

Sl. No. 771

D-VSF-L-URA

## CHEMICAL ENGINEERING

### Paper—I

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 parts of a question are indicated against each.

Answers must be written in ENGLISH only.

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

Neat sketches may be drawn, wherever required.

### Section—A

1. Answer any *four* of the following :

- (a) (i) Write the Bernoulli's equation for pumping water from underground storage to the tank on the top of a building. Explain the significance of each term. 5
- (ii) Explain clearly the fluid drag and pressure drop due to friction. 5

- (b) Explain crushing and grinding principles. What is work index? 10
- (c) Explain the following :
- (i) Relative volatility 3
  - (ii) Fick's law of diffusion 3
  - (iii) Humidification and dehumidification 4
- (d) Explain the following :
- (i) LMTD and effectiveness factor 4
  - (ii) Analogy between heat and momentum transfer 3
  - (iii) Free and forced convections 3
- (e) Explain briefly the concepts of compressible and incompressible flows. 10
2. (a) Explain with a neat sketch the working principle of spray dryer. 20
- (b) Explain the principles of drying. 20
3. By what percentage would rate of absorption be increased or decreased by increasing total pressure from 100 to 200 kN/m<sup>2</sup> in the following cases?
- (a) The absorption of ammonia from a mixture of ammonia and air containing 10% of ammonia by volume using pure water as solvent. Assume that all the resistance to mass transfer lies within the gas phase 20

- (b) The same condition as (a), but the absorbing solution exerts a partial vapor pressure of ammonia of  $5 \text{ kN/m}^2$  20

Assume that if pressure is doubled, the diffusivity is halved.

4. Liquid oxygen is distributed by road in a large spherical insulated vessel, 2 m internal diameter, well-lagged on the outside. What thickness of magnesia lagging of thermal conductivity  $0.07 \text{ W/m K}$ , must be used so that not more than 1% of the liquid oxygen evaporates during a journey of 2.78 hours if the vessel is initially 80% full? 40

Latent heat of vaporization of

oxygen =  $215 \text{ kJ/kg}$

Boiling point of oxygen =  $90 \text{ K}$

Density of liquid oxygen =  $1140 \text{ kg/m}^3$

Atmospheric temperature =  $288 \text{ K}$

Heat transfer coefficient from outside

lagging to atmosphere =  $4.5 \text{ W/m}^2 \text{ K}$

### Section—B

5. Answer any *four* of the following :

(a) Explain the mechanical properties of the more common materials used in the construction of chemical process equipment. 10

(b) What are the various membrane processes? Explain the working principle of each membrane process. 10

- (c) What are the important points to be considered for design of underground storage tank for higher pressure? 10
- (d) What are the desirable properties of thermocouples for industrial use? Explain. 10
- (e) Explain about control valve construction. 10
6. (a) What are the various sources of fouling of reverse osmosis membrane? 20
- (b) Explain how fouling of reverse osmosis membranes can be prevented. 20
7. (a) Explain how skirt supports are designed. 20
- (b) Explain the various methods of designing reinforcement for a nozzle. 15
- (c) Explain the merits and demerits of flat and elliptical heads. 5
8. (a) Explain the working principles of constant-area flowmeter and variable-area flowmeter with neat sketches. 20
- (b) Explain the response of first-order system in series for non-interacting system and interacting system. 20

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