Total number of printed pages-6

## 53 (FPT 403) TPEN

# 2017

#### TRANSFER PROCESS ENGINEERING

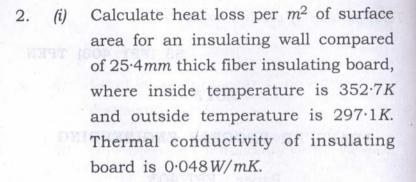
Paper : FPT 403 Full Marks : 100 Time : Three hours

# The figures in the margin indicate full marks for the questions.

Answer any five questions from seven.

- 1. (i) What is fluid viscosity ?
  - (ii) Write Newton's law of viscosity and define all terms.
  - (iii) How viscosity of gas and liquid change with pressure and temperature and why ?
    - (iv) Write Fourier's Law of heat conduction. 3+5+8+4=20

Contd.



(ii) Do shell momentum balance inside a pipe and show how momentum flux and fluid linear velocity varies with radial distance ?

8+12=20

- 3. (i) What is conductive and convective heat transfer process ?
  - (ii) How thermal conductivity varies for gas, liquid and solid ?
  - (iii) Air at  $206 \cdot 8kPa$ . and an average of  $477 \cdot 6K$  is being heated as it flows through a tube of  $25 \cdot 4mm$  inside diameter at a velocity of  $7 \cdot 62m/s$ . The

2

53 (FPT 403) TPEN/G

.

heating medium is 488.7K steam condensing on the outside of tube. Since the heat transfer coefficient of condensing steam is several thousand  $W/m^2$ , K and the resistance of the metal wall is very small, it will be assumed that the surface wall temperature of the metal in contact with the air is 488.7K. Calculate the heat transfer coefficient for an L/D > 60 and also the heat transfer Flux (a/A). 4+6+10=20

4. (i) Define the following :

Steady State Equilibrium Phase Rule

 (ii) Write solute transfer in "steady state co-current process" and "steady state countercurrent process" with diagram. 6+14=20

5. (i) Define "stage" and "stage efficiency".

53 (FPT 403) TPEN/G

Contd.

(ii) Absorption of a solute in a counter current multistage contact process :

> It is desired to absorb 90% of solute in a gas containing 1.0 mol% solute in air in a counter current stage tower. The total inlet gas flow to the tower is 30 kg mol/h, total inlet pure liquid to be used to absorb the solute is 90 kg mol liquid/h. The process is to operate isothermally at 300K and total pressure of 101.3kPa. The equilibrium relation for the solute in the gas-liquid is  $y_A = 2.53x_A$ . Determine the number of theoritical stages required for separation. 3+5+12=20

6.

(i) Write briefly on the following : Absorption Distillation Liquid-liquid extraction Adsorption Leaching.

4

## (ii) Interphase Mass transfer :

The equilibrium distribution of a solute and water at low concentration at a particular temperature is given by y=1.2x. At a curtain spatial position, the concentration of solute A in bulk air is 0.04mol fraction and that in bulk liquid phase is 0.025. The individual mass transfer coefficient for transport are  $Ky = 7.2kmol/m^2h(\Delta y)$ and  $Kx = 4.6kmol/hm^2\Delta y$ .

Calculate :

- (a) Flux  $N_A$
- (b) Overall gas phase and liquid phase driving force for mass transfer.
- (c) Interphase concentration in gas and liquid.
- (d) Overall mass transfer coefficient Kx and Ky.

53 (FPT 403) TPEN/G

5

Contd.

- (e) Which resistance controls the mass transfer here ? 12.5+7.5=20
- 7. (i) What is diffusive and convective mass transfer ?
  - (ii) Write Fick's 1st and 2nd law, define all terms and conditions.
    - (iii) What is Flux ?
    - (iv) Write unit of Flux, diffusion coefficient, mass transfer coefficient, volumetric oxygen transfer coefficient.
  - (v) Mention diffusivity range of gas and liquid.
  - (vi) How diffusivity changes with pressure, temperature, molecular size, molecular weight ?

4+5+1+4+2+4=20

53 (FPT 403) TPEN/G

6

100