國立高雄大學 102 學年度研究所碩士班招生考試試題

科目：化工熱力學與化學反應工程　系所：化學工程及材料工程學系（甲組）　是否使用計算機：是

考試時間：100 分鐘　本科原始成績：100 分

Table: Values of the universal gas constant

R = 8.314 J mol^{-1} K^{-1} = 8.314 m^3 Pa $mol^{-1}K^{-1}$
= 83.14 cm^3 bar mol^{-1} K^{-1} = 8314 cm^3 kPa mol^{-1} K^{-1}
= 82.06 cm^3 (atm) mol^{-1} K^{-1} = 62356 cm^3 (torr) mol^{-1} K^{-1}
= 1.987 (cal) mol^{-1} K^{-1} = 1.986 (Btu)(lb mole)$^{-1}$ $(R)^{-1}$
= 0.7302 $(ft)^3$ (atm) (lb mol)$^{-1}$ $(R)^{-1}$ = 10.73 $(ft)^3$ (psia)(lb mol)$^{-1}$ $(R)^{-1}$
=1545 (ft)(lb_f)(lb mol)$^{-1}$$(R)^{-1}$

1. For the parallel reactions

$$A + B \rightarrow D: \qquad r_D = k_1 C_A^{\alpha 1} C_B^{\beta 1}$$

$$A + B \rightarrow U: \qquad r_B = k_2 C_A^{\alpha 2} C_B^{\beta 2}$$

consider all possible combinations of reaction orders and reactors that will maximize selectivity ($S_{D/U}$). (20%)

2. Show that when the three phases of a pure substance are in equilibrium, the specific Gibbs function of each phase is the same. (15%)
3. A 1200 W electric resistance heating element whose diameter is 0.5 cm is immersed in 40 kg of water initially at 20^{O}C. Assuming water with constant specific heats is 4.18 kJ/kg·°C and the water container is well-insulated, determine how long it will take for this heater to raise the water temperature to 50^{O}C. Also, determine the entropy generated during this process, in kJ/K. (20%)
4. Consider a well-insulated horizontal rigid cylinder that is divided into compartments by a piston that is free to movie but does not allow either gas to leak into the other side. Initially, one side of the piston contains 2 m^3 of N_2 gas at 250 kPa and 100^{O}C while the other side contains 1 m^3 of He gas at 250 kPa and 25^{O}C. Now thermal equilibrium is established in the cylinder as a result of heat transfer through the piston. Using constant specific heats at different temperatures, determine (a) the final equilibrium temperature in the cylinder and (b) the entropy generation during this process. What would your answer be if the piston were not free move? Assuming both N_2 and He are ideal gases with constant specific heats. (25%)

Properties: R = 0.2968 kPa.m^3/kg.K, c_v = 0.743 kJ/kg·°C and c_p = 1.039 kJ/kg·°C for N_2, and R = 2.0769 kPa.m^3/kg.K, c_v = 3.1156 kJ/kg·°C, and c_p = 5.1926 kJ/kg·°C for He

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5. The elementary liquid phase reaction $A + 2B \underset{K2}{\overset{K1}{\rightleftharpoons}} R$

with rate equation $-r_A = -\frac{1}{2}r_B =$（12.5 liter^2/mol^2.min）$C_A C_B^2$ − (1.5 min^{-1})C_R, $[\frac{mol}{liter.\min}]$

is to take place in a 6 liter steady state mixed flow reactor. Two feed streams, one containing 2.8 mol A/liter and the other containing 1.6 mol B/liter, are to be introduced at equal volumetric flow rates into the reactor, and 75% conversion of limiting component is desired. What should be the flow rate of each stream? Assume a constant density density throughout. (20%)