UNIVERSITY OF GHANA
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SCHOOL OF ENGINEERING SCIENCES
DEPARTMENT OF FOOD PROCESS ENGINEERING
B.Sc FIRST SEMESTER FINAL EXAMINATION, 2014/2015

FPEN 201: INTRODUCTION TO FOOD PROCESS ENGINEERING (2 Credits)

Answer <u>FOUR</u> questions only. All questions carry equal marks.   <u>Time: 2 Hrs</u>

Question 1

a) It is desired to prepare a sweetened concentrated orange juice. The initial pressed juice contains 5% of total solids and it is desired to lift this to 10% of total solids by evaporation and then to add sugar to give 2% of added sugar in the concentrated juice. Calculate the quantity of water that must be removed and of sugar that must be added with respect to each 1000 kg of pressed juice.

b) A gaseous mixture containing 90% C_2H_6 and 10% O_2 is burned in an engine with 200% excess air. Ninety percent of the ethane goes to CO_2, 5% goes to CO and 5% remains unburned.

    i) What is the amount of the excess air per 100 moles of the gas?

    ii) What is the moles CO produced per 100 moles of the gas?

Question 2

a) What made the Haber process for the manufacture of ammonia so important industrially as to win Fritz Haber the Nobel prize in Chemistry in 1919?

b) In the famous Haber process to manufacture ammonia, the reaction is carried out at pressures of 800 to 1000 atm and at 500 to 600°C using a catalyst. Only small fraction of the material entering the reactor reacts on one pass, so recycle is needed. Also, because the nitrogen is obtained from the air, it contains almost 1% rare gases (chiefly argon, Ar) that do not react. The rare gases would continue to build up in the recycle until their effect on the reaction equilibrium would become adverse, so that a small purge stream is used.

As shown in the diagram below, the fresh feed of gas composed of 74.35% H_2, 25.4% N_2, and the remainder Ar, is mixed with the recycled gas and enters the reactor with a composition of

78.4% H_2. The gas stream leaving the ammonia separator contains 79.2% H_2 and no ammonia. The product ammonia contains no dissolved gases. Per 100 mole of fresh feed:

i) How many moles are recycled?

ii) How many moles are purged?

$$3H_2 + N_2 = 2NH_3$$

N₂, H₂, Ar
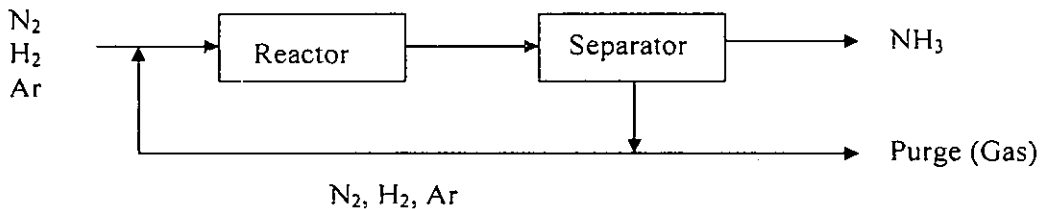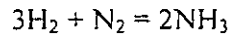
Question 3

a) Convert 9.32 mg/kg air of a certain pollutant in air to parts per million, ppm

A tomato juice evaporator takes in juice at the rate of 1200 kg/h. If the concentrated juice contains 35% of solids and the hourly rate of removal of water is 960 kg.
Calculate

    b) percentage water in the original mixture

    c) the quantity of steam needed per hour for heating if the evaporator works at a pressure of 10 kPa and the heat available from the steam is 2200 kJ/kg.

Assume no heat losses and the latent heat of vaporization of water at the given condition is 2200 kJ/kg.

Question 4

a) Show with the aid of separate flowsheet diagrams, recycling, bypassing and purging.
    Explain with one sentence each, the purpose of each process.

b) Fish caught by human beings can be turned into fish meal, and the fish meal can be used as feed to produce meat for human beings or used directly as food. The direct use of fish meal significantly increases the efficiency of the food chain. However, fish-protein concentrate,