Technical University of Mombasa

Faculty of Applied and Health Sciences

DEPARTMENT OF PURE AND APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN APPLIED CHEMISTRY (ANALYTICAL OPTION)

BTAC Y2 S2

ACH 4206 : CHEMICAL PROCESSES

SEMESTER EXAMINATION

DECEMBER 2013 SERIES 2 HOURS

Instructions to candidates:

This paper consists of FIVE questions
Answer question ONE (compulsory) and any other TWO questions

QUESTION ONE

a) Explain the following terms **(8marks)**

(i) Theoretical oxygen
(ii) Accumulation
(iii) Purge stream
(iv) Orsat analysis

b) List Two guidelines for mass and energy balances **(2marks)**

c) When 5.00g of NaOH are added to 100g of water using a calorimeter (with Cp=493.24J/K), the temperature rises from 25.0 to 37˚C. Calculate the molar heat of solution.

$$NaOH(s) \xrightarrow{(aq)} Na^{+}(aq) + OH^{-}(aq)$$

Assume that the specific heat capacity of water is 4.18J/gK; and that of the NaOH(aq)

solution is the same. **(5marks)**

d) Covert the following into the unit given in brackets.

a) 1.5kg/sec(g/hr) **(2marks)**
b) 4.3 x $10^2 m^2/g$ (nm^2/kg) **(2marks)**

e) An aqueous solution of NaCl is prepared by dissolving 25kg NaCl in 100kg H_2O. Calculate the composition of solution by mole%. (Na = 23, Cl = 35.5, H = 1, O = 16) **(4marks)**

f) List THREE energy loss components in chemical plants. **(3marks)**

g) 100moles/hr of C_4H_{10} and 5000moles/hr of air are fed into a combustion reactor. Calculate the percent of excess air. **(4marks)**

QUESTION TWO

a) When ethane (C_2H_6) is burned with atmospheric air, the volumetric analysis of the dry products of combustion yields the following: 10% CO_2, 1% CO, 3% O_2 and 86% N_2. Assume air is composed of 21% oxygen and 79% nitrogen by volume.

(i) Sketch a well labelled diagram for the process **(3marks)**
(ii) Develop the combustion equation for 1mole of ethane **(5marks)**
(iii) Determine the percentage of excess air **(4marks)**

b) During an air pollution monitoring study, the inlet gas stream to a bag filter is 1,690,920m^3/hr and the dust loading is 4577 mg/m^3. The outlet gas stream from the bag filter is 185,040m^3/hr and the dust loading is 57mg/m^3.

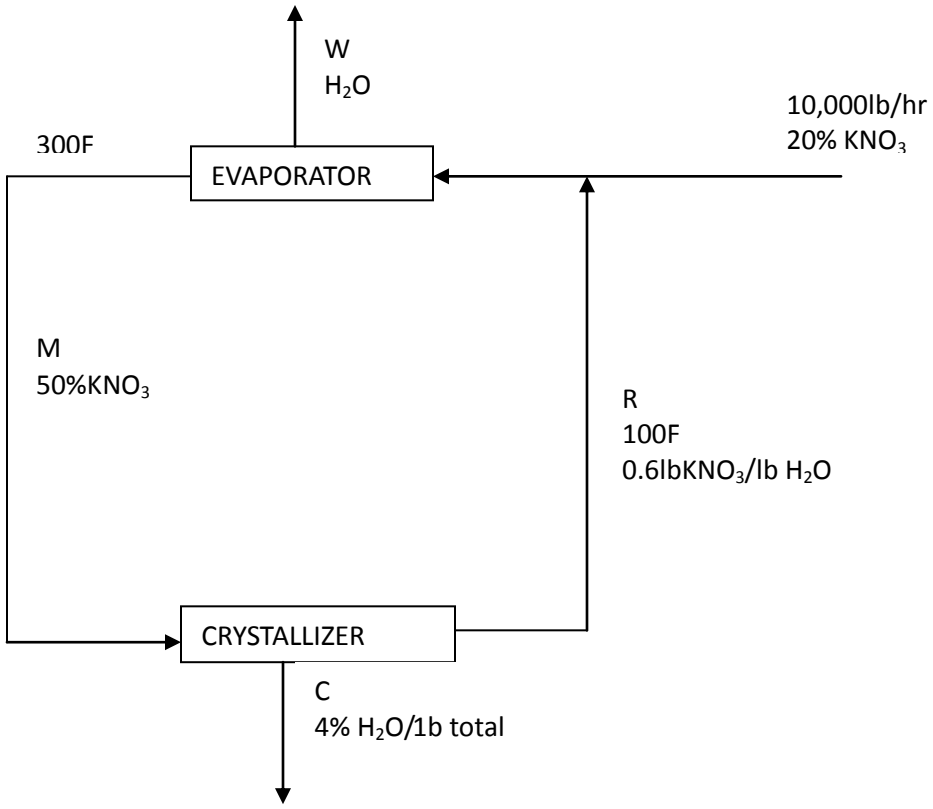
(i) Draw a well labelled flow diagram for the system. **(2marks)**
(ii) Calculate the maximum quantity of ash that will have to be removed from the bag filter hopper in Kg/hr. **(6marks)**

