國立中央大學九十一學年度碩士班研究生入學試題卷

所別：化學工程與材料工程學系 不分組　科目：化工熱力學及化學反應工程　共 2 頁 第 1 頁

化工熱力學試題(A)

A 1. The van der Waals equation of state is (16%)

$$P = \frac{RT}{v-b} - \frac{a}{v^2}$$

When we solve the above EOS for the volumes of different systems at the specific temperature and pressure you should obtain three different roots. Explain how do you determine which root is

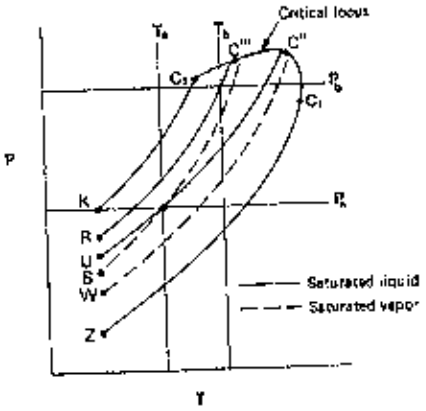
a) the vapor volume of a pure substance.

b) the liquid volume of a pure substance.

c) how do you apply this EOS to obtain the vapor volume of a mixture and

d) the liquid volume of a mixture

A 2. How (also explain why) to find the equilibrium compositions of vapor and liquid phases at a specific T and P from the below PT phase diagram. (9%)



A3. Write out the energy balance eq. for a flow process. (5%)

A4. (a) Write out the entropy balance eq. for a flow process. (5%)

(b) Prove that the entropy generation is greater than zero or equal to zero. (5%)

(c) By giving appropriate examples, prove that friction, heat conduction and diffusion all results in entropy generation. (10%)

注意：背面有試題

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反應工程試題(B)

B 1.(12%)

A first order irreversible gas phase reaction A→2B is carried out isothermally and isobarically at 200℃ and 15 atm total pressure in a tubular plug flow reactor (PFR) of 45 cm in inside diameter. The feed flow rate is 20 gmol/min of a mixture of 40% A and 60% inerts. The rate constant k is 0.2min^{-1}. For a conversion of 90%, determine the length of the PFR reactor.

Hint: $\int_0^x \left(\frac{1+ax}{1-x}\right)dx = (1+a)\ln\left(\frac{1}{1-x}\right) - ax$

B 2.(13%)

A liquid phase reaction, 2A→Products, has been conducted in a 2-liter reactor at 89℃ with a feed concentration C_{A0}=0.473 mol/liter. The following data has been obtained:

Volumetric flow rate (liter/min)	0.05	0.10	0.25	0.50
Conversion	0.94	0.885	0.758	0.609

The reaction rate can be expressed as $-r_A = kC_A^{\alpha}$. Determine the reaction order (α) and rate constant (k).

參考用

B3 (10%) The first-order reversible liquid reaction

$A \leftrightarrow R$, $C_{A0} = 0.5$ mol/liter, $C_{R0} = 0$

Take place in a batch reactor. After 10 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation for this reaction.

B4 (7%) A gaseous feed of pure A (1 mol/liter) enters a mixed flow reactor 3 liters and reacts as follows:

$2A \rightarrow R$, $-r_A = 0.05\ C_A^2$ mol/ (liter*sec)

Find what feed rate (liter/ min) will give an outlet concentration $C_A = 0.5$ mol/liter.

B5 (8%) When aqueous A and aqueous B ($C_{A0} = C_{B0}$) are brought together they react in two possible ways:

$A + B \rightarrow R + T$, $r_R = 50\ C_A$ mol/ (m^3*hr)

$A + B \rightarrow S + U$, $r_S = 100\ C_A$ mol/ (m^3*hr)

To give a mixture whose concentration of active components (A, B, R, S, T, U) is $C_{total} = C_{A0} + C_{B0} = 60$ mol/m^3. Find the size of reactor needed and the R/S ratio produced for 90% conversion of an equimolar feed of $F_{A0} = F_{B0} = 300$ mol/hr in a mixed flow reactor.