Department of Chemical Engineering
SRM University
Cycle Test – 1

CH2002 Computer Aided Process Plant Design

Year/Sem. : I/1st Date : 23/09/2016
Total Marks : 50 Duration : 50 min

Part - A
Answer **ALL** Questions
(5 x 2 = 10 Marks)

Bold face fonts of choices are the answers for the Part – A questions

1. Which of the following is **INCORRECT**? A batch process is

   (a) designed to operate intermittently.
   (b) being frequently shut down and start up
   (c) used where some flexibility is desired in production rate
   (d) designed to operate without downtime (start up and shut down)

2. Identify the **FALSE** Statement? A steady state process is

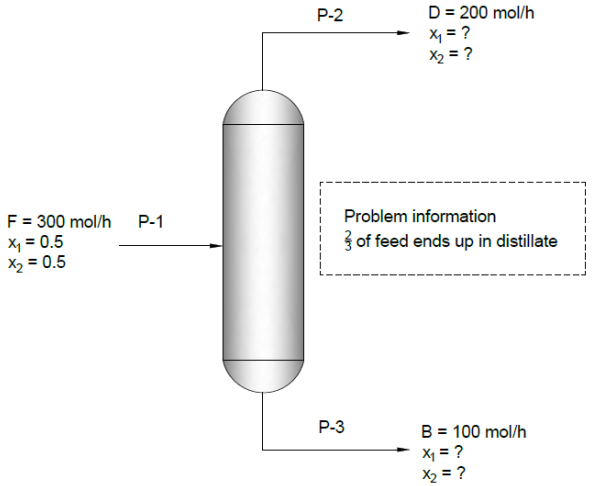
   (a) the one where the process parameters remains unchanged with time
   (b) the one in which temperature, pressure, and concentration remains unchanged with time
   (c) a transient process in which the parameters vary with time
   (d) in which input to the system is equal to output from the system

3. Is the set of equations independent? Justify your answer.

$$x + 2y + z = 2$$
$$2x + 1y - z = 2$$
$$3x + 3y = 3$$

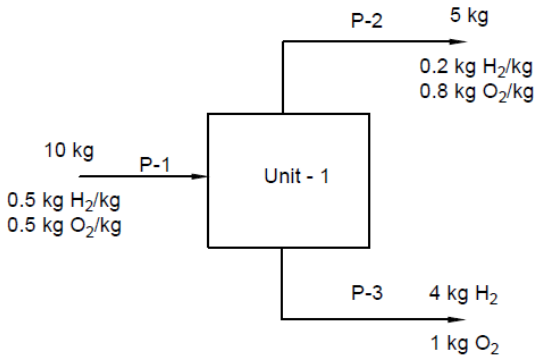
Ans: The above equations are independent. Since we cannot add or subtract to get another equation.

4. Consider the process flow diagram as shown in figure given below and perform a degrees of freedom analysis.



Ans: DoF (Degrees of freedom) = Number of unknowns – Number of independent equations – Number of auxiliary relations

5. Prove that the following flow diagram depicts a balanced process by writing three balances (2 components and 1 Overall balance).



H_2 Balance:

H_2 in = H_2 out

$10 \times 0.5 = 5 \times 0.2 + 4$

5kg = (1 + 4) kg

(5kg) H_2 in = (5kg) H_2 out

O_2 Balance:

O_2 in = O_2 out

$10 \times 0.5 = 5 \times 0.8 + 1$

5kg = (1 + 4) kg

5kg = 5 kg

(5kg) H_2 in = (5kg) H_2 out

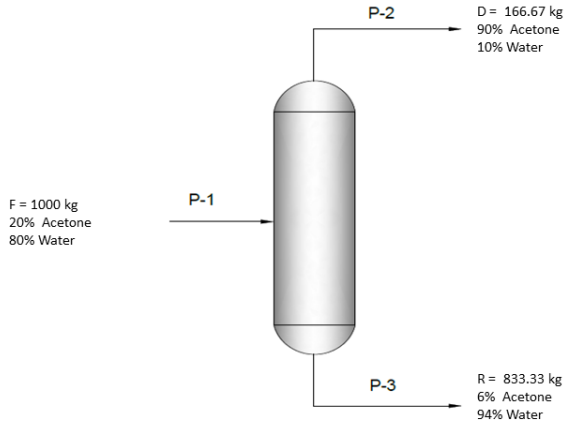
Part – B

Answer **ALL** Questions

(8 x 5 = 40 Marks)

6. A plant distills 1000 kg of 20% solution of acetone in water 50 kg of pure acetone is lost in the water residue. The distillate contains 90% acetone and 10% water. Draw the flow chart representing all the inlet ad outlet streams. Calculate the weight of the distillate and residue. Label and show all the calculated quantities in the flow chart. **(8 Marks).**

Solution flow chart is given in the flow chart as follows:



7. A solution contains 25% salt in water (i) express the composition in kilogram of water per kilogram of salt and kilogram of salt per per kilogram of water. (ii) what is the composition of the solution in weight percent of salt if 40% of water originally present is evaporated? (iii) what is the composition if an amount of water equal to 40% of the weight of the original solution is evaporated? (iv) how much of water must be evaporated from 100 kg of a solution if the final composition has to be 40% water? **(8 Marks)**

