

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED CHEMISTRY

END OF SECOND SEMESTER EXAMINATIONS - MAY 2003

UNIT OPERATIONS - SCH 2208

TIME - 3 HOURS

INSTRUCTIONS TO CANDIDATES

Answer only five (5) questions.

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1. (a) With the aid of a sketch diagram derive the continuity equation. (6 marks)
- (b) The initial solution of NaOH contains 79g/l of water. The density of the vaporized solution at 30°C is 1.555g/cm³, which corresponds to a concentration of 840g/l of solution. Determine the amount of water evaporated from 1 ton of initial solution. (8 marks)
- (c) Define the following terms:
(i) evaporation
(ii) evaporator economy
(iii) boiling point elevation (6 marks)
2. (a) After leaving the refinery number 2, fuel oil is piped to a tank farm, where it is pumped into a large cylindrical storage and has a height of 13.20m. If the tank is initially empty, determine the required time to fill it to a height of 12.6m using a pumping rate of 90m³/h. (10 marks)
- (b) A tank initially contains 3.6m³ of brine solution with a concentration of 36kg of salt per cubic meter of solution. If water enters the tank at a rate of 1.0m³/h and the brine solution leaves at the same rate, determine the salt concentration in the tank after half an hour. Assume perfect mixing. (10 marks)
3. (a) Give the advantages and disadvantages of employing forward feed or backward feed. With the aid of a sketch diagram depict either a forward feed or a backward feed of three effects, label clearly. (12 marks)
- (b) A triple effect evaporator is concentrating a liquid that has no appreciable deviation in boiling point. The temperature of the steam in the 1st effect is 110.5°C, the boiling point of the solution in the last effect is 53.7°C. The overall heat-transfer coefficients are 2 800, 2 200 and 1 100 W/m²°C. At what temperature will the liquid boil in the 1st and 2nd effect. (8 marks)

4. Determine the number of plates in a continuous fractional distillation column for the separation of a mixture of methanol – water at atmospheric pressure. The feed contains 31.5%(mol) methanol. If the distillate obtained contains 97.5% (mol) of methanol, whilst the residue of distillation contains 1.1% (mol) of the alcohol. The coefficient of excess reflux is 1.75. The number of plates equivalent to a stage change of concentration is 1.7. The column is heated with vapor from an indirect reboiler. The following information is given at 760mm Hg.

Equilibrium components of liquid and vapor in binary system methanol – water at 1 atm.

t, °C	% (mol) methanol	
	liquid	vapor
100.0	0	0
96.4	2	13.4
93.5	4	23.0
91.2	6	30.4
87.7	10	41.8
81.7	20	57.9
78.0	30	66.5
75.3	40	72.9
73.1	50	77.9
71.2	60	82.5
69.3	70	87.0
67.5	80	91.5
66.0	90	95.8
64.5	100	100

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(20 marks)

5. (a) When choosing solvents for extraction operations, certain qualities are required for this selection. Mention *any three* and explain them in brief. (6 marks)
- (b) For a single-stage extraction derive the material balance and component balance. Use a sketch diagram and also explain how to locate the extract and raffinate points on a triangle diagram. (14 marks)
6. Seeds, containing 20 percent by mass of oil are extracted in a counter current plant, and 90 percent of the oil is recovered in a solution containing 50 percent by mass of oil. If the seeds are extracted with fresh solvent and 1.2kg of solution is removed in the underflow in association with every 2kg of insoluble matter, how many ideal stages are required? (20 marks)

7. (a) A wet solid is to be dried from 80 to 5% moisture, wet basis. Compute the moisture to be evaporated per 1 000kg of dried product. (6 marks)
- (b) With the aid of a sketch diagram, show the equilibrium moisture curve and label it fully. (8 marks)
- (c) Define the following terms:
- (i) equilibrium moisture
 - (ii) free moisture
 - (iii) bound moisture
- (6 marks)

END OF QUESTION PAPER!!!

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