Indian Forest Service Exam, 2010

Serial No. 0822 **B–JGT–K–DFB**

CHEMICAL ENGINEERING

Paper—II

Time Allowed : Three Hours *Maximum Marks : 200*

INSTRUCTIONS

*Candidates should attempt question nos. **1** and **5** which are compulsory, and any **THREE** of the remaining questions, selecting at least **ONE** question from each Section.*

All questions carry equal marks. Marks allotted to each part of a question are indicated against each.

*Answers must be written in **ENGLISH** only.*

Assume suitable data, if considered necessary, and indicate the same clearly.

Symbols and notations have their usual meanings.

Neat sketches may be drawn, wherever required.

SECTION—A

1. Answer any **FIVE** of the following in about 100 words each : 8×5=40

   (a) What is criteria for Chemical Reaction Equilibria ?

   (b) A solution of acetic acid (CH_3COOH) in water (H_2O) contains 20 mole percent CH_3COOH. Express the composition of the solution in weight percent (weight %).

   (c) Derive the following relation from fundamentals :

   $$Tds = C_p dT - \beta VTdp.$$

   The symbols have their usual meanings.

   (d) Briefly discuss about "Effectiveness Factor".

   (e) Distinguish between ideal and non-ideal flow reactors.

   (f) Explain in brief the procedure to calculate bubble point and dew point of a given binary mixture.

2. (a) Derive an expression for the design equation of CSTR. 15

   (b) Analyse the performance of three-CSTR in series. 15

   (c) Bring out the criteria for vapour-liquid equilibria. 10

3. (a) Draw a P-x-y diagram for binary system consisting of Benzene (1) and Toluene (2) at 50°C. The vapour pressures of Benzene and Toluene at 50°C are P_1^{Sat} = 35·98 kPa and P_2^{Sat} = 12·20 kPa. Using above data, calculate and tabulate isothermal P-x-y data. Draw a P-x-y diagram using graph paper. 16

(b) The value of equilibrium constant for chemical reaction equilibria is four (4) at 200°C temperature and 1 atm pressure for reaction :

$$A + B \rightleftharpoons C + D.$$

Calculate the value of equilibrium conversion for the above reaction under given sets of conditions. Make suitable assumptions if required. 12

(c) Discuss and bring out the significance of the terms 'Fugacity', 'Activity' and 'Chemical potential'. 12

4. (a) Pure oxygen is mixed with air to produce an enriched air containing 60% by volume of oxygen (O_2). Determine the ratio of air to oxygen used. 10

(b) Discuss the following with suitable examples :

(i) Limiting and Excess Reactant

(ii) Recycle and Bypass Ratio

(iii) Bypass and Purge Streams. 18

(c) Define Adiabatic Flame Temperature and show how it can be determined for a gaseous fuel burning in air. 12

SECTION—B

5. Write on any **FIVE** of the following in about 100 words each : 8×5=40

(a) Cracking and Reforming of Petroleum Fractions

(b) Ozone layer depletion

(c) Pay Back Analysis

(d) Chemicals from Coal

(e) Emergency Planning and Disaster Management

(f) Production of Polystyrene.

6. (a) Describe manufacture of "Ammonia" with a neat Process Flow Diagram. 20

(b) Write briefly about Fire and Explosion hazards rating with special reference to "HAZOP" and "HAZAN". 20

7. (a) Explain the thermal processes for the treatment of solid wastes. 20

(b) What are various sources of Air Pollutants and discuss their effect on man and environment. 20

8. (a) Give a critical account of the following :

(i) Break Even Point Analysis

(ii) Estimation methods of fixed and working capital. 20

(b) Explain profitability and discuss various methods for its determination. 20