# 國立臺北科技大學

## 九十二學年度生物科技研究所入學考試

## 反應工程試題

填准考證號碼



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**注意事項：**

1. 本試題共【6】題，配分共 100 分；第 1 題為 10 分，第 2~6 題每題為 18 分。
2. 請按順序標明題號作答，不必抄題。
3. 全部答案均須答在答案卷之答案欄內，否則不予計分。

1. Experiment shows that the primary reaction in the homogeneous decomposition of nitrous oxide proceeds with stoichiometry

$$N_2O \rightarrow N_2 + \tfrac{1}{2} O_2$$

and rate

$$-r_{N_2O} = \frac{k_1 [N_2O]^2}{1 + k_2 [N_2O]}, \quad \text{mol/L·min}$$

where

$$k_1 = 10^{19.39} e^{-81800/RT}$$

$$k_2 = 10^{8.69} e^{-28400/RT}$$

What is the activation energy for this reaction ?

2. The aqueous reaction $A \rightarrow R + S$ proceeds as follows,

| Time, min | 0 | 36 | 65 | 100 | 160 | ∞ |
|---|---|---|---|---|---|---|
| $C_A$, mol/L | 0.1823 | 0.1453 | 0.1216 | 0.1025 | 0.0795 | 0.0494 |

with $C_{A0}$ = 0.1823 mol/L, $C_{R0}$ = 0, $C_{S0} \fallingdotseq$ 55 mol/L. Find the rate equation for this reaction.

3. Nitrogen pentoxide decomposes as follows:

$$N_2O_5 \rightarrow \tfrac{1}{2} O_2 + N_2O_4, \qquad -r_{N_2O_5} = (2.2 \times 10^{-3}\ \text{min}^{-1})\, C_{N_2O_5}$$

$$N_2O_4 \rightleftarrows 2\, NO_2, \qquad \text{instantaneous, } K_P = 45\ \text{mmHg}$$

Find the partial pressures of the contents of a constant-volume bomb after 6 hours if we start with pure $N_2O_5$ at atmospheric pressure.

4. The homogeneous gas reaction $A \rightarrow 3\,R$ follows second-order kinetics. For a feed rate of 5 $m^3$/hr of pure A at 6 atm and 300℃, an experimental reactor consisting of a 2.5 cm ID pipe 2 m long gives 60% conversion of feed. A commercial plant is to treat 360 $m^3$/hr of feed consisting of 50% A, 50% inerts at 30 atm and 300℃ to obtain 80% conversion. Assume plug flow in the pipe, negligible pressure drop, and ideal gas behavior. How many 2-m lengths of 2.5 cm ID pipe are required ?

5. It has been reported that the reaction

$$(OH)CH_2CH_2Cl + NaHCO_3 \rightarrow (OH)CH_2CH_2OH + NaCl + CO_2$$

is elementary with rate constant $k$ = 5.2 L/mol·hr at 82℃. On the basis of this information we wish to construct a pilot plant to determine the economic feasibility of producing ethylene glycol from two available feeds, a 12 wt% aqueous solution of sodium bicarbonate and a 25 wt% aqueous solution of ethylene chlorhydrin. Assume all operations at 82℃, at which temperature the specific gravity of the mixed reacting fluid is 1.02.

(a) What volume of tubular (plug flow) reactor will produce 15 kg/hr ethylene glycol at 95% conversion of an equimolar feed produced by intimately mixing appropriate quantities of the two feed streams.

(b) What size CSTR is needed for the same feed, conversion, and production rate as in part (a) ?

6. Under appropriate conditions A decomposes as follows:

$$A \xrightarrow{k_1 = 0.15/\text{min}} R \xrightarrow{k_2 = 0.15/\text{min}} S$$

R is to be produced from 900 L/hr of feed in which $C_{A0}$ = 1 mol/L, $C_{R0} = C_{S0} = 0$.

(a) What size plug flow reactor will maximize the yield of R, and what is the concentration of R in the effluent stream from this reactor ?

(b) What size CSTR will maximize the yield of R, and what is $C_{R,max}$ in the effluent stream from this reactor ?