QUESTION THREE

a) The bond energy (KJ) for H_2,F_2 and HF are 436, 158 and 568KJ respectively. Considering the reaction: $H_2(g) + F_2(g) \rightarrow 2HF$

(i) Calculate the enthalpy (energy) of the reaction **(3marks)**
(ii) Draw an energy level diagram for the reaction. **(4marks)**

b) Given the process shown below;



Determine;

(i) Production rate of KNO_3 in Kg/hr. (1kg = 2.21b) **(3marks)**
(ii) Recycle ratio **(2marks)**

c) A stack gas contains 60mole % N_2, 15% CO_2, 10% O_2 and the balance H_2O. Calculate the molar composition of the gas on a dry basis. **(4marks)**

QUESTION FOUR

a) Explain the term Humidification. **(2marks)**
b) Determine the air-fuel for the complete combustion of n-butane (C_4H_{10}) with.

(i) Theoretical air, **(4marks)**
(ii) 50% excess air. **(4marks)**

c) Pineapples contain about 15wt% solids and 85wt% water. To make pineapple Jam, crushed pineapples and sugar are mixed in 55:45 mass ratio and the mixture is heated to evaporate water until the residue contained one-third water by mass.

(i) Draw a well labelled flow diagram for the system **(4marks)**
(ii) Calculate the amount of pineapple jam in kg. **(4marks)**
(iii) Calculate the amount of pineapples needed to make a kg of jam. **(2marks)**

QUESTION FIVE

a) An autoclave contains 1000cans of pea soup. It is heated to an overall temperature of 100˚C. The specific heats of the pea soup and the can metal are respectively 4.1kJ/kg ˚C and 0.50kJ/kg ˚C. The weight of each can is 60g and it contains 0.45kg of pea soup. The cans are to be cooled to 40˚C before leaving the autoclave. (Assume that the heat content of the autoclave walls above 40˚C is 1.6×10^4kJ and that there is no heat loss through the walls. Let w = weight of cooling water required ; and the datum temperature be 40˚C , the temperature of the cans leaving the autoclave. Cooling water enters at 15˚C and leaves at 35˚C). Determine the;

(i) Heat entering the autoclave **(5marks)**
(ii) Heat leaving the autoclave **(3marks)**
(iii) Amount of cooling water required **(2marks)**

b) A part mixture containing 25% of a pigment and the balance water sells for Ksh 18/kg and a mixture containing 12% pigment for Ksh 10/kg. A paint retailer produces a blend containing 17% pigment.

(i) Draw a well labelled diagram for the process **(3marks)**
(ii) Calculate the price, in Ksh, the product should be sold to yield a 10% profit. **(7marks)**