

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
END OF SECOND SEMESTER EXAMINATIONS – APRIL/MAY 1999
UNIT OPERATIONS – SCH 2208
TIME: THREE HOURS

INSTRUCTIONS TO CANDIDATES

There are *two* sections to this paper. Pay special attention to the instructions given at the beginning of each section.

SECTION A

Answer *all* question from Section A. Total marks for Section A is 40.

1. Define the following terms:
 - (a) Stack gas
 - (b) Theoretical air
 - (c) Orsat analysis (6 marks)

2. A fuel gas containing 4% H₂, 30% CO, 6% CO₂, 1% O₂ and 59% N₂ is burned with 29% excess air. The combustion of CO is only 95% complete. For 100kg mol of fuel gas, calculate the moles of each component in the outlet stream. (10 marks)

3. Discuss *two* ways in which the utilisation of steam in evaporation processes can be improved. (10 marks)

4. (a) Explain the operation of differential distillation. Derive the main equations. (8 marks)

(b) In flash distillation, how can the mole fraction of the more volatile component in the vapour and the liquid phases be evaluated.

5. Explain the operation of tray and rotating dryers. (6 marks)

SECTION B

Answer *three* questions only from Section B. Each question is worth 20 marks.
Total marks for Section B is 60.

1. In order to concentrate 4536kg/h of NaOH solution containing 10wt % to 20wt % solution, a single effect evaporator is being used with an area of 37.6 m². The feed enters at 294.3K. Saturated steam at 383.2K is used for heating and the temperatures of the evaporator is 353K. Calculate:
- (a) kg/h of steam used.
 - (b) Overall heat transfer coefficient

The latent heat of vaporisations are:

For steam = 2230kJ/kg

For the vapour = 2309kJ/kg (20 marks)

(Use the diagram on page 4)

2. (a) State *any five* parameters to be considered when choosing a solvent for liquid-liquid extraction. (5 marks)
- (b) Write the material balance equations over stage 1,2 and n for multiple extraction in counter-current contact with immiscible solvents. Draw the flow diagram. Explain how the number of theoretical stages can be determined graphically. (15 marks)
3. (a) What is reflux ratio. Explain the influence of the reflux ratio on the number of plates. (5 marks)
- (b) Draw the flow sheet for continuous fractionating column with reboiler and condenser. (5 marks)
- (c) Discuss the graphical method for determining the number of stages using the method of McCabe and Thiele. (10 marks)

4. Calculate the drying time for a liquid (89% moisture w.w.b) which must be dried to 8% moisture (w.w.b). Assume critical and falling rate periods apply with a critical moisture content of 2kg/kg dry material and the following is known.

Liquid

Density	= 993kg/m ³
Particle Diameter	= 279 microns
Latent Heat of Vaporisation	= 2.39 x 10 ⁶ J/kg
Thermal Conductivity	= 0.0314W/m°C

Air

Incoming Temperature (dry bulb)	= 175°C
Wet Bulb Temperature	= 43°C
Exit Air Temperature	= 104.4°C

Product

Density	= 300kg/m ³
Exit Temperature	= 54.4°C

(20 marks)

END OF QUESTION PAPER!!!