

End Semester Examinations - 2015-16 Even Semester - May 2016

14FP3002 Mass Transfer Processes in Food Engineering

Set B

Time : 3 hrs
Total Marks: 100

1. Calculate the volume occupied by 1 gm mole of water vapour at 900 C and 100 atm. (i) by the perfect gas law and (ii) using Vander Waal's equation. The Vander Waal's constants for water are, $a = 5.404 \text{ (liter)}^2 \text{ (atm) / (gm.mole)}^2$ and $b = 0.3049 \text{ (liter/gm.mol)}$. Vander Waal's equation is $(P + a/V^2)(V - b) = RT$ (20 marks)

OR

2. a. What are the various types of material balance problems and how to solve these problems (8 marks).
b. An approximate equation for C_p (cal/gm mole $^{\circ}$ K) of gaseous HCl is $C_p = 6.6 + 0.96 \times 10^{-3}T$. Calculate the heat required to raise the temperature of 1 gm mole of gas from 100 to 200 $^{\circ}$ C (12 marks).
3. a. It is required to make 1000 kg mixed containing 60% H₂SO₄, 32% HNO₃ and 8% water by blending i) the spent acid containing 11.3% HNO₃, 44.4% H₂SO₄ and 44.3% H₂O ii) aqueous 90% HNO₃ and iii) aqueous 98% H₂SO₄. All percentages are by mass. Calculate the quantities of the three acids required for blending (12 marks).
b. How much water must be added to 200 kg of concentrated orange juice with 65% solids to produce orange juice with 12% solids?(8 marks).

OR

4. a. Derive the Rayleigh equation starting from the material balance for simple batch distillation (15 marks).
b. Find the ratio of milk with 3.8% fat to milk with 0.5% fat that have to be mixed in order to produce a blend with 3.5% fat (5 marks).
5. a. What are the factors that will affect the process of evaporation explain in detail (10 marks)
b. Obtain the expression for material and energy balance for triple effect evaporator (10 marks)

OR

6. a. An evaporator is fed continuously with 50,000 Kg/hr of a solution containing 10% NaOH, 10% NaCl and 80% water by weight. During the evaporation, water is boiled off and NaCl precipitates as crystals and removed from the remaining liquor. The concentrated liquor leaving the evaporator contains 50% NaOH, 2% NaCl and 48% water. Calculate
i. Kg of water evaporated per hour
ii. Kg of salt precipitated per hour.
iii. Kg of concentrated liquor produced per hour (15 marks).
b. How much glucose syrup with 20% concentration has to be mixed with 100 kg glucose syrup with 40% concentration so that the mixture will have 36% glucose?(5 marks).
7. Derive the equation for operating line for the case of multistage crosscurrent extraction with immiscible solvents and also explain the graphical procedure (equal amount of solvent and $Y_s = 0$) (20 marks).

OR

8. A solution contains 50% benzene, 30% toluene and 20% xylene by weight at a temperature of 100 $^{\circ}$ C. The vapors are in contact with the solution. Calculate the total pressure and the molar percentage compositions of the liquid and the vapour. The vapour pressures and molecular weights are as follows: (20 marks)

Components	Vapor Pressures at 100 $^{\circ}$ C	Molecular Weight
Benzene	1340 mmHg	78

Toluene	560 mmHg	92
Xylene	210 mmHg	106

9. Milk with 3.8% fat and 8.1% fat-free solids (FFS) is used for the production of canned concentrated milk. The process includes separation of the cream in a centrifuge and concentration of the partially defatted milk in an evaporator. If the cream that is produced in the centrifuge contains 55% water, 40% fat, and 5% fat-free solids, calculate how much milk is necessary in order to produce a can of concentrated milk that contains 410 g milk with 7.8% fat and 18.1% fat-free solids. How much cream and how much water must be removed in the centrifuge and the evaporator respectively? Assume steady state (20 marks).

Wishing you All the Best
