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RP-IX-XII-12

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CHEMICAL ENGINEERING

2011

SECOND PAPER

Full Marks : 200

Time : 3 hours

The figures in the margin indicate full marks for the questions

Answer any five questions

1. (a) What do you mean by diffusion of heat? State and explain the Fourier's law of diffusion. 2+6=8
- (b) What is thermal resistance? Write down the thermal resistance expressions of a wall, a spherical shell and an annular cylinder. 2×4=8
- (c) Define Biot number. Explain its significance in heat transfer operations. 8
- (d) What is Colburn j_H factor? Explain how this factor is utilized in calculating HT coefficient for transition flow. 8
- (e) Draw the temperature profiles for hot and cold fluids as a function of distance along the flow path for parallel and counter flow heat exchanger. 4+4=8

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(Turn Over)

2. (a) With the help of a neat sketch, describe the various types of moisture. 8
- (b) What is two-film theory? Explain the basic principle and concept of this important theory. 2+6=8
- (c) What do you mean by nucleation? Write the essential differences between primary nucleation and secondary nucleation. 2+6=8
- (d) Give the procedure for determination of 'tower height' of an absorption column. 8
- (e) Explain the principle of liquid-liquid extraction process and give a suitable example from various industrial operations. 8
3. What are the basic differences between—
- (a) proportional sensitivity and proportional bandwidth of a controller;
- (b) servocontrol and regulatory control actions;
- (c) first-order instruments and second-order instruments;
- (d) root locus methods and frequency response methods of stability analysis of controllers;
- (e) feedback control configuration and feed-forward control configuration of process control? 8×5=40

4. (a) Write briefly on the static and dynamic characteristics of an instrument. Classify these characteristics into DESIRABLE and UNDESIRABLE categories. 10
- (b) What is LMTD? Why do we calculate it? Explain the significance of this calculation by showing some sample calculation (assume adequate values). 10
- (c) State Kirchhoff's law of radiation and prove that the emissivity of a body is equal to its absorptivity under thermal equilibrium. 10
- (d) What is pool boiling? Explain the different boiling regimes in detail with the help of the boiling curve for pool boiling. What is critical heat flux? 10
5. (a) Describe the measurement of thermal conductivity by a gas analyser and a thermistor. 10
- (b) Discuss with a neat sketch, the working principle of an electromagnetic flow-meter. 10
- (c) What are the advantages of using mercury as a manometric fluid? Besides Hg, what are the other types of fluids used in these applications? Discuss relative merits and demerits of these fluids. 10

(d) Discuss the working principle of a paramagnetic analyzer used for continuous measurement of oxygen in a flowing gas stream. Provide a neat sketch.

10

6. Provide to-the-point answer to the following :

4×10=40

- (a) What is the effect of non-condensable gases on condensation?
- (b) Why is saturated steam used as a heating medium in evaporator?
- (c) What do you mean by melt crystallization?
- (d) What information do we gather from 'adiabatic saturation' curves?
- (e) What do you mean by mass-transfer coefficient?
- (f) What do you mean by 'loading' and 'flooding' in a distillation column?
- (g) What are packings? Give the essential properties of these packings used in various mass-transfer columns.
- (h) What is time constant? How do you calculate it?

(5)

- (i) Giving a neat sketch of an instrument of your choice, show the four basic elements of an instrument.
- (j) What is the basic principle behind measurement of temperature by a resistance thermometer?

7. Write short notes on any *five* of the following : 8×5=40

- (a) Heat transfer in fluidized bed
- (b) Enthalpy-concentration diagram
- (c) On-off control system
- (d) Controlling an unstable CSTR
- (e) Effect of impurities in crystallization
- (f) Breakpoint curve in adsorption process
- (g) Working principle of a cooling tower
