國立高雄大學 104 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

1. It has been suggested that since the one parameter Margules expansion is not flexible enough to fit most activity coefficient data, it should be expanded by adding additional constants. In particular, the following have been suggested

   2 parameter models: $\ln\gamma_1 = Ax_2^2$ $\ln\gamma_2 = Bx_1^2$

   or $\ln\gamma_1 = Ax_2^n$ $\ln\gamma_2 = Ax_1^n$

   or

   3 parameter models: $\ln\gamma_1 = Ax_2^n$ $\ln\gamma_2 = Bx_1^n$

   In each case the reference states are the pure components at the temperature and pressure of the mixture.

   (a). Which of these models are reasonable? (10%)

   (b). What are the allowable values for the parameters A, B, and n in each of the models? (10%)

2. The electric heating systems used in many houses consist of a simple duct with resistance heaters. Air is heated as it flows over resistance wires. Consider a 15 kW electric heating system. Air enters the heating section at 100 kPa and 17^{o}C with a volume flow rate of 150 m^3/min. If heat is lost from the air in the duct to the surroundings at a rate of 200 W, determine the exist temperature of air. Assuming air is an ideal gas, the C_p and the universal gas constant are 1.005 kJ/kg.^{o}C and 0.287 kPa.m^3/kg.K, respectively. (19%)

3. A 100 kg block of iron casting at 440^{o}F is thrown into a large lake that is at a temperature of 54^{o}F. The iron block eventually reaches thermal equilibrium with the lake water. Assuming an average specific heat of 0.45 kJ/kg.K for the iron, determine (a) the entropy change of the iron block, (b) the entropy change of the lake water, and (c) the entropy generated during this process. (21%)

4. Consider a second order irreversible reaction of decomposition A → rR, carried out in a gas phase. Initially, a test I was conducted in a batch reactor, introducing pure A, at 300 K. After 10 min, the pressure was 3 atm. After a sufficiently long time, the pressure reached 5 atm, remaining constant afterward. Subsequently, a test was carried out in a closed system with a piston without friction, but at constant pressure of 1 atm. The final volume was double. Determine the equation of the rate and calculate both the rate for a conversion of 50% and the initial rate at such conditions. It is known that k = 0.03 L/(mol.min). (20%)

5. Ester is hydrolyzed with an excess of caustic soda. The ester solution is fed to the first reactor at a rate of 200 L/min and concentration 0.02 mol/L, while the caustic soda at 50 L/min and 1 mol/L. The reaction rate constant of this irreversible second order reaction is 2L/(mol.min). Three continuous stirring tank reactors in series are utilized; the volume of the first is unknown, the second is 2200 L and the third is 800 L. Assuming the final conversion is 95%. Calculate the volume of the first reactor and the conversion at the outlet of each reactor. (20%)