國立臺北科技大學九十六學年度碩士班招生考試

系所組別：3510 化學工程研究所甲組

第二節 化工熱力學與反應工程 試題

注意事項：

1. 本試題共五大題：第一題 20 分、第二題 20 分、第三題 10 分、第四題 20 分和第五題 30 分，合計共 100 分；各小題配分如標示百分數值。
2. 請標明大題、子題編號作答，不必抄題。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

一、 A solution of A is mixed with an equal volume of solution of B containing the same number of moles and the reaction

$$A + B \rightarrow C$$

occurs. At the end of 1.0 hr in 70 % reacted. How much of A will be left unreacted at the end of 2.0 hr if the reaction is:

1. first order in A and zero order in B;(7%)
2. first order in both A and B; (7%)
3. zero order in both A and B? (6%)

二、 A proposed mechanism for the reaction between $H_{2(g)}$ and $Br_{2(g)}$ is

$$Br_2 \underset{k_5}{\overset{k_1}{\rightleftharpoons}} 2Br\bullet$$

$$H_2 + Br\bullet \xrightarrow{k_2} HBr + H\bullet$$

$$Br_2 + H\bullet \xrightarrow{k_3} HBr + Br\bullet$$

$$HBr + H\bullet \xrightarrow{k_4} H_2 + Br\bullet$$

Assuming that $\frac{dC_{H\bullet}}{dt} = 0$ and $\frac{dC_{Br\bullet}}{dt} = 0$ at steady states.

1. Find the concentration ($C_{Br\bullet}$) of free radical $Br\bullet$ in terms of C_{H_2}, C_{Br_2} and C_{HBr}. (5%)
2. Find the concentration ($C_{H\bullet}$) of free radical $H\bullet$ in terms of C_{H_2}, C_{Br_2} and C_{HBr}. (5%)
3. Find the rate formula of $\frac{dC_{HBr}}{dt}$ in terms of C_{H_2}, C_{Br_2} and C_{HBr}. (5%)
4. If $1 >> \frac{k_4 C_{HBr}}{k_3 C_{Br_2}}$, what is the pseudo-order of the reaction? (5%)

三、 The homogeneous gas decomposition of phosphine (PH_3)

$$4\,PH_{3(g)}(A) \rightarrow P_{4(g)} + 6\,H_{2(g)}$$

proceeds at 900 K with first order rate:

$$-r_A = k\,C_A, \qquad k = 15\ hr^{-1}$$

What size of plug flow reactor operating at 900 K and 5.0 bar can produce 70% conversion of a feed consisting of 1,800 mol of pure phosphine per hour? (10%)

Hint: $\int_0^V \frac{dV}{F_{A0}} = \int_0^{X_A} \frac{dX_A}{-r_A}$

注意：背面尚有試題

四、 A piston/cylinder apparatus as shown in Figure A contains an inert gas at a temperature of 300 K and a pressure of 10 bar initially. The system of inert gas then heated until the pressure up to 20 bar. The equation of states for the inert gas over the range under consideration may be expressed by

$$P\underline{V} = (1 - 0.01\,P/\text{bar})RT$$

and the constant-volume heat capacity by

$$C_V / \text{J mol}^{-1}\text{K}^{-1} = 4.563 + 1.557 \times 10^{-2} T$$

For 1.0 mol of the inert gas, calculate

1. $\Delta\underline{U}$, the internal energy change of the system, (5%)
2. W, the work effect of the system, (5%)
3. Q, the heat effect of the system, (5%)
4. $\Delta\underline{H}$, the enthalpy change of the system. (5%)

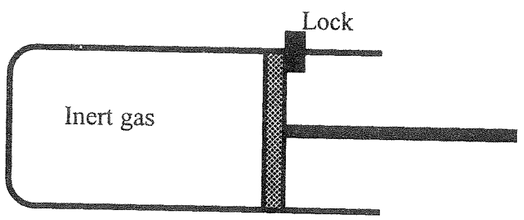

Figure A

五、 Air at 300 K and 100 bar is passed into a storage tank from a larger high pressure vessel, at the rate of 0.050 mol min^{-1}, in order to increase the flow of water from the tank as shown in Figure B. The tank contains 1.5 m^3 of air at 1.0 bar and 300 K and 1.5 m^3 of water, initially. When the pressure in the tank reaches 5.0 bar, the water is released at rate of 0.15 $\text{m}^3\ \text{min}^{-1}$. Neglect all losses and assume air to be an ideal gas. The constant-volume heat capacity for air may be assumed independent of temperature,

$C_V = (5/2)R = 20.785\ \text{J mol}^{-1}\text{K}^{-1}$.

Questions:

1. Calculate the air temperature in tank when the pressure just rising to 5.0 bar. (10%)
2. Calculate the moles of air in tank when the pressure just rising to 5.0 bar. (10%)
3. When releasing process in steady as the pressure in the tank maintain 5.0 bar, finding the differential equation from mass balance and energy balance equations to describe the relation between air temperature in tank (T) and releasing time (t). (10%)

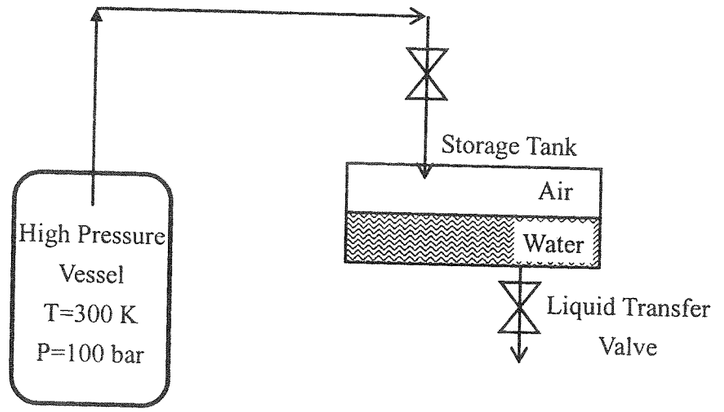

Figure B

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