A. Chemical Engineering Thermodynamics (50%)

(A1) Explain precisely by words or mathematical formula of the following terms

a) Chemical potential of component *i* in terms of total enthalpy and Gibbs free energy of a mixture. (4%)

b) Partial molar enthalpy and Gibbs free energy of component *i* in a mixture. (4%)

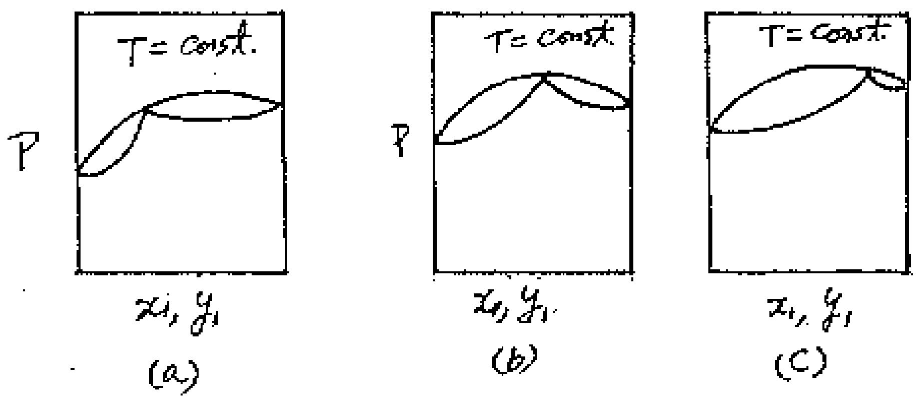
c) Thermal efficiency of a Carnot cycle. (3%)

d) Criterion of vapor-liquid equilibrium of a ternary mixture. (5%)

e) Criterion of a chemical reaction equilibrium $aA + bB = cC + dD$ (4%)

f) Residual enthalpy of a mixture (2%)

g) Which one is correct among the figures shown below. (3%)



參考用

(A2) 回答下列問題

a) 解釋 ideal gas temperature scale and thermodynamic temperature 該倆 temperatures 爲何相等? (3%)

b) 熱力學第二定律之 entropy 與統計熱力學之 entropy 如何定義？ (4%)

c) 解釋系統之 steady state, equilibrium, 與可逆程序。(3%)

d) 舉出三個不可逆程序。(3%)

e) 如何可求成分 *i* 之逸壓係數(fugacity coefficient), $\hat{\phi}_i$. (3%)

f) 如何可求成分 *i* 之活性係數(activity coefficient), γ_i. (3%)

g) 如何實驗以求 Henry's Law constant? (3%)

h) 如何計算 gas solution 相對於其 reference state 之 enthalpy ? (3%)

B. Chemical Reaction Engineering (50%)

(B1) A pure gas A (reaction $A \longrightarrow 2R$) with volumetric flow rate $0.1\ m^3/min$ is introduced into a mixed flow reactor. The reactor volume needed for 50% conversion of A is $0.5\ m^3$. Find the corresponding (a) space-time (b) mean residence time for this system. (12%)

(B2) Determine the conditions such as T, C_A (high, low, intermediate, etc.) and reactor type (plug, mixed) which will favor the formation of the desired product indicated. Also, give the reasons.

$$A \xrightarrow{1} R_{desired} \xrightarrow{2} S, \qquad R_{desired} \xrightarrow{3} T$$

n_1, E_1	n_2, E_2	n_3, E_3
0,30	2,40	1,20

where n_i: reaction order of ith step
E_i: activation energy of ith step (13%)

(B3) At present 80% of reactant is converted into product by a first order reaction ($A \rightarrow B$) in a single mixed flow reactor. We plan to place a second reactor similar to the one being used in series or in parallel with it. For the same conversion, by how much can the treatment rate be increased if we operate these two units (a) in parallel and (b) in series. (13%)

(B4) For the competitive reactions

$A + B \rightarrow R$, desired $\quad dC_R/dt = k_1 C_A^{0.5} C_B$

$A + B \rightarrow S$, unwanted $\quad dC_S/dt = k_2 C_A C_B^{0.5}$

,order the following contacting schemes from the most desirable to the least desirable from the standpoint of favorable product distribution. (12%)

(a) (b) (c)