113CH03

國立臺北科技大學 113 學年度碩士班招生考試

系所組別：3510 化學工程與生物科技系化學工程碩士班甲組

第二節　化工熱力學與反應工程　試題

注意事項：

1. 本試題共 9 大題，共 100 分。
2. 不必抄題，作答時請將試題題號及答案依照順序寫在答案卷上。
3. 全部答案均須在答案卷之答案欄內作答，否則不予計分。

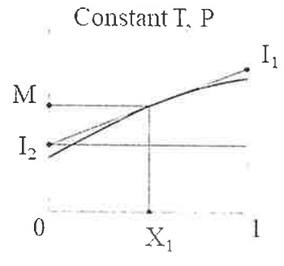
1. Steam flows steadily through an insulated, horizontal nozzle. Show that the corresponding energy balance can be reduced to this form. (5%)

$$\Delta H + \frac{\Delta v^2}{2g_c} = 0$$

2. Please explain the correlation of corresponding states using the reduced temperature and pressure. (5%)

3. Two systems, one at T_1 and the other at T_2 are placed in thermal contact and in isolation from their surroundings. Use the second law to determine the direction of heat flow. (10%)

4. Please show that I_1 is $\overline{M_1}$ and I_2 is $\overline{M_2}$ in the following figure. (10%)



The figure shows a representative plot of M (solution property) vs. x_1 (the molar fraction of species 1), for a binary system. The tangent line shown extends across the figure, intersecting the edges (at $x_1 = 1$ and $x_1 = 0$) at points labeled I_1 and I_2. The terms $\overline{M_1}$ and $\overline{M_2}$ represent the partial molar properties of components 1 and 2, respectively, when the molar fraction of component 1 = x_1

5. Please derive the Clapeyron equation for a two-phase system. (10%)

6. Please define the following terms with the corresponding equations.
   (1) Residual property (M^R) (5%)
   (2) Excess property (M^E) (5%)

7. Please derive the entropy change of mixing in terms of the mole fraction for ideal gases at constant temperature and pressure. (10%)

8. A feed solution containing a reactant A (C_A= 1 k mol/m^3) is fed to a Continuous-Stirred Tank Reactor (CSTR) or a Plug Flow Reactors (PFR) at a constant volumetric flow rate of 0.001 m^3/sec and converted to product P in the reactor. The first-order reaction rate constant is 0.02 sec^{-1}. Please derive the design equation of each reactor and determine the reactor volumes of each reactor required to attain a fractional conversion of A, X_A=0.95. (20%)

9. In a non-isothermal Continuous Stirred-Tank Reactor (CSTR) operation with no shaft work, the energy balance is expressed as follows, where T_a represents the ambient temperature, and C_{Pi} is the molar heat capacity of species i.

$$[-F_{A0}\Delta H_R(T)X_A] + [UA(T_a - T)] = [\sum \int_{T_0}^{T} (F_{i0}C_{pi}dT)]$$

(bracket-1)　(bracket-2)　(bracket-3)

(1) The energy balance equation contains three distinct brackets. Please provide a concise explanation for each bracket, including the source of energy associated with it. (10%)

(2) Additionally, demonstrate how the equation can be transformed into a second format by substituting T with T_R in $\Delta H_R(T)$. $\Delta H_R^o(T_R)$ is the standard enthalpy of reaction at T=T_R. Illustrate this transformation with a diagram to justify its validity. (10%)

$$\Delta H_R(T) = \Delta H_R^o(T_R) + \int_{T_R}^{T} (\sum_{Product} v_i C_{pi} - \sum_{Reactant} v_i C_{pi}) dT$$