Department of Chemical Engineering

MAJOR

CHL -122

Date: - 05/05/07 **Marks: - 40**

Venue: - WS 209 & WS 213 **Duration: - 2 hrs**

(There are two parts. Use separate answer script for each part)

Part - I

1. One of the key steps in manufacturing of acetic anhydride is

$CH_3COCH_3 \rightarrow CH_2CO + CH_4$, which is a first order reaction with respect to acetone and the specific reaction rate can be expressed by

$ln\,k = 34.34 - \dfrac{34{,}222}{T}$, where k is in reeiprocal seconds and T is in Kelvin. In the design it is desired to feed 8000 kg of acetone per hour to a tubular reactor. If the reactor is adiabatic, the feed pure acetone, the inlet temperature 1035 K, and the pressure 162 kPa (1.6 atm), a tubular reactor of what volume is required for 20% conversion?

Given data: $R = 8.31 \dfrac{kPa.m^3}{kmol.K}$ *and at 298 K the standard heats of formation are:*

$$H^0(T_R)_{CH_3COCH_3} = -216.67\, {}^{kJ}\!/_{mol}$$

$$H^0(T_R)_{CH_2CO} = -61.09\, {}^{kJ}\!/_{mol}$$

$$H^0(T_R)_{CH_4} = -74.81\, {}^{kJ}\!/_{mol}$$

Heat capacities are:

CH_3COCH_3 : $C_{PA} = 26.63 + 0.183T - 45.86\times10^{-6}T^2 J/mol.K$

CH_2CO : $C_{PB} = 20.04 + 0.0945T - 30.95\times10^{-6}T^2 J/mol.K$

CH_4 : $C_{PC} = 13.39 + 0.0775T - 18.71\times10^{-6}T^2 J/mol.K$ 12

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2. A liquid antibiotic containing 500 mg of active ingredient is given to a patient with a body fluid of 40 liters. In the stomaeh, the antibiotie can either be absorbed into the bloodstream through the stomach walls or ean be eliminated through the gastrointestinal traet. Both these processes are first order with rate constants of 0.25 h^{-1} and 0.5 h^{-1} respectively. The only mechanism for the antibiotic to leave the bloodstream is by elimination through urine. This reaction can also be assumed to be first order with a rate constant of 0.4 h^{-1}. The doetor wants to find out the exact time at which the concentration of this antibiotic in the blood peaks in the patient. Determine this time and the concentration of the antibiotic in the blood stream at this time. **8**

Part – II

1. Compound A undergoes a reversible isomerization reaction, $A \rightleftharpoons B$, over a supported metal catalyst. Under pertinent conditions, A and B are liquid, miseible, and of nearly identical density; the equilibrium constant for the reaction (in concentration units) is 5.8. In a fixed bed isothermal flow reaetor in which backmixing is negligible, a feed of pure A undergoes a net conversion to B of 55 %. The reaction is elementary. If a second, identical flow reactor at the same temperature is placed downstream from the first, what overall conversion of A would you expect if:

(a) The reactors are directly conneeted in series?

(b) The products from the first reactor are separated by appropriate processing and only the unconverted A is fed to the second reactor? 14

2. The stochiometry of the deeomposition of ethane could be represented by $C_2H_6 \longrightarrow C_2H_4 + H_2$. The rate of decomposition of ethane was found to be first order with respect to ethane, and the following expression for rate constant was given by

$Log_{10}K_c=15.12-15970/T$

where T is in K and K_c has units of reciprocal seconds. Calculate the conversion of ethane which can be achieved in a plug flow reactor which is operated isothermally at 650 °C and 1 atm pressure with $V/v_T=4$ sec.,where V is the total volume of the reactor and v_T is the volumetric flow rate of the feed at the reactor conditions 650 °C and 1 atm. Use Newtons method to solve the problem.

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