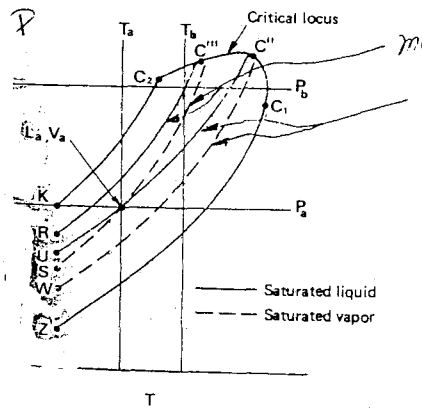
國立中央大學97學年度碩士班考試入學試題卷

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

＊請在試卷答案卷（卡）內作答

熱力學部份

1. Comparing a gas being heated in a constant pressure cylinder and in a constant volume bomb which process requires more heat? (3 %)
   a) the former; b) the latter; c) hard to tell; d) the same.
2. The fugacity coefficient is defied as $\phi = f / p$ (f is fugacity and p is pressure).
   What is $\hat{\phi}_i^v$ for component i in an **ideal gas mixture**? (3 %)
   a) -1; b) 1; c) ∞; d) -∞; e) none of them.
3. What is $\hat{\phi}_i^v$ for component i in an **ideal solution of a gas mixture**? (3 %)
   a) -1; b) 1; c) ϕ; d) ∞; e) -∞.
4. A retrograde condensation means that condensation of a vapor mixture occurs when
   a) temperature is increased; b) pressure is increased; c) temperature is decreased; d) pressure is decreased. (3%)
5. How many degrees of freedom are for a reaction system consisting of H_2, O_2, H_2O and a reaction H_2 (g) + O_2 (g) → H_2O (l) (3%)
   a) 2; b) 4; c) 3; d) 1.
6. The molar volume of a binary mixture is correlated by $V/(ft^3/mol) = 3 + 2(x_1 - x_2)$
   What is the partial molar volume of component 1 in mixture? (5 %)
   a) 2; b) 5; c) 4; d) 3; e) none of them
7. The phase diagram of **constant composition** of methane-water system is shown below where solid lines represent saturated liquid and dotted lines represent saturated vapor. What are the compositions of **water in vapor and liquid** of one equilibrium point shown in the figure? (5%)
   a) 30% and 65%; b) 65% and 30%; c) 30% and 30% d) 65% and 65%.



methane 35%

methane 70%

Constant composition phase diagram

8. Two connected chambers are separated by a piston. The wall and the piston are both well insulated. Initially the piston is fixed with a clip. The volume of chamber A is 0.5 m^3 and the filled ideal gas is at 600 K and 0.2 MPa. The volume of chamber B is also 0.5 m^3 and the filled ideal gas is at 300 K and 0.1 MPa. Assuming the process is close to a reversible process, what will be the final temperature of each chamber after the clip is released. Take the constant volume heat capacity to be 2.5 R. (10 points)
   Note: You need not to obtain the final numerical answer. Simply list all the required equations!

9. There are two bottles of water. Each of them 2 kgs of water. Bottle A is initially at 360 K and Bottle B is at 302.5 K. Assume there is no heat loss to the environment. What is the maximum work that can be obtained from these two bottles of water? Take the specific heat of water to be 4.2 $J\,K^{-1}kg^{-1}$. (10 points)
   Note: If you are not able to obtain the numerical answer. Please list all the required equations!

10. Explain what is so called "second order phase transition" and how to measure this property. (5 points)

參考用

注意：背面有試題

僅應工程部份

Problem 1

A homogeneous liquid phase second-order irreversible reaction A + B → C + D is carried out in a tubular plug-flow reactor having a volume of 5.33 ft^3. A conversion of 50% is attained with a volumetric flow rate of 4.39 ft^3/hr of A and 4.82 ft^3/hr of B (which provides an equimolar flow of A and B of 1.51 lbmol/hr). It is proposed that to increase conversion, a 13.37 ft^3 continuous stirred tank reactor be installed in series and immediately upstream of the plug-flow reactor. Calculate the new conversion. (17 points)

Problem 2

A specific enzyme acts as catalyst in the fermentation of reactant A. At a given enzyme concentration in the aqueous feed stream (50 liter/min) find the volume of plug flow reactor needed for 90% conversion of reactant A (C_{A0} = 1 mol/liter). The kinetics of the fermentation at this enzyme concentration is given by A → R, $-r_A = (0.2\ C_A)/(1 + 0.5\ C_A)$ mol/(liter·min). (10 points)

Problem 3

100 liters/hr of radioactive fluid having a half-life of 30 hr is to be treated by passing it through two ideal stirred tank in series, V = 30,000 liters each. In passing through this system, how much will the activity decay? (7 points)

Problem 4

You are the engineer in charge of an adiabatic CSTR reactor of volume V for producing B from the irreversible elementary reaction A→B in the liquid-phase. It is desired to feed pure A (F_{A0}) to this reactor at the inlet temperature T_0 (K). The data of k_0 (pre-exponential factor of rate constant), E (activation energy of reaction), H_i° (heat of formation of A, B at the reference temperature 298 K) and $C_{pi}(T)$ (heat capacity function of A, B) are given. You want to know the temperature at the outlet stream to prevent losing too much substance by vaporization through the vent system. Describe how to obtain the outlet conversion and temperature. (16 points)

Note: You don't need to make any calculation, but you must clearly list the relationships used.

注意:背面有試題