

1.5.5-2009

Serial No.

0415

B-JGT-J-DIFA

CHEMICAL ENGINEERING

Paper—I

Time Allowed : Three Hours

Maximum Marks : 200

INSTRUCTIONS

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

The number of marks carried by each question is indicated at the end of the question.

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

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

Neat sketches may be drawn, wherever required.

SECTION—A

1. Answer any **FOUR** of the following :— $10 \times 4 = 40$

(a) Classify fluids rheologically on the basis of their stress-strain relationship. Explain them with examples. 10

(b) Discuss flow pattern caused by a turbine type impeller in an agitated tank. Mention ways to prevent swirling and vortex formation in the agitated tank. 10

- (c) (i) Define capacity and effectiveness of a screen. Derive an expression for the overall effectiveness of a screen. 5
- (ii) State Rittinger's law of crushing. Mention its limitations. 5
- (d) Discuss, the mechanism of nucleate boiling. How does it differ from film boiling ? 10
- (e) Discuss, with the help of a sketch, the principle of a steam jet ejector for creating vacuum. 10
2. (a) (i) Differentiate between differential and cumulative analysis to find the average size of a sample. 5
- (ii) What is a ball mill? Derive an expression for its critical speed. 5
- (b) Determine an expression for terminal velocity of solid particles settling in a fluid stream under hindered condition. How will you modify it when the container is of limited size ? 10
- (c) Explain the construction and operation of a plate and frame filter press. State the difference between washing and non-washing plate. 10
- (d) What is an ultrafine grinder ? Explain its principle and operation. 10
3. (a) Draw boiling curve and explain various regimes occurring therein. What is the significance of critical heat flux point on the curve ? 10

- (b) Compare forward feed double effect evaporator with backward feed double effect evaporator. 10
- (c) What is boiling point elevation ? Discuss its effect on the capacity and steam economy of an evaporator. 10
- (d) Briefly describe the procedure to calculate radiant heat load of an oil fired furnace. 10
4. (a) Discuss clearly the concept of film transfer coefficient and overall transfer coefficient in mass transfer.
How does penetration theory of mass transfer differ from surface renewal theory ? 10
- (b) Explain the construction and operation of a packed extraction tower. 10
- (c) (i) Define 'relative volatility'. How can it be used to draw equilibrium curve of a binary system ? 5
- (ii) Mention limitations of McCabe-Thiele method. How are these overcome in Ponchon-Savarit method ? 5
- (d) With a neat drying rate curve, explain various zones of drying. Mention the mechanism of moisture movement in each zone. 10

SECTION—B

5. Answer any **FOUR** of the following :— $10 \times 4 = 40$

- (a) Explain stepwise procedure for the design of an elliptical head for a cylindrical vessel.
- (b) Discuss failure of vessels based on the theory of plasticity.
- (c) Name various supports generally used for process vessels. Give their advantages and disadvantages.
- (d) Develop an expression for frequency response of a transportation lag. Show it graphically thro' a sketch.
- (e) Discuss procedure for plotting of open loop transfer function by root locus method.

6. (a) What is pervaporation ? Explain it with the help of a neat sketch and also indicate its areas of application. 10

(b) Discuss various types of membranes. Mention procedure of immersion precipitation process for the production of a membrane. 10

(c) Describe dialysis and electrodialysis processes. Give their areas of applications.

Briefly explain the working of an instrument based on electrodialysis. 10

- (d) What is Super Critical Fluid Extraction ? Compare super critical fluid with the conventional fluid as a solvent. Give areas of application of super critical fluid extraction process. 10
7. (a) Describe Coate's theoretical analysis for bending stress at the head-shell junction of a vessel. 10
- (b) Explain the design equations for calculating the thickness of cylindrical and spherical shells. How will you select a standard plate for the fabrication of a shell ? 10
- (c) Estimate the thickness of the shell and head of a process vessel. The vessel is a cylinder having ellipsoidal heads (major to minor axis ratio = 2 : 1) at its bottom and top ends. The inside diameter and length of the vessel are 1.5 m and 2 m respectively. The vessel is to operate at a pressure of 1.4 MN/m^2 (absolute). The allowable stress for the material (plain carbon steel) is 85 MN/m^2 . Weld is fully radiographed. A corrosion allowance of 2 mm may be taken.
- Take design pressure as 10% above operating pressure. 10
- (d) What are the various stresses on a tall vessel to be installed in a seismic zone ? 10

8. (a) How do you measure liquid level if the liquid contains suspended solid particles ? Suggest a suitable measuring instrument and explain its working principle. 10
- (b) Explain the following :—
- (i) Negative and positive feedback control systems 5
 - (ii) Servo and regulatory control problems. 5
- (c) Develop a transfer function between pressure drop and the manometer reading for a mercury manometer. State the assumptions made. 10
- (d) Explain the working of a PID control system. Draw a pneumatic control circuit for this system and give its characteristics. 10