

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.

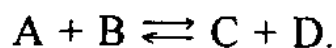
Neat sketches may be drawn, wherever required.

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 $P_1^{\text{Sat}} = 35.98 \text{ kPa}$ and $P_2^{\text{Sat}} = 12.20 \text{ kPa}$. 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 :



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