

UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualifications:-

B.Eng. M.Eng.

Chemical Eng E879: Biochemical Reaction Engineering

COURSE CODE : CENGE879

UNIT VALUE : 0.50

DATE : 21-MAY-03

TIME : 10.00

TIME ALLOWED : 3 Hours

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 limited productivity found in enzyme catalysed reactions.

- a) What measures are used to assess productivity in biocatalytic processes and how would you decide which of these are most important? Give typical numerical values for these metrics. [5]
- b) What is the cause of low productivities? [5]
- c) What techniques are available to increase the product concentration attainable? [5]
- d) What techniques are available to increase the reaction rate? [5]
- e) Describe in detail with diagrams (as appropriate) the operation of one technique listed in your answer to the previous two parts to this question. [5]

2.

This question concerns *in-situ* product removal (ISPR).

- a) Under what circumstances would you consider implementing ISPR? [5]
- b) List the advantages and disadvantages of ISPR. [5]
- c) Devise a development programme to assess the usefulness of implementing ISPR in a biocatalytic process. [15]

3.

This question concerns reaction kinetics.

- a) Derive the Michaelis-Menten expression to describe the kinetics of a homogeneous single substrate conversion using an isolated enzyme. [15]
- b) Define competitive product inhibition and give the mathematical expression to describe this based on Michaelis-Menten kinetics as in (a). [5]
- c) Describe the expression for (a) and (b) graphically with a Lineweaver-Burke plot. [5]

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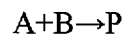
4.

This question concerns biocatalytic reactor kinetics.

- a) Derive the expression (based on mass 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]

5.

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 $C_{A0} = C_{B0} = 1.23 \text{ mol/dm}^3$.

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

6.

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 100kg 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]

END OF PAPER