1. Consider the following enzymatic reaction

\[ E + S \xrightarrow{k_1} E \cdot S \xrightarrow{k_F} P + E \]

where E, S, E·S, and P represent the enzyme, substrate, enzyme–substrate complex, and the reaction product, respectively. Please derive the rate law for this reaction.

2. A highly exothermic organic reaction between A and B is carried out in oil droplets dispersed in water to effectively dissipate the heat (see Fig. 2). The volume of the reacting organic mixture, of 10 (volume)% organic and 90% water is 1 dm³. The oil-phase droplet diameter is on the average of 10 microns. The specific reaction rate constant is 0.001 dm³/mol·s. The 1 dm³ vessel contains 0.05 moles of A and 0.05 moles of B. The reaction is first order in A and B.

(a) What is the initial rate of disappearance of A?
(b) Estimate the number of moles of A consumed in the first three seconds.

3. The elementary gas-phase reaction \( A \rightarrow 3B \) is carried out in a flow reactor. The specific reaction rate at 50 °C is \( 10^{-4} \) min and the activation energy is 85 KJ/mol. Pure A enters the reactor at 10 atm and 127 °C and a molar flow rate of 2.5 mol/min. Calculate the reactor volume to achieve 90% conversion in

(a) a CSTR and (b) a PFR

\( R = 8.314 \text{ J/mol·K} \)
\( \text{atm·dm}^3/\text{mol·K} = 0.082 \)
4. In a closed vessel, we input a specific function, and at the exit we measured the following concentration readings. Please draw the corresponding curve on graph paper (i.e., exit age distribution vs. time). (Figure)

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>0, 5, 10, 15, 20, 25, 30, 35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trace output concentration (g/l)</td>
<td>0, 3, 5, 5, 4, 2, 1, 0</td>
</tr>
</tbody>
</table>

5. In a case of diffusion resistance and external film mass transfer resistance, a first-order gas phase reaction takes place in a porous catalyst. If

\[ C_A = 10^{-5} \text{ mol/cm}^3, \quad 1 \text{ atm}, \quad 400^\circ \text{C}, \quad \text{Me} \text{ rate constant} \]

\[ k = 10^{-6} \text{ mol/s/cm}^2 \text{ atm}. \]

If effective diffusivity is 1, the reaction at the chemical reaction control region is

If the catalyst's height cannot exceed 10 cm.
6. Butan-2-ol (BuOH) 在锌氧化物催化剂上可反应生成Methyl ethyl ketone (MEK) 及H₂

\[ \text{BuOH} + \text{H₂O} \rightarrow \text{MEK} + \text{H₂} \]

如果反应是在490°C，differential reactor 中进行，可得下面的 data

<table>
<thead>
<tr>
<th>时间 (min)</th>
<th>2</th>
<th>0.1</th>
<th>0.5</th>
<th>1</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>P_{rem} (atm)</td>
<td>5</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P_{ex} (atm)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>\text{F}_{ex}/W (mol/hr·gcat)</td>
<td>0.044</td>
<td>0.040</td>
<td>0.069</td>
<td>0.060</td>
<td>0.043</td>
<td>0.059</td>
</tr>
</tbody>
</table>

differential reactor 的 mole balance 可以得到 \( W = F_{ex}/P_{ex} \)，这个反应是在 dual site 上进行的

\[
\begin{align*}
\text{Bu} + \text{S} & \rightarrow \text{MEK} + \text{H₂} \\
\text{Bu} + \text{S} & \rightarrow \text{MEK} + \text{H₂} \\
\text{MEK} \rightarrow \text{MEK} + \text{S} \\
\text{H₂} + \text{S} & \rightarrow \text{H₂} + 2\text{S}
\end{align*}
\]

其反应方程式是

\[ y_{\text{MEK}} = \frac{P_{\text{MEK}}}{(1 + K_{\text{Bu}}P_{\text{Bu}})^2} \]

试求出及 \( K_{\text{Bu}} \) 的值。（表中所有的 data 都要用到，请利用方程求解）