

B.TECH SEM - III (2007 COURSE) (CHEMICAL ENGG.) :
SUMMER - 2018
SUBJECT : STOICHIOMETRY

Day : Friday
Date : 25/05/2018

S-2018-2561

Time : 02.30 PM TO 05.30 PM
Max. Marks : 80

N. B. :

- 1) **Q. No. 1 and Q. No. 5 are COMPULSORY.** Out of remaining attempt **ANY TWO** question from Section – I and Section – II.
- 2) Figures to the right indicate **FULL** marks.
- 3) Answers to both the sections should be written in **SEPARATE** answer books.
- 4) Draw neat and labeled diagram **WHEREVER** necessary.
- 5) Assume suitable data, if necessary.

SECTION - I

- Q. 1 a)** A saturated solution of salicylic acid ($\text{HOC}_6\text{H}_4\text{COOH}$) in methanol contains 64 kg salicylic acid per 100 kg methanol at 298 K. Find the weight % and mole % compositions of the solution. **(04)**
- b)** The spent acid from a nitrating process contains 21 % HNO_3 , 55 % H_2SO_4 and 24% H_2O by weight is to be concentrated by addition of concentrated sulphuric acid containing 93 % H_2SO_4 and concentrated nitric acid containing 90 % HNO_3 to get desired mixed acid containing 28% HNO_3 and 62 % H_2SO_4 . Calculate the weights of spent acid, concentrated sulphuric acid and concentrated nitric acid that must be combined to obtain 1000 kg of the desired mixed acid. **(06)**
- c)** Explain limiting reactant and percent conversion with suitable example. **(04)**
- Q. 2 a)** A gas mixture has the following composition by volume: **(07)**
 $\text{C}_2\text{H}_4 = 30.6\%$, $\text{C}_6\text{H}_6 = 24.5\%$, $\text{O}_2 = 1.3\%$, $\text{CH}_4 = 15.5\%$,
 $\text{C}_2\text{H}_6 = 25\%$ and $\text{N}_2 = 3.1\%$
Calculate:
i) The average molecular weight of gas mixture.
ii) The composition by weight and
iii) The density of the mixture in kg/m^3 at 101.325 kPa and 273 K.
- b)** Explain normality, molarity and molality of the solution. **(06)**
- Q. 3 a)** The ground net seeds containing 45 % oil and 45 % solids are fed to expeller, the cake coming out of expeller is found to contain 80% solids and 5 % oil. Find the percentage recovery of oil. **(07)**
- b)** Explain in detail evaporation operation with block diagram and material balance. **(06)**
- Q. 4 a)** Gaseous benzene reacts with hydrogen in presence of Ni catalyst as per the following reaction **(07)**
$$\text{C}_6\text{H}_6 (g) + 3\text{H}_2 (g) \rightarrow \text{C}_6\text{H}_{12} (g)$$

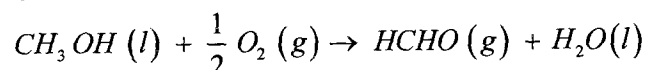
30 % excess hydrogen is used above that required by the given reaction. Conversion is 50 % and yield is 90 %. Calculate the requirement of benzene and hydrogen gas for 100 moles of cyclohexane.
- b)** Explain in detail bypass operation with suitable example. **(06)**

P. T. O.

SECTION - II

Q. 5 a) Explain dry bulb temperature, wet bulb temperature and dew point. **(06)**

b) Calculate the standard heat of reaction of the following reaction: **(04)**



Data:

| Component | $\Delta H_f^0, kJ/mol$ at 298k |
|-------------|--------------------------------|
| $CH_3OH(l)$ | -239.2 |
| $HCHO(g)$ | -108.6 |
| $H_2O(l)$ | -285.83 |

c) Calculate the net calorific value (NCV) at 298 K for a sample of fuel oil **(04)**
having C/H ratio 9.33 (by weight) and containing sulphur to the extent of 1.3 % by weight.

Data: The GCV of fuel oil at 298 K = 41785 kJ/kg.

Latent heat of water vapour at 298 K = 2442.5 kJ/kg.

Q. 6 a) A mixture of acetone vapour and nitrogen contains 14.8 % acetone by **(07)**
volume. Calculate the following at 239 K and a pressure of 99.33 kPa.

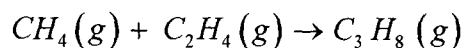
Calculate:

- i) Partial pressure of acetone
- ii) Moles of acetone per moles of nitrogen.
- iii) Relative saturation of mixture at 293 K.

Data: vapour pressure of acetone at 293 K = 24.638 kPa.

b) Explain in detail humidification and dehumidification. **(06)**

Q. 7 a) Obtain an empirical equation for calculating the heat of reaction at any **(07)**
temperature T (in K) for the following reaction:



Data: ΔH_R^0 at 298k = -82.66 kJ/mol

$$C_p^0 = a + bT + cT^2 + dT^3, kJ/(kmol.K)$$

| Component | a | $b \times 10^3$ | $c \times 10^6$ | $d \times 10^9$ |
|-------------|---------|-----------------|-----------------|-----------------|
| $CH_4(g)$ | 19.2494 | 52.1135 | 11.973 | -11.3173 |
| $C_2H_4(g)$ | 4.1261 | 155.0213 | -81.5455 | 16.9755 |
| $C_3H_8(g)$ | -4.2227 | 306.264 | -158.6316 | 32.1455 |

b) Explain general procedure for energy balance calculations. **(06)**

Q. 8 a) The Orsat analysis of the flue gas from a boiler house chimney has the (07)
following composition by volume:

$$CO_2 = 11.4\%, O_2 = 4.2\% \text{ and } N_2 = 84.4\%$$

Assuming the complete combination

Calculate:

- i) % excess air and
- ii) C : H ratio of dry flue gas

b) Explain in detail Net Calorific Value (NCV) and Gross Calorific Values (06)
(GCV) of fuel.

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