A First Course on Kinetics and Reaction Engineering

Unit 13. CSTR Data Analysis

Definitions

head space - vapor space above the liquid phase in a vessel that is not completely filled with liquid

space time - the average amount of time that flowing fluid spends within a reactor

space velocity - the average number of times that the contents of a reactor are completely replaced per unit time

Nomenclature

τ	space time (average residence time)
C_i	molar concentration of species i, a superscripted 0 denotes the reactor inlet concentration of species i
P	total pressure, a subscripted i denotes the partial pressure of species i
R	ideal gas constant
SV	space velocity
T	absolute temperature
V	volume within which the reaction is taking place
$\dot{V}$	volumetric flow rate, a superscripted 0 denotes the inlet volumetric flow rate
$\dot{n}_i$	molar flow rate of species i, $i = tot$ denotes the total molar flow rate, a superscripted 0 denotes the molar flow rate at the reactor inlet
$r_{i,j}$	rate of reaction j with respect to species i (rate of generation of species i via reaction j)
y_i	mole fraction of species i

Equations

$$\dot{n}_i - \dot{n}_i^0 = V r_{i,j} \tag{13.1}$$

$$C_i^0 = \frac{\dot{n}_i^0}{\dot{V}^0} \tag{13.2}$$

$$C_i = \frac{\dot{n}_i}{\dot{V}} \tag{13.3}$$

$$\dot{V}^0 = \dot{V} \quad \text{(incompressible liquids)} \tag{13.4}$$

$$\dot{V} = \frac{\dot{n}_{tot} RT}{P} \quad \text{(ideal gas)} \tag{13.5}$$

$$\dot{n}_{tot} = \sum_{\substack{i=all \\ species}} \dot{n}_i \tag{13.6}$$

$$y_i = \frac{\dot{n}_i}{\dot{n}_{tot}} \tag{31.7}$$

$$P_i = y_i P = \frac{\dot{n}_i P}{\dot{n}_{tot}} \tag{31.8}$$

$$\tau = \frac{V}{\dot{V}^0} \tag{13.9}$$

$$SV = \frac{1}{\tau} = \frac{\dot{V}^0}{V} \tag{13.10}$$