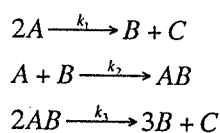


1. An autocatalytic reaction, in which the product formed can itself act as catalyst for the reaction, has a typical form:

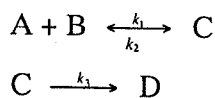


- (a) Please show the characteristics of the autocatalytic reaction using (i) rate $(-r_A)$ versus concentration (C_A) curve and (ii) reciprocal rate $(1/(-r_A))$ versus conversion (X_A) curve. (6%)
- (b) How should we design a system using CSTR and/or plug flow reactor for this reaction (i) to obtain the minimum total reactor volume; (ii) when unconverted reactant can be separated and recycled? Explain your answer in detail. (12%)
- (c) The following set of mechanistic equations is proposed to the reaction $2A \rightarrow B + C$

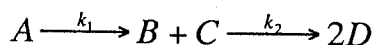


Verify that this mechanism gives rise to autocatalytic behavior. (8%)

2. For the mechanism



- (a) Please drive the rate law; (5%)
- (b) Assuming that $k_3 \ll k_2$, express the pre-exponential factor A and E_a for the apparent rate constant in terms of A_1, A_2 , and A_3 and E_{a1}, E_{a2} , and E_{a3} for the three steps. (3%)
3. The following reaction sequence takes place in the liquid phase in a continuous stirred tank reactor.

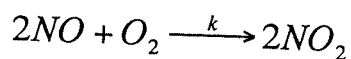


The feed concentration of A is C_{A0} , and the reactions may be assumed to be irreversible reactions proceeding by this mechanism. No B, C , or D are present in the feed. If the

(背面仍有題目,請繼續作答)

input volumetric flow rate is v_0 and the reactor volume is V , derive equations for the effluent concentrations of B, C, and D. If species B is the desired product, determine the space time that corresponds to the maximum production of B. (11%)

4. The gas-phase homogeneous oxidation of nitrogen monoxide (NO) to dioxide (NO_2),



is known to have a form of third-order kinetics which suggests that the reaction is elementary as written, at least for low partial pressures of the nitrogen oxides. However, the rate constant k actually *decreases* with increasing absolute temperature, indicating an apparently *negative* activation energy. Because the activation energy of any elementary reaction must be positive, some explanation is in order.

Provide an explanation, starting from the fact that an active intermediate species, NO_3 , is a participant in some other known reactions that involve oxides of nitrogen. (10%)

5. Analyze the following statement: An adiabatic CSTR usually gives a shorter residence time than a PFTR for the same conversion. (12%)

6. 簡答下列問題 (每小題 4 分, 共 16 分)

(a) 酸觸媒 (Acid catalysts) 可用於那些類型的反應? 請舉出二個反應及二種觸媒。

(b) 請例舉二種金屬擔體觸媒 (Supported metal catalysts)。

(c) 何謂三相泥漿式反應器 (Three-phase slurry reactors)? 請圖示並簡單說明之。

(d) 請就化學吸附與物理吸附舉出四個重要不同點。

7. 以填充床反應器(Packed bed reactor)進行一階不可逆反應(First-order irreversible reaction)。若反應流體之體積不隨轉化率變大或縮小，

(1) 請導出轉化率(X)與觸媒重量(W)之關係式；(5分)

(2) 將上式改以反應器體積表示之。(2分)

8. 一般吸附劑吸附溶液中之溶質可比照 Fluid-solid reaction 模擬之。

(1) 請就一個球形多孔性吸附劑寫出其中溶質 A 之質量平衡式、起始條件及邊界條件。(6分)

(2) 若吸附劑單位重量吸附溶質之量(q_A)與溶液中溶質濃度(C_A)之關係可用 Langmuir isotherm 表示，請導出該關係式。(4分)