UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:-

B.Eng. *M.Eng.*

Biochemical Eng 3008: Biochemical Reaction Engineering

COURSE CODE	:	**BENG3008**
UNIT VALUE	:	**0.50**
DATE	:	**11-MAY-05**
TIME	:	**10.00**
TIME ALLOWED	:	**3 Hours**

TURN OVER

*Answer **FOUR QUESTIONS.*** **Only the first four answers given will be marked.**
*ALL questions carry a total of **25 MARKS** each, distributed as shown* [ ]

1.

This question concerns the use of immobilised enzymes. Ensure you explain your answers in sufficient depth.

(a) What is the rationale for enzyme immobilisation? [4]

(b) What problems arise when presenting enzymes in this form for potential process implementation and industrial operation? [7]

(c) Describe diffusional limitation in terms of effectiveness factor, Thiele modulus and Damkohler number. [10]

(d) What types of reactors are best suited to operation with an immobilised enzyme? [4]

2.

This question concerns the application of *in-situ* product removal (ISPR) to biocatalytic processes. Ensure you explain your answers in sufficient depth.

(a) Describe the concept of ISPR as applied to biocatalysis. [12]

(b) Under what circumstances is it beneficial to implement ISPR? [4]

(c) What are the constraints on implementation of ISPR on scale-up? [5]

(d) Draw and describe a flowsheet for a typical ISPR-based biocatalytic process using process-medium recycle. [4]

3. This question concerns the kinetics of enzyme-catalysed chemical conversions. Ensure you explain your answers in sufficient depth.

(a) Derive the Michaelis-Menten expression to describe the conversion of a single substrate to product in solution. [15]

(b) What significant feature characterises such kinetics and how does this affect the performance of a continuous stirred tank reactor compared with a continuous plug flow reactor? [5]

(c) Under what circumstances will the expression derived in (a) become invalid? [5]

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4. This question concerns the application of biocatalysis to chemical processing. Ensure you explain your answers in sufficient depth.

(a) Draw a typical flowsheet for an isolated-enzyme based process for chemical synthesis. [5]

(b) In such a process, what are the key capital and operating costs and outline the role of rDNA technology in reducing these costs? [10]

(c) What are the key features of the chemical market served by biocatalysis? [5]

(d) What type of reactions are most commonly mediated by biocatalysis? [5]

5. Hinshelwood and Askey studied the thermal decomposition of dimethyl ether in a batch reactor. For pressures above 0.5 atm the decomposition was first order and proceeded as follows:

$$(CH_3)_2O \rightarrow CH_4 + CO + H_2$$

The expression found for the rate constant for the first-order decomposition of dimethyl ether was

$$\ln k = 30.36 - \frac{29440}{T}$$

where k has the units of s^{-1}, T is in K.

It is proposed to carry this same reaction out in a perfectly mixed flow reactor operated at 550°C and 1 atm pressure. Calculate the respective space velocities (evaluated at the temperature and pressure of the reactor) which are required to achieve conversions of 20%, 50% and 80% of pure dimethyl ether in the perfectly mixed flow reactor. Assume that the mixture behaves as an ideal gas. [25]

6. A liquid phase first-order reaction A→B takes place in two reactors of the same volume which are connected in series. There is a constant feed to the first reactor with flowrate 75 m^3/h and reactant concentration $C_{A0} = 1.6$ mol/m^3. The reactant concentration at the outlet of the second reactor is 0.1 mol/m^3. The reaction rate constant is $k = 0.4\ h^{-1}$. After several days operation, inlet and outlet flows are stopped. The reaction is allowed to continue for time t_F. At that point ($t = t_F$), both reactors are emptied into a common container. In order for the product quality to be maintained, the reactant concentration in the mixture of the container must be 0.1 mol/m^3. Find the time t_F. [25]

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