UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Year 2003/2004

February/March 2004

IEK 101/3 – CHEMICAL PROCESS CALCULATION

Duration : 3 Hours

Please make sure that this examination questions contains **FIVE (5)** printed pages before you start the examination.

Answer FIVE from six questions. Questions may be answered in English or in Bahasa Malaysia.

1. Antimony is obtained by heating pulverized stibnite (Sb_2S_3) with pieces of scrap iron while drawing off the molten antimony from the bottom of the reactor.

    $$Sb_2S_3 + 3Fe \quad 2Sb + 3FeS$$

    If approximately 0.006kg of stibnite and 0.20 kg scrap iron turnings are heated together to generate 0.200 kg metal Sb. Calculate what is ?

    - i)   The limiting reactant.
    - ii) The percentage of excess reactant
    - iii) The degree of completion (fraction)
    - iv) The percent conversion
    - v)   The Yield

Components	Mol Wt	Kg
Sb_2S_3	339.7	0.600
Fe	55.85	0.250
Sb	121.8	0.200
FeS	87.91	

(100 point)

2. A petroleum mixture contains 20% propane (C_3), 20% isobutane (i-C_4), 20% isopentane (i-C_5) and 40% normal pentane (C_5) is fed into a distillation column. All C_3 and no of C_5 will be present in the top product stream. Analysis of the distillation yield indicates that 50% C_3 and 45% i-C_4. Calculate the composition of the bottom stream.

50% C_3
45% i-C_4 D
5% ?   (i-C_5)

20% C_3
F   20% i-C_4
20% i-C_5
40% C_5

?   (C_5)
?   (i-C_4)   B
?   (i-C_5)
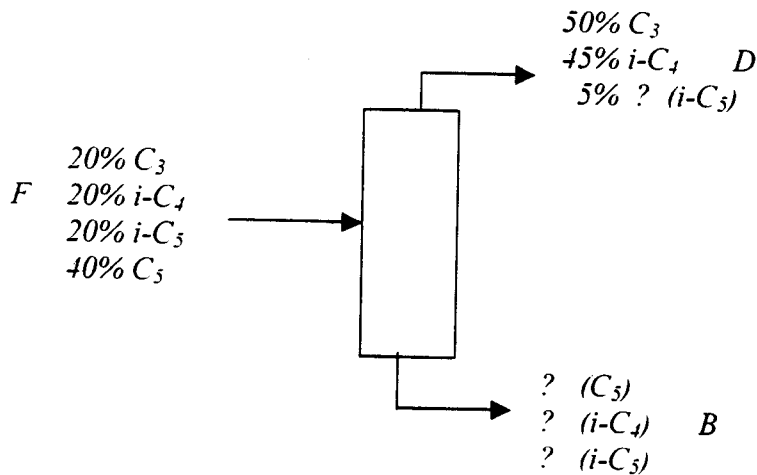
(100 points)

3. Calculate the heat enthalpy of 1 kg of steam in various conditions below:

(a) 1723 kPa. 79°C
(b) 232.1 kPa. 125°C. q = 0.9
(c) 700 kPa. 211°C. C_p = 2265.6 J/kg-°C
(d) 800.0 kPa. 79.57°C. superheat. C_p = 2265.6 J/kg-°C
(e) What is the amount of condensate needed to superheat steam at 400 kPa having superheated temperature at 56.37°C ?
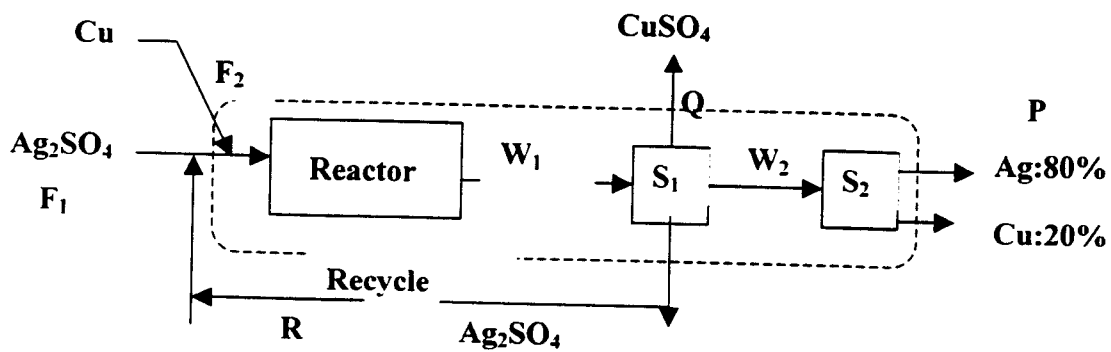
(100 points)

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4. A furnace is burning coke that contains only carbon and inorganic ash. The carbon content in the coke is 90 %. Analysis of waste ash after having wetted with water indicates 10 % carbon. 40 % ash and water. The gas analysis from the chimney shows that 14 % CO_2. 1 % CO, 6.4 % O_2. and the remaining is nitrogen. In order to assess the condition of the furnace calculate:

(a) No of mol of flue gas per 2000 kg coke fed into the furnace;
(b) Percent excess air that is utilized;
(c) Percent of combustable materials that is lost with ash.

(100 points)

5. A tank containing 500 g gas having composition as indicated: CS_2. 20%: CO. 30%: CH_4. 50%. What is the average molecular weight for the gas mixtures ?

(100 points)

6. Silver metal is obtained from sulfide ores by a grilling process and converting it to sulfate while mixing with water. and settled the silver with copper. In the figure below. material that has been left in the second separator contains 80% silver and 20% copper. In order to produce 100 kg material from separator S_2. determine the amount of Cu. If the reaction is up to 80% complete and Ag_2SO_4 as the limiting reactant .what is the recycle stream R in kg ?

$$Ag_2SO_4 \quad + \quad Cu \quad \rightarrow \quad 2Ag \quad + \quad CuSO_4$$

Molecular Wt   312   63.5   107.9   159.6

(100 points)

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