

CRE Chapter 1 Assignment 1

- P1-6_B** **Example 1-1** Calculate the volume of a CSTR for the conditions used to figure the plug-flow reactor volume in Example 1-1. Which volume is larger, the PFR or the CSTR? Explain why. Suggest two ways to work this problem incorrectly.
- P1-7_A** Calculate the time to reduce the number of moles of A to 1% of its initial value in a constant-volume batch reactor for the reaction and data in Example 1-1.
- P1-8_A** What assumptions were made in the derivation of the design equation for:
- the batch reactor?
 - the CSTR?
 - the plug-flow reactor (PFR)?
 - the packed-bed reactor (PBR)?
 - State in words the meanings of $-r_A$, $-r'_A$, and r'_A . Is the reaction rate $-r_A$ an extensive quantity? Explain.

- P1-12_A** The United States produced 32.5% of the world's chemical products in 2002 according to "Global Top 50," *Chemical and Engineering News*, July 28, 2003. Table P1-12.1 lists the 10 most produced chemicals in 2002.

TABLE P1-12.1. CHEMICAL PRODUCTION

2002 Chemical	Thousands of Metric Tons	1995 Rank	2002 Chemical	Thousands of Metric Tons	1995 Rank
1. H ₂ SO ₄	36,567	1	6. H ₂	13,989	—
2. N ₂	26,448	2	7. NH ₃	13,171	6
3. C ₂ H ₄	23,644	4	8. Cl ₂	11,362	10
4. O ₂	16,735	3	9. P ₂ O ₅	10,789	—
5. C ₃ H ₆	14,425	9	10. C ₂ H ₂ Cl ₂	9,328	—

Reference: *Chemical and Engineering News*, July 7, 2003, <http://pubs.acs.org/cen/>

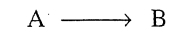
- What were the 10 most produced chemicals for the year that just ended? Were there any significant changes from the 1995 statistics? (See Chapter 1 of 3rd edition of *Elements of CRE*.) The same issue of *C&E News* ranks chemical companies as given in Table P1-12.2.
- What 10 companies were tops in sales for the year just ended? Did any significant changes occur compared to the 2002 statistics?
- Why do you think H₂SO₄ is the most produced chemical? What are some of its uses?
- What is the current annual production rate (lb/yr) of ethylene, ethylene oxide, and benzene?
- Why do you suspect there are so few organic chemicals in the top 10?

- P1-13_A** Referring to the text material and the additional references on commercial reactors given at the end of this chapter, fill in Table P1-13.

TABLE P1.13 COMPARISON OF REACTOR TYPES

Type of Reactor	Characteristics	Kinds of Phases Present	Use	Advantages	Disadvantages
Batch					
CSTR					
PFR					
PBR					

- P1-15_B** The reaction



is to be carried out isothermally in a continuous-flow reactor. Calculate both the CSTR and PFR reactor volumes necessary to consume 99% of A (i.e., $C_A = 0.01C_{A0}$) when the entering molar flow rate is 5 mol/h, assuming the reaction rate $-r_A$ is:

(a) $-r_A = k$ with $k = 0.05 \frac{\text{mol}}{\text{h} \cdot \text{dm}^3}$ (Ans.: $V = 99 \text{ dm}^3$)

(b) $-r_A = kC_A$ with $k = 0.0001 \text{ s}^{-1}$

(c) $-r_A = kC_A^2$ with $k = 3 \frac{\text{dm}^3}{\text{mol} \cdot \text{h}}$ (Ans.: $V_{\text{CSTR}} = 66,000 \text{ dm}^3$)

The entering volumetric flow rate is 10 dm³/h. (Note: $F_A = C_A v$. For a constant volumetric flow rate $v = v_0$, then $F_A = C_A v_0$. Also, $C_{A0} = F_{A0}/v_0 = [5 \text{ mol/h}]/[10 \text{ dm}^3/\text{h}] = 0.5 \text{ mol/dm}^3$.)

- (d) Repeat (a), (b), and (c) to calculate the time necessary to consume 99.9% of species A in a 1000 dm³ constant volume batch reactor with $C_{A0} = 0.5 \text{ mol/dm}^3$.

- P1-16_B** Write a one-paragraph summary of a journal article on chemical kinetics or reaction engineering. The article must have been published within the last five years. What did you learn from this article? Why is the article important?