淡江大學八十七學年度碩士班入學考試試題

系別： 化學工程學系　　科目： 化學反應工程 50%

本試題共 1 頁

1. The elementary irreversible organic liquid-phase reaction

$$A + B \xrightarrow{k} C$$

is carried out in a CSTR. An equal molar feed in A and B enters at 300 K, and the volumetric flow rate is 2 dm^3/s.

(a) Calculate the CSTR volume necessary to achieve 85% conversion when the reaction is carried out adiabatically. [18 pts]

(b) What is the maximum inlet temperature one could have so that the boiling point of the liquid (550 K) would not be exceeded even for complete conversion? [7 pts]

Additional data:

$H_A^0(273\,K) = -20\,kcal/mol$, $H_B^0(273\,K) = -15\,kcal/mol$,

$H_C^0(273\,K) = -41\,kcal/mol$

$C_{A0} = 0.1\,kmol/m^3$

$C_{pA} = C_{pB} = 15\,cal/(mol \cdot K)$, $C_{pC} = 30\,cal/(mol \cdot K)$

$k = 0.01\,dm^3/(mol \cdot s)$ at 300 K, $E = 10{,}000\,cal/mol$

2. An isothermal reversible reaction $A \leftrightarrow B$ is carried out in an aqueous solution. The reaction is first-order in both directions. The forward rate constant is 0.4 hr^{-1} and the equilibrium constant is 4.0. The feed to the plant contains 100 kg/m^3 of A and enters at the rate of 12 m^3/hr. Reactor effluents pass to a separator, where B is completely recovered. The reactor is a stirred tank of volume 60 m^3. A fraction y of the unreacted effluent is recycled as a solution containing 100 kg/m^3 of A and the remainder is discarded.
Product B is worth \$2 per kilogram and operating costs are \$50 per cubic meter of solution entering the separator. What value of y maximizes the operating profit of the plant? What fraction of A fed to plant is converted at the optimum? [25 pts]

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Problem 1 (30 points)

For a mixture of A and B, the partial molal enthalpy of A is given by the formula

$\bar{h}_A = h_A^\circ + C x_B^3$ where h_A° : pure component enthalpy of A

C :constant [Btu / lb.mole]　　x_B: mole fraction of B

(a) compute the corresponding formula for the partial molal enthalpy of B,

(b) if we add isothermally one lb.mole of B to ten lb.mole of A, how much heat is absorbed or released? (given in this case C = 0.5 Btu / lb.mole)

Problem 2 (20 points)

For natural gas, the equation of state is

$Z = 1 - P_r\ [\ 0.554 - 0.3033\ T_r\ ]$ where Z is the compressibility factor (Pv/RT), P_r and T_r are the reduced pressure and reduced temperature. Based on the given equation, calculate the enthalpy change (in Btu/ lb.mole) of a gas that is compressed isothermally from P_r =0.1 to P_r =0.9 at T_r =1.12 ;

given: for homogeneous fluid of constant composition, $dH = TdS + VdP$

$T_c = 500^\circ$ R, $C_p = (\partial H / \partial T)_P$

$(\partial T / \partial P)_S = (\partial V / \partial S)_P$, and $(\partial S / \partial P)_T = -(\partial V / \partial T)_P$