

JK Lakshmipat University, Jaipur
Institute of Engineering and Technology
End Term Examination

B.Tech.[2nd Year]/[3rd Semester]/[2013-14]

Course Name: CHEMICAL PROCESS CALCULATIONS

Max Marks: 40

Course Code: CHE301

Time: 03.00 hr

Instructions:

1. Attempt all sections.
2. Draw diagrams wherever necessary.

Section A

(10 Marks)

Q.1 ANSWER THE FOLLOWING:

(5 MARKS)

1. Convert 5.5 in to m.
2. Define Molar Volume.
3. Define Selectivity.
4. State the ideal gas law in terms of Molar Volume.
5. Explain BYPASS in industrial application of material balance.

Q.2 ANSWER IN BRIEF:

(5 MARKS)

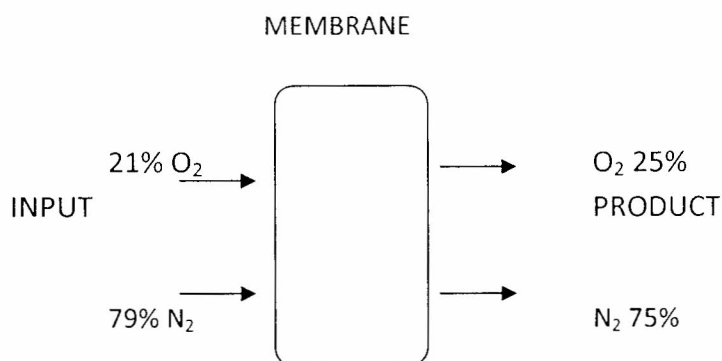
1. The heat capacity of sulfuric acid has the units J/ (gmol)(⁰C) and is given by the relation
Heat capacity = $139.1 + 1.56 \times 10^{-1}T$
Where T is expressed in ⁰C. modify the formula so that the resulting expression has the associated units of Btu/(lbmol)(⁰R) and T is in ⁰R.
2. Find the value for universal gas constant R to match the following combinations of units: for 1 gmol of ideal gas when the pressure is in atm, the volume is in cm³ and the temperature is in K.

Section B

(20 Marks)

Q.3 ANSWER ANY FOUR:

1. A cylinder containing CH₄, C₂H₆ and N₂ has to be prepared to containing a CH₄ to C₂H₆ mole ratio of 1.5 to 1. Available to prepare the mixture are (1) a cylinder containing mixture of 80% N₂ and 20% CH₄, (2) a cylinder containing a mixture of 90% N₂ and 10% C₂H₆, and (3) a cylinder containing pure N₂. What is the number of degrees of freedom?
2. The following figure illustrates a nanoporous membrane that is made by coating a very thin layer of polymer on a porous graphite supporting layer.



3. A limestone analyses (weight%)

CaCO₃ 92.89%

MgCO₃ 5.41%

Inert 1.70%

By heating the limestone you recover oxides known as lime.

- How many pounds of calcium oxide can be made from 1 ton of this limestone?
- How many pounds of CO₂ can be recovered per pound of limestone?
- How many pounds of limestone are needed to make 1 ton of lime?

4. Explain:

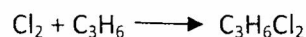
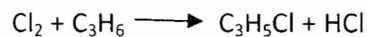
- Extent of reaction
- Conversion
- Recycle
- Bypass
- Purge

5. What is the density of N₂ at 27°C and 100 KPa in SI units?

Section C

(10 Marks)

1. For the following two reactions:



COMPONENT	M.W
C ₃ H ₆	42.08
C ₃ H ₅ Cl	76.53
C ₃ H ₆ Cl ₂	112.9

The species recovered after the reaction takes place for sometime are:

SPECIES	Gmol
Cl ₂	141.0

C_3H_6	651.0
C_3H_5Cl	4.6
$C_3H_6Cl_2$	24.5
HCl	4.6

Based on the product distribution, calculate the following:

- How much Cl_2 and C_3H_6 were fed to the reactor in gmol?
- What was the limiting reactant?
- What was the excess reactant?
- What was the fraction conversion of C_3H_6 to C_3H_5Cl ?
- What was the selectivity of C_3H_5Cl to $C_3H_6Cl_2$?
- What was the yield of C_3H_5Cl expressed in gram of C_3H_5Cl to gram of C_3H_6 fed to the reactor?
- What was the extent of reaction of the first and second reaction?

2. For the reaction:

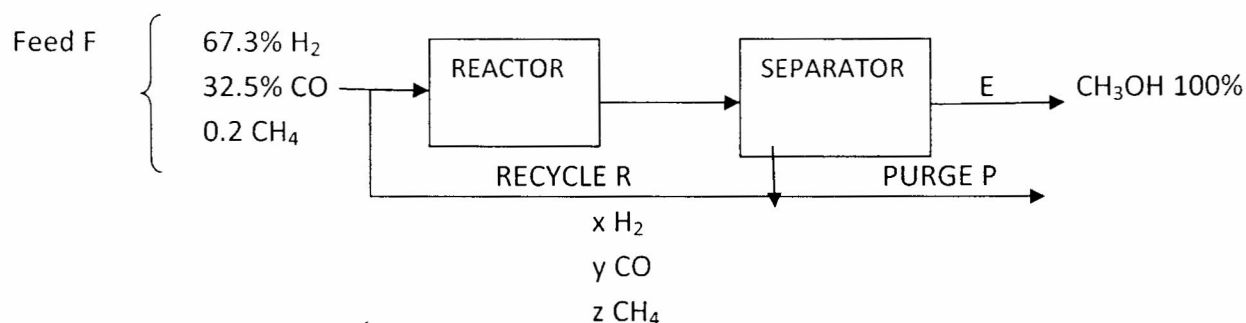
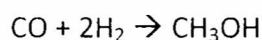


figure illustrates a steady state process for the production of methanol. All of the compositions are in mole fractions or percent. The stream flows are in moles.

Note, in the figure, some CH_4 enters the process, but does not participate in the reaction. A **purge** stream is used to maintain the CH_4 concentration in the exit from the separator at no more than 3.2 mol%, and prevent hydrogen buildup as well. The once through conversion of the CO in the reactor is 18%.

Compute the moles of recycle, CH_3OH and purge per mole of feed, and also compute purge gas composition.