UNIVERSITY COLLEGE LONDON

University of London

EXAMINATION FOR INTERNAL STUDENTS

For The Following Qualification:-

M.Sc.

Biochem Eng G20: Bioprocess Engineering Design and Regulatory Constraints

COURSE CODE	:	**BENGEG20**
DATE	:	**06-MAY-05**
TIME	:	**14.30**
TIME ALLOWED	:	**2 Hours**

05-C0117-3-50

TURN OVER

*Answer **Question 1** and **THREE** other questions from the rest of the paper.*
Only the first four answers given will be marked.

ALL questions carry a total of 25 marks each, distributed as shown [ ]

1. Define the terms:

a) Lower Flammable Limit
b) Upper Flammable Limit
c) Flash Point
d) Minimum Ignition Energy
e) Autoignition Temperature [8]

and graphically sketch the typical flammability characteristics above identifying the boiling point, flammability range and autoignition region. [7]

List the four sources of ignition that will start a fire and describe an example of each type. [10]

2. Cyclohexane can be produced by the reaction

$$\text{Benzene} + 3\ H_2 \leftrightarrow \text{Cyclohexane}$$

The reaction takes place at 200 °C and 25 atm absolute. Pure benzene is used as a feed stream, but the hydrogen stream contains 2 mole% methane. The desired production rate is 100 mol/h and the costs are benzene at $6.50/mol, hydrogen at $1.32/mol, cyclohexane at $12.03/mol and fuel at $4.00/10^6 Btu. Answer the following questions, justifying and explaining your decisions:

(a) Should the process be batch or continous? [2]

(b) Draw the input-output flowsheet. [10]

(c) Draw the recycle structure. [5]

(d) Assuming that the reaction proceeds to less than 100% conversion, suggest a separation sequence for the process and identify one difficulty in achieving a high purity product stream for this process. [8]

Data: 1 atm boiling points: benzene at 80.1 °C, hydrogen at -252.76 °C, cyclohexane at 80.7 °C and methane at -161.5 °C.

3. Given the following hot and cold process streams:

Stream	***mCp (kW/°C)***	***Tin (°C)***	***Tout (°C)***
C1	2.5	20	125
C2	3	25	100
H1	2.5	150	60
H2	8	90	60

(a) Apply pinch analysis to this set of streams to identify the minimum utility loads assuming a ΔT_{min}=20 °C. Show all work. [15]

(b) What are the pinch temperatures? [5]

(c) Draw the temperature-enthalpy graph for this problem using the results obtained in part (a). Label all quantities identified in (a) and (b) on this graph. [5]

4. What is the role of dislocations in defining the ultimate strength of a material? [5]

How might crack propagation be avoided once a crack has commenced? [5]

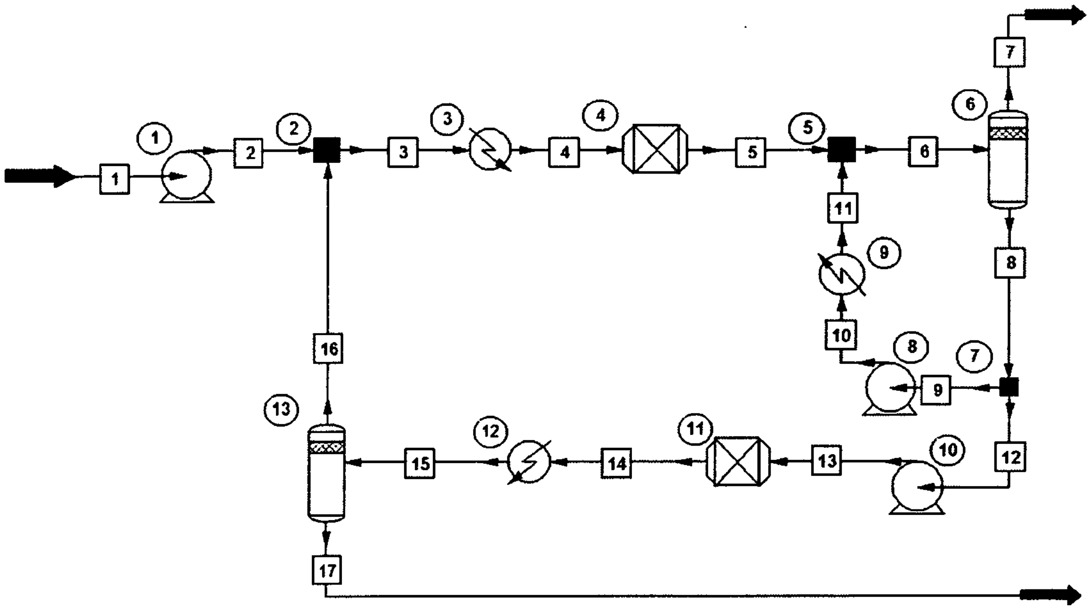
In the pressure vessel codes why is it necessary to add additional thickness to the pressure vessel wall beyond that calculated from a straight stress analysis? [5]

Stainless steels are widely used in the process industries. Why? Give two examples where this would not be a good choice of material of construction. [5]

What is the purpose of creating alloys? Give an example where an alloy other than a steel alloy is needed in a particular process situation. [5]

CONTINUED

5. Draw up a *signal flowgraph* and a *stream precursors list* for the process flowsheet shown in the figure below, where the stream numbers are shown in boxes and unit numbers in circles. [8]



Question 5: Process flowsheet

Starting from this *signal flowgraph* and using *non-essential* and *essential stream node reduction*, determine graphically a *minimum tear set*. [12]

This flowsheet contains "loops within loops". What special step or steps may be taken to help converge such a flowsheet? [5]

6. In the context of process simulation, discuss *briefly* **TWO** of the following:

(i) Selection of vapour-liquid equilibria models. [12½]

(ii) Convergence and convergence acceleration. [12½]

(iii) Simultaneous solution of distillation systems. [12½]

END OF PAPER