NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

PRINCIPLES OF PROCESS ENGINEERING

SCH 2218

Supplementary Examination Paper

July 2016

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Engr S Mudono

INSTRUCTIONS

1. Answer **ALL** questions
2. Each question carries 25 marks
3. Use of calculators is permissible

MARKS ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
TOTAL	100

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QUESTION 1

A. With the aid a diagram, explain Newtonian and Non-Newtonian Fluids, highlighting their differences. **[8]**

B. 2×10^5 kg/h of apple juice having a density of 1.85 g/cm^3 and a viscosity of 120 x10^{-3} Pa.s is to be pumped through a 200 mm internal diameter steel pipe 1.5 km long. The delivery end of the pipe is 10 m below the intake.

   i. Calculate the pressure drop due to friction. **[9]**

  ii. If the overall efficiency for the pump is 70 %, what should be the HP of the pump motor? (1 HP = 0.747 kW) **[5]**

  iii. If the electricity costs 9.86 cents per kWh, calculate the annual cost of pumping the oil for 300 days a year. **[3]**

$$\frac{\Delta P_{fr}}{\rho g} = h_{fr} = \frac{4fLv^2}{2gd}; f = \frac{16}{Re} \text{ (laminar)}, f = 0.04\, Re^{-0.4} \text{ (turbulent)}$$

$$\frac{\Delta P_{net}}{\rho g} = h_{fr} + \frac{v^2}{2g} + h_{lift}$$

QUESTION 2

A. Define equimolar counter diffusion with the aid of a well labeled**.** **[6]**

B. Calculate the rate of diffusion of acetic acid (A) across a film of non-diffusing water (B) solution 1 mm thick at 17°C when the concentrations on opposite sides of the film are 9 wt% (density = 1 012 kg/m^3) and 3 wt % (density = 1 003 kg/m^3) acid respectively. The diffusivity of acetic acid in the solution is 0.95 x 10^{-9} m^2/s. **[19]**

M$_W$ of water = 18; M$_W$ of acetic acid = 60

$$N_A = \frac{D_{AB}}{z\, x_{BM}} \left(\frac{\rho}{M}\right)_{av} (x_{A1} - x_{A2})$$

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QUESTION 3

A. Explain what is meant by:

    i.   Blackbody   **[3]**

    ii.   Gray body   **[3]**

B. Sketch a dry rate versus moisture content curve and explain each of the regions. **[12]**

C. What is the heat content of a 5 kg tomato soup concentrate at 30°C above a reference temperature of 0°C.? The specific heat capacity of the soup is 5.025 kJ/kg.K.   **[7]**

QUESTION 4

A. Discuss the factors to be considered when selecting a solvent during liquid-liquid extraction.   **[8]**

B. Counter current extraction system is being used to extract oil from 1 500 kg/h cotton seeds. The system is to be designed to extract oil from cotton seeds with 22 % oil and provide 50 % oil in the extract solution leaving at 1 200 kg/h. If the weight of the extract solution in solids leaving the system is equal to 50 % of the weight of solids, compute the composition of stream containing solids leaving the first stage and the composition of solvent entering stage 1.   **[12]**

C. Explain the importance of distillation in process engineering operations.   **[5]**

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