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

2. *(i)* Calculate heat loss per m^2 of surface area for an insulating wall compared of 25·4*mm* thick fiber insulating board, where inside temperature is 352·7*K* and outside temperature is 297·1*K*. Thermal conductivity of insulating board is 0·048*W/mK*.

(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 206·8*kPa*. and an average of 477·6*K* is being heated as it flows through a tube of 25·4*mm* inside diameter at a velocity of 7·62*m/s*. The

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".

(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 300*K* and total pressure of 101·3*kPa*. The equilibrium relation for the solute in the gas-liquid is $y_A = 2{\cdot}53x_A$. 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.

(ii) Interphase Mass transfer :

The equilibrium distribution of a solute and water at low concentration at a particular temperature is given by $y=1{\cdot}2x$. At a curtain spatial position, the concentration of solute A in bulk air is $0{\cdot}04 mol$ fraction and that in bulk liquid phase is 0·025. The individual mass transfer coefficient for transport are $Ky = 7{\cdot}2 kmol/m^2 h(\Delta y)$ and $Kx = 4{\cdot}6 kmol/hm^2 \Delta y$.

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.

(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