I.F.S. EXAM-2016

वियोज्य DETACHABLE

CHEMICAL ENGINEERING

Paper I

0000031

Time Allowed : Three Hours	Maximum Marks : 200

QUESTION PAPER SPECIFIC INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

There are **EIGHT** questions in all, out of which **FIVE** are to be attempted.

Question Nos. **1** and **5** are compulsory. Out of the remaining **SIX** questions, **THREE** are to be attempted selecting at least **ONE** question from each of the two **Sections A** and **B**.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

All questions carry equal marks. The number of marks carried by a question/part is indicated against it.

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

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

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

Neat sketches may be drawn, wherever required.

SECTION 'A'

1. Answer all parts in this question : 5×8=40

1.(a) How would you increase the sensitivity of the manometer ? Suggest at least two ways. 5

1.(b) Explain briefly the difference between a fan, blower and a compressor. 5

1.(c) State Raoult's law and its limitations. 5

1.(d) Explain wet bulb and adiabatic saturation temperatures of a vapour gas mixture. Under what circumstances they are same ? 5

1.(e) Express overall heat transfer coefficient in terms of individual film transfer coefficient. 5

1.(f) Define and explain the significance of Froude Number and Power Number. 5

1.(g) Explain briefly about film theory. 5

1.(h) What are the simplified assumptions of McCabe Thiele method ? Explain. 5

2.(a) Draw a Roll crusher and explain its working briefly. Describe the equation to calculate the diameter of a roll in Roll crusher. 10+10

2.(b) A fluidized bed (0·5 m dia and 0·5 m high) of spherical particles with diameter 2000 μm, and with specific gravity 2·5, uses water as medium. The porosity of the bed is 0·4. Determine ΔP using Ergun equation for the system

$$\frac{\Delta P}{L} = 4\times10^{5} Um_f + 1 + 10^{7} Um_f^2$$

Um_f is in m/s. What is minimum fluidization velocity ? 10

2.(c) An orifice meter having diameter of 0·025 m is located in a 0·08 m pipe. Water is flowing through the line and a mercury manometer measures the differential pressure over the instrument. The leads are filled with water. When the manometer reading is 0·35 m, what is flow rate of water per minute ? 10

3.(a) Explain the factors to be considered for selection of a solvent in absorption. 10

3.(b) Derive an equation for estimation of time of drying when met solid contains both bound and unbound moisture. 10

3.(c) Ammonia is stripped from a dilute aqueous solution by counter-current contact with air in a column containing seven sieve trays. The equilibrium relationship is $y_e = 0{\cdot}8\, x_e$ and molar flow rate of air is 1·5 times that of the solution. 90% of NH_3 is to be removed. How many ideal stages does the column have and what is the stage efficiency ? 20

4.(a) Give detailed procedure for calculation of Heat load of a furnace. 10

4.(b) Derive an equation for estimation of overall heat transfer coefficient from individual coefficients. 10

4.(c) A solution of organic colloids is to be concentrated from 15 to 50 per cent solids in a vertical-tube evaporator. The solution has a negligible elevation in boiling point, and the specific heat of the feed is 0·93. Saturated steam is available at 0·8 atm abs, and the pressure in the condenser is 100 mm Hg abs. The feed enters at 15°C. The overall coefficient is 1,700 W/m²·°C. The evaporator must evaporate 25,000 kg of water per hour. How many square metres of surface are required, and what is the steam consumption in kilograms per hour ? Enthalpy of super heated water vapour is 575 kcal/kg and that of steam is 4406 kcal/kg. Temperature in evaporator is 50°C. Enthalpy of thick liquor is 122 kcal/kg, enthalpy of feed is 30 kcal/kg. 20

SECTION 'B'

5. Answer all parts in this question :

5.(a) List out and explain the various static and dynamic characteristics of a Temperature measuring Instrument. 6

5.(b) Define Stability criteria and explain Routh test method for finding the stability of the control system. 8

5.(c) What are the advantages of liquid membrane process over liquid extract. 6

5.(d) Explain the Pervaporation operation. 6

5.(e) What is meant by crossover frequency of a control system ? 4

5.(f) Give the transfer function for transportation lag. 4

5.(g) Distinguish between Reverse Osmosis and Ultra Filtration. 6

6.(a) What is the principle of Electro-Dialysis ? List out applications of this operation. 10

6.(b) What are the commercial applications of dialysis operation ? 10

6.(c) A gas containing 70 per cent H_2, 24 per cent CH_4, and 6 per cent C_2H_6 is to be separated into a nearly pure H_2 stream and a fuel gas using a hollow-fibre permeate with a selectivity of 100 for H_2/CH_4. (a) If the upstream and downstream pressures are 40 and 20 atmospheres absolute, what fraction of H_2 in the feed is recovered in permeate if the permeate is 96% H_2 ? What is the stage cut ? (b) How much more H_2 could be recovered by lowering the permeate pressure to 12 atmospheres absolute ? 20

7.(a) Give the material of construction for Storage Vessels to handle Hydrochloric Acid of various compositions. 10

7.(b) Discuss the design procedure of closures flat and elliptical head. 10

7.(c) Estimate the thickness of the shell of a spherical process vessel of diameter 2 mts. The vessel is to be operated at a pressure of 1·5 MN/m² (absolute). Take the design pressure as 10% above the operating pressure. Allowable stress for the material of the vessel is 85 MN/m². Weld is fully radiographed. A corrosion allowance of 2 mm may be taken. Joint efficiency can be taken as 95%. 20

8.(a) Explain the PID control action of a Pneumatic controller with a neat sketch. 15

8.(b) For the transfer function shown below, sketch carefully the gain versus frequency portion of the asymptotic plot of the Bode diagram. Determine the actual (exact) value of gain and phase angle at $\omega = 1$. Determine the phase angle as $\omega \to \infty$

$$G(s) = \frac{2(0{\cdot}1s + 1)}{S^2(10s + 1)}$$

Indicate very clearly the slopes of the asymptotic Bode diagram of $G(s)$. 25