



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
DEPARTMENT OF APPLIED CHEMISTRY
BACHELOR OF SCIENCE HONOURS DEGREE
END OF SECOND SEMESTER EXAMINATIONS – MAY 2011
UNIT OPERATIONS – SCH 2208
TIME: 3 HOURS

Instructions and notes to Candidates

1. There are two sections to this paper: A and B.
 2. Answer ***all*** questions in Section A (40 marks).
 3. Answer ***any two*** questions in Section B (40 marks).
 4. Answer ***all questions*** in Section C (20 marks).
 5. Section A carries 5 questions, Section B carries 3 questions and Section C carries 1 question.
 6. Show all your working steps logically.
 7. Write legibly.
 8. Start answers for each question on a fresh page.
 9. Graph Paper is required
-

SECTION A (40 Marks)

1. Fill in the blanks

- a) A _____ is any part of potentially multiple-step process which can be considered to have a single function for example _____ and _____
[3 marks]
- b) _____ is a process which is generally used to separate a mixture of two or more liquids based on their boiling points but _____ is used for concentrating solutions.
[2 marks]
- c) In evaporation, _____ evaporator is used for producing condensed milk, whilst a _____ evaporator is widely used for concentrating heat sensitive materials such as orange juice because the hold up time is very small.
[2 marks]
- d) The general transport equation is given by _____. [1 mark]

2. a) State the main purpose of the following;
- i) crystallization. [2 marks]
 - ii) drying [2 marks]
- b) State **4** reasons why drying is carried out in the majority of process industries. [4 marks]
3. a) Define the following terms:
- i) Bound moisture. [2 marks]
 - ii) Equilibrium moisture content . [2 marks]
- b) List **4** steps for carrying out a material balance. [4 marks]
4. a) Compare and contrast pasteurization and sterilization. [6 marks]
- b) State Fick's Law. [2 marks]
5. List four factors that affect:
- a) The selection of a solvent in liquid-liquid extraction [4 marks]
 - b) The rate of extraction in leaching. [4 marks]

SECTION B (40 marks)

6. a) With the aid of diagrams, compare and contrast horizontal-tube natural circulation evaporator to vertical-tube natural circulation evaporator. [8 marks]

b) A granular material containing 40 percent moisture is fed to a countercurrent rotary dryer at a temperature of 295 K and is withdrawn at 305 K, containing 5 % moisture. The air supplied which contains 0.006 kg water vapour/kg dry air, enters at 385 K and leaves at 310 K. The dryer handles 0.125 kg/s wet stock. Assuming that radiation losses amount to 20 kJ/kg dry air used, determine the mass flowrate of dry air supplied to the dryer and the humidity of the exit air. The latent heat of water vapour at 295 K = 2449 kJ/kg, specific heat capacity of dried material = 0.88 kJ/kg K, the specific heat capacity of dry air = 1.00 kJ/kg K, and the specific heat capacity of water vapour = 2.01 kJ/kg K.

[12 marks]

7. a) Explain the meaning of the following terms as applied in evaporation.

i) Evaporator economy

ii) Evaporator capacity

[4 marks]

b) With the aid of a diagram, explain the principle of operation of a Bollmann Extractor, and give examples of its industrial application.

[10 marks]

c) After precipitation and draining procedures, it is found that 100 kg of fresh casein curd has a liquid content of 66% and this liquid contains 4.5% of lactose. The curd is washed three times with 194 kg of fresh water each time. Calculate the residual lactose in the casein after drying. Also calculate the quantity of water that would have to be used in a single wash to attain the same lactose content in the

curd as obtained after three washings. Assume perfect washing, and draining of curd to 66% of moisture each time. [6 marks]

8. a) With the aid of a diagram, explain what is freeze drying. Give examples of its industrial application. [7 marks]

c) In 1922, Webre examined the effect of feed temperature on the economy and the evaporation in each effect, for the case of a liquor fed at the rate of 12.5 kg/s to a triple-effect evaporator in which a concentrated product was obtained at a flow rate of 8.75 k g/s. Using the results obtained by Webre, explain the relationship between evaporator economy and initial feed temperature for backward feed triple effect evaporator. [8 marks]

c) In the concentration of orange juice a fresh extracted and strained juice containing 7.08 wt % solids are fed to a vacuum evaporator. In the evaporator, water is removed and the solids content increased to 58 wt % solids. For 1000 kg/h entering, calculate the amounts of the outlet streams of concentrated juice and water. [5 marks]

SECTION C (20 marks)

9. One of the Millennium Development Goals is having a clean environment by around 2025. Understanding unit operations (separation processes) can be of importance in ensuring sustainable process development. Environmental Management Agency (EMA) is facing a number of problems in ensuring sustainable development in Zimbabwe. Advise EMA on the role of unit operations in sustainable process development. [20 marks]

END OF QUESTION PAPER!!!