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**

03-C0202-3-60

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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

$$A+B \rightarrow P$$

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

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 $\alpha = 0.009\ kg^{-1}$. What is the conversion of the reaction mixture exiting the fixed bed reactor? [25]

END OF PAPER