In class activity: Conversion and Reactor sizing

Lecture notes for chemical reaction engineering

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Design equations in terms of conversion

- Derive design equation in terms of conversion for a CSTR
- Derive design equation in terms of conversion for a PFR

CSTR sizing

Using the data in Table 1, calculate V_{CSTR} for $X = 0.4$, and $X = 0.8$

Table 1: Problem 1 data

X	0.00	0.10	0.20	0.40	0.60	0.70	0.80
$\frac{F_{A0}}{-r_A}$	0.89	1.08	1.33	2.05	3.56	5.06	8.00

Solution notebook on Google colab

PFR sizing

Using the data in Table 2, calculate V_{PFR} for $X = 0.4$, and $X = 0.8$
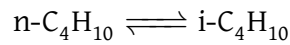
Table 2: Problem 2 data

X	0.00	0.10	0.20	0.40	0.60	0.70	0.80
$\frac{F_{A0}}{-r_A}$	0.89	1.08	1.33	2.05	3.56	5.06	8.00

Solution notebook on Google colab

An Adiabatic Liquid-Phase Isomerization

The isomerization of butane

$$n\text{-}C_4H_{10} \rightleftharpoons i\text{-}C_4H_{10}$$

was carried out adiabatically in the liquid phase. The data for this reversible reaction are given in Table 3. The reactor scheme shown below in Figure 1. Calculate the volume of each of the reactors for an entering molar flow rate of n-butane of 50 kmol/hr.

Table 3: Problem 4 data

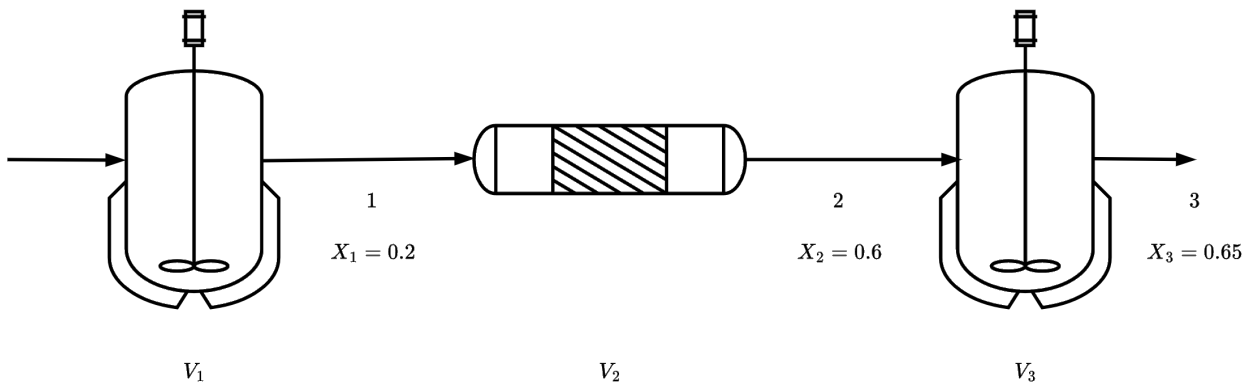| X	0.00	0.20	0.40	0.60	0.65
$-r_A, \frac{kmol}{m^3 \cdot h}$	39.00	53.00	59.00	38.00	25.00

Figure 1: Reactor configuration for problem 4

Solution notebook on Google colab

Batch reactor sizing

a. Discuss how you can use Levenspeil plots to design batch reactors.

b. We are planning to operate a batch reactor for converting A into R. This is a liquid phase reaction with stoichiometry A $\longrightarrow$ R. How long must we react each batch for concentration to drop from C_{A0} = 1.3 mol/l to C_{Af} = 0.30 mol/l? The data of rate of reaction v/s concentration of A is given in Table 4.

Table 4: Problem 3 data

$C_A, mol/dm^3$	0.100	0.200	0.300	0.400	0.500	0.600	0.700	0.800	1.000	1.300	2.000
$-r_A, \frac{mol}{l \cdot min}$	0.100	0.300	0.500	0.600	0.500	0.250	0.100	0.060	0.050	0.045	0.042