UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For the following qualifications :-

B.Eng. *M.Eng.*

Biochemical Eng E120: Bioprocess Recovery and Purification

COURSE CODE	:	**BENGE120**
UNIT VALUE	:	**1.00**
DATE	:	**03-MAY-02**
TIME	:	**14.30**
TIME ALLOWED	:	**3 hours**

TURN OVER

UNIVERSITY OF LONDON

Biochemical Engineering

E120

Answer ***FOUR QUESTIONS.***
ALL *questions carry a total of* ***25 MARKS*** *each, distributed as shown* [ ]

1. The specification of many downstream processing operations is based on the use of theoretical models and requires assumptions be made about the system being described. In reality performance often differs quite significantly from that predicted by these ideal equations.

Taking two of the following operations as examples explain why deviations from ideality occur and discuss how the differences are dealt with by biochemical engineers.

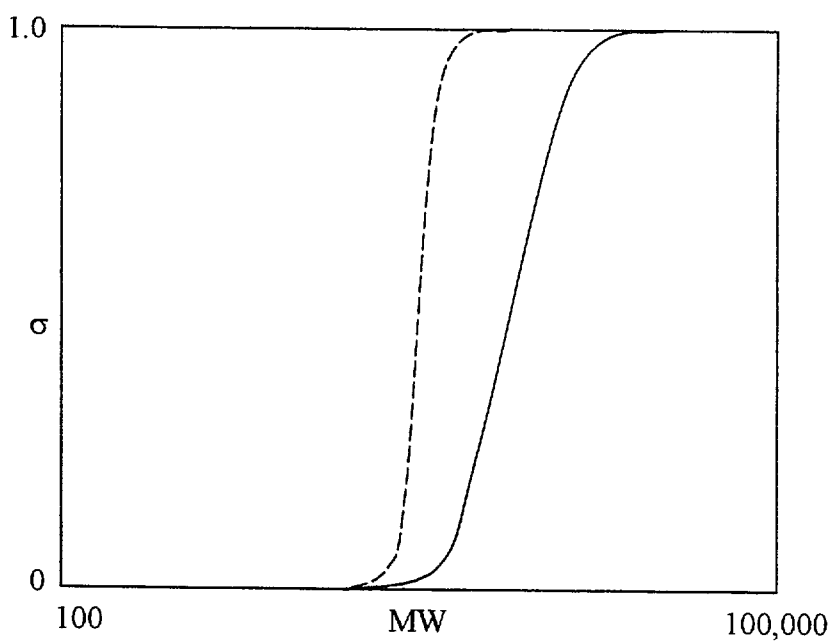
a) Centrifugation [12.5]
b) Membrane selection [12.5]
c) Filtration [12.5]

2. Define the following and explain their use and significance in bioprocess design.

a) Sigma Theory [5]
b) rejection coefficient [5]
c) micronisation [5]
d) Window of Operation [5]
e) Van Deemter curve [5]

3. The specification of a membrane unit for the concentration of a labile protein requires estimation of key design parameters as well as a selection of the appropriate module and membrane type. Provide a checklist for this specification that reflects all aspects of operation including re-use. [15]

The following figure presents rejection data for two membranes. Discuss the salient details and relate these to likely fractionation and transmission behaviour. [10]



TURN OVER

4. a) In practice the conditions selected for many unit operations require that a balance be struck in order to achieve an acceptable output specification. Taking the example of high pressure disruption and subsequent solids removal discuss how such a trade-off comes about and detail the procedure you might adopt in order to identify a suitable operating strategy. [15]

b) The operating conditions chosen will need to reflect the capabilities of subsequent steps in a process. How might the adoption of an expanded bed process alter the decisions reached in part a) of this question? [10]

5. A 1000L batch of clarified fermentation broth is contacted with a solution of a precipitating agent (200L) to recover and concentrate an extracellular protein. A continuous disc stack centrifuge is used for this recovery process. The protein yield at the full scale is just 50% while at laboratory scale using the same precipitating agent solution the yield was ~95%.

Prepare a full analysis of how this reduction of yield may be occurring. [12]

You suspect that much of the problem lies in the properties of the precipitate particles and how easily they are recovered by centrifugation.

Prepare a design of a reactor to work with just 100mL of clarified broth which produces precipitate of the same physical properties as that obtained at the large scale. Give full reasons for all your choices of design. [13]

Details of large-scale reactor; height = diameter; baffled vessel; stirrer speed 30 rpm; stirrer diameter = one third vessel diameter; clarified broth viscosity and density 0.010 Nsm^{-2} and 1000 kg/m^3 respectively.

6. Explain, with full considerations of temperature and moisture profiles in drying droplets, how the following processing variables might affect the retention of activity of a heat labile protein during a spray drying process.

a) concentration of feed [5]
b) inlet air temperature [5]
c) outlet air temperature [5]
d) feed rate of solution to the drier [10]

In all cases the drier is to be operated to keep to the same final powder moisture content. Sketches of locations on moisture sorption isotherms and enthalpy humidity charts for air water systems are required where relevant.

TURN OVER

7. A recombinant strain of *Saccharopolyspora erythraea* has been engineered to produce a novel antibiotic, AB1. During fermentation, however, the strain continues to produce two related antibiotic compounds, AB2 and AB3. The table below gives the mass fraction of each antibiotic in the fermentation broth together with their equilibrium distribution coefficients for extraction with butyl acetate at pH 9.

	AB1	AB2	AB3
Mass fraction (g kg^{-1})	20.0	14.5	10.0
Distribution coefficient, K	10.0	3.0	6.0

a) It is intended to recover AB1 at the pilot scale by extraction with butyl acetate using a centrifugal contactor. The flow rates of broth and solvent to be used are 100 kg hr^{-1} and 40 kg hr^{-1} respectively. If it is necessary to recover 95% w/w of AB1, and the centrifugal contactor corresponds to 2 theoretical stages, estimate the mass fraction of each antibiotic in the solvent extract. Clearly state any assumptions made. [17]

b) Briefly outline the design and operation of centrifugal liquid-liquid contactors and their advantages compared to alternative contactor designs. [8]

A sheet of graph paper is supplied.

END OF PAPER