Solution:

Basis: 100 kg of solution

Wt. of salt in 100 kg of solution = 25 kg

Wt. of water in 100 kg of solution = 75 kg

Total Wt. of the solution = 100 kg

i. Compositions: kg of salt/ kg of water = 75/25 = 3.00 kg

kg of salt/kg of water = 25/75 = 0. 33 kg

ii. Wt. of H_2O present in original solution= 75 kg

Wt. of H_2O evaporated (75×40/100) = 30 kg (40 % H_2O removed)

Wt. of water remained = 75 – 30 = 45 kg of water
Weight of final solution = Wt. of Salt + Wt. of Water
= 25 + 45 = 70 kg
Now composition of Salt in solution = Wt. of salt/ Wt. of final soln. = 25/70 ×100 = 35.71 %

iii. Wt. of original solution = 100 kg
Wt. of H_2O evaporated (100×40/100) = 40 kg (40% of H2O removed)
Wt. of water remaining in the soln. = 75 – 40 = 35 kg
Composition of salt in the solution = 25/60×100 = 41.67 Wt%.

iv. H_2O is evaporated until the wt. % of H_2O in the resultant solution becomes 40%. The remaining 60% is salt which weighs 25 kg.
Wt. of H_2O in the resultant solution = 25×40/60 = 16.67 kg
Wt. of H_2O to be evaporated = (Wt. of H_2O in Original Solution – Wt. of water in final solution) = 75 – 16.67 = 58.33 kg

8. Name the various flow diagrams used in the development of a process industries and explain each of them. **(8 Marks)**

Ans.

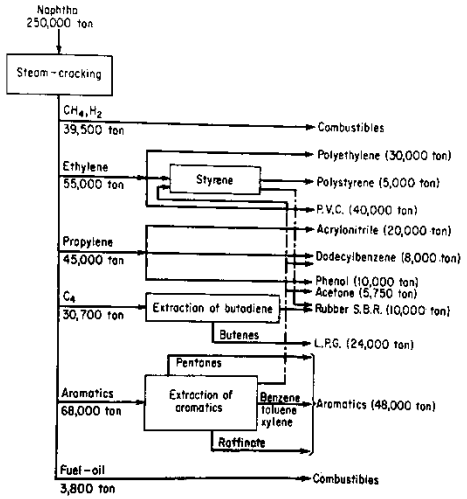
(a) Block Diagram (b) Process Flow Diagram (PFD) and (C) Piping and Instrumentation Diagram (P&ID).

(a) Block Diagram: Simplest form of presentation of material flows. Each block represents single piece of equipment or complete stage of processes. It is useful representing a process in a simplified form.

(b) Process Flow Diagram: All the incoming and outgoing materials and utilities are shown. Arrangement of major pieces of equipment and their interconnections. Operating conditions of each stream.

(c) Piping and instrumentation diagram shows the arrangement of the process equipment, instrument, piping, valves and fittings and their arrangement.

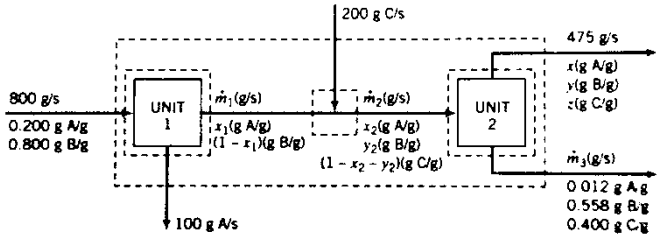
9. Examine the flow sheet given below which illustrates the conversion of Naptha into useful products through steam cracking. Write the general balance equation on conserved quantitates. Check the mass in equal to mass out? Give any two reasons why the mass does or does not balance.



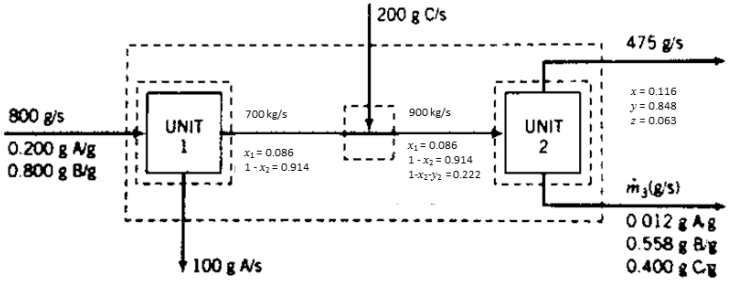
Solution

Input is not equal to output.
Combustion process involved in the product formation is complex in order to balance the mass. Also accumulation, generation and consumption terms in general material balance is not clear in the above flow diagram.

10. Following is a labeled flow chart for a steady-state two unit process, with boundaries shown to denote subsystems about which balances can be taken. State the maximum number of balances that can be written for each subsystem and the order in which you would write balances to determine unknown process variables. Calculate all the unknown quantities shown in the flow chart. Draw and label all the unknown quantitates in the flow chart. **(8 Marks)**



Solution



(or)

11. Draw the detailed structure of chemical engineering project representing basic and detailed engineering. **(8 Marks)**

Ans.