions
  - Feed batch, no outlet - $\dot{n}_i = 0$
  - Well-mixed, spatially uniform - $G_i = r_i V(t)$