

$$\int_0^x \frac{1+ax}{1-x} dx = (1+a) \ln \frac{1}{1-x} - ax$$

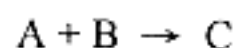
$$\int_0^x \frac{1+ax}{(1-x)^2} dx = \frac{(1-a)x}{1-x} - a \ln \frac{1}{1-x}$$

$$\int_0^x \frac{(1+ax)^2}{(1-x)^2} dx = 2a(1+a) \ln(1-x) + a^2x + \frac{(1+a)^2x}{1-x}$$

$$Q - W_s - F_{A0} \int_{T_0}^T C_{p,\max} dT - \left[ \Delta H_{RX}^\circ(T_R) + \int_{T_R}^T \Delta C_p dT \right] F_{A0} X = 0$$

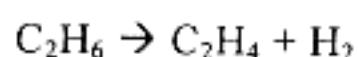
1. (10%) A reversible reaction  $A_{(g)} \rightleftharpoons B_{(g)} + C_{(g)}$  is carried out in a tubular reactor. The product B may diffuse through the reactor wall and is collected outside of the reactor.
- (1) Please **explain** the advantages of this type of reactor.
  - (2) Please sketch curves to show the flow rates along the reactor for all components. Make the **explanation**.

2. (24%) A gas-phase reaction between A and B to produce C is carried out in a tubular reactor.

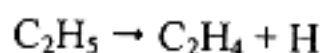
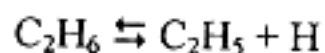
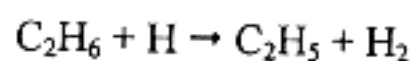


The feed, containing 40 mol% A, 40 mol% B, and 20% inert species, enters the reactor at a total rate of 1.5 mol/min, with a flow rate of 2.5 liter/min. The reaction is first-order with respect to both A and B, with  $k_A = 0.25$  liter/mol/min.

- (a) Determine the reactor volume required to produce a product that contains 60 mol% C. Assume temperature and pressure are unchanged.
  - (b) How do you decide the reactor size if the reaction is carried out adiabatically?
  - (c) How do you decide the reactor size if the pressure drops along the reactor linearly?
3. (12%) The gas phase dehydrogenation of ethane to ethylene



proceeds through the elementary reaction steps



- (a) Identify the initiation, propagation, and termination steps.  
(b) Find a reasonable expression for  $r(\text{C}_2\text{H}_6)$ .  
(c) The bond energy of ethane is 104 kcal/mole, and the propagation steps have very low activation energies. What is the approximate activation energy of this reaction?
4. (10%) Show that  $r(X,T)$  for  $A \rightarrow B$ ,  $r = k_f C_A - k_b C_B$  has a maximum  $\partial r / \partial T = 0$  if the reaction is exothermic but not if endothermic.
5. (12%) For the parallel decompositions of A, where R is desired,
- $$\left. \begin{array}{l} A \rightarrow R \quad r_R = 1 \\ A \rightarrow S \quad r_S = 2C_A \\ A \rightarrow T \quad r_T = C_A^2 \end{array} \right\} \dots\dots\dots \text{with } C_{A0} = 1$$
- What is the maximum  $C_R$  we may expect in isothermal operations  
(a) in a mixed reactor,  
(b) in a plug flow reactor.
6. (8%) 請簡要說明觸媒孔徑分佈(pore size distribution)與下面性質之關係：  
(1)觸媒表面積，(2)單位觸媒重量之活性。
7. (8%)  $A_2$  與 B 皆能被某觸媒吸附，但吸附後彼此不反應，且知  $A_2$  是以解離形式被吸附( $A_2 + 2S \rightleftharpoons 2A \cdot S$ )，請導出 A 之等溫吸附式(adsorption isotherm)。
8. (8%) 以一個蜂巢狀之觸媒當反應器進行  $A + B \rightarrow \text{Products}$  之反應，若其活性甚高，因此其外表面之薄膜擴散為控制步驟，(1)請導出 A 在此觸媒內之質量平衡式，(2)若軸向擴散效應可忽略，請導出軸向  $C_A$  之表示式。
9. (8%) (a)氣液固三相反應器與氣固二相反應器互相比較，前者有何優點？(上述固相是觸媒)  
(b)在何種情況(溫度、觸媒粒徑、流速等)下，求得外顯(apparent)反應活化能會低於真實值？何故？