

UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:-

B.Eng. M.Eng.

Chemical Eng E836: Chemical Reaction Engineering

COURSE CODE : **CENGE836**

UNIT VALUE : **0.50**

DATE : **21-MAY-03**

TIME : **10.00**

TIME ALLOWED : **3 Hours**

Answer 4 out of 5 questions. Only the first four answers will be marked.
ALL questions carry a total of 25 each, distributed as shown []

1.

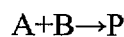
Reactant A produces R and S in the liquid phase by a parallel reaction scheme. The reaction to R is 2nd order and the reaction to S is 1st order. The feed ($C_{A0} = 1 \text{ mol/m}^3$, $C_{R0} = C_{S0} = 0 \text{ mol/m}^3$) enters two CSTRs in series ($\tau_1 = 2.5 \text{ min}$, $\tau_2 = 10 \text{ min}$). Knowing the concentrations in the first reactor ($C_{A1} = 0.4 \text{ mol/m}^3$, $C_{R1} = 0.4 \text{ mol/m}^3$, $C_{S1} = 0.2 \text{ mol/m}^3$), find the concentrations of A, R and S in the outlet of the second reactor. [25]

2.

Consider an elementary, liquid phase irreversible reaction $A \rightarrow B$. Pure, liquid reactant A enters a CSTR with a volumetric flowrate $2.52 \times 10^{-6} \text{ m}^3/\text{min}$ and temperature 20°C . After that it flows to a PFR connected in series with the CSTR. The conversion of A at the exit of the PFR is 97%. Both reactors operate adiabatically. Calculate the volume of the PFR if the volume of the CSTR is 0.378 m^3 . Additional information: $\Delta H_R^\circ = -0.4 \text{ kJ/g}$, $c_{pA} = c_{pB} = 2 \text{ J/g K}$, $k = 7.25 \times 10^{10} e^{(-14570/T)} \text{ s}^{-1}$ (T is in K). [25]

3.

The elementary, liquid phase reaction



with a rate constant $k = 5.2 \text{ dm}^3/\text{mol h}$, is taking place in a continuous reactor. The initial concentrations are $C_{A0} = C_{B0} = 1.23 \text{ mol/dm}^3$.

- What is the volume of a PFR required if a 95% conversion of A and a production of P equal to 322 mol/h are desired?
- What is the volume of a CSTR required for the same inlet and outlet conditions as above? [25]

4.

The irreversible, elementary gas phase reaction $2A \rightarrow 2B$ is carried out isothermally in a fluidised catalyst reactor which behaves as a CSTR and contains 100 kg of catalyst. 50% conversion is obtained for pure A entering at a pressure of 20 atm . There is virtually no pressure drop in the fluidised reactor. It is proposed to use a fixed bed reactor containing the same catalyst weight immediately after the fluidised bed reactor. The pressure drop parameter is $\alpha = 0.009 \text{ kg}^{-1}$. What is the conversion of the reaction mixture exiting the fixed bed reactor? [25]

PLEASE TURN OVER

5.

This question concerns biocatalytic reactor kinetics.

- a) Derive the expression (based on a material balance) to describe the productivity of a batch stirred tank reactor. State the assumptions used. [15]
- b) Why is this type of reactor preferable for industrial operation than a plug-flow reactor or a continuous stirred tank reactor? [5]
- c) For industrial operation why is the batch stirred tank usually used in fed-batch mode? [5]

END OF PAPER