2015

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*

1. (a) A fresh extracted juice containing 10 *wt.* % solids is fed into an vacuum evaporator. In the evaporator, water is removed and the solid content is increased to 60 *wt.*% solids. Calculate the amount of outlet stream of concentrated juice and water for 1000 *kg/hr* of juice entering into the evaporator. 4

   (b) In a process producing KNO_3 salt, 1000 kg./hr of a feed solution containing 15 *wt.*% of KNO_3 is fed to an evaporator, which evaporates some water at $500k$

to produce a 45 $wt.$% KNO_3 solution. This is then fed into a crystallizer at 300k, where crystals containing 95 $wt.$% KNO_3 are removed. The saturated solution containing 35 $wt.$% KNO_3 is recycled to the evaporator. Calcute the amount of recycle stream R in Kg/hr and the product stream of Crystals P in Kg/hr. 6

(c) Explain the concept of convective momentum transport. 10

2. (a) Define Newtonian and Non-Newtonian fluids. 4

(b) Explain the various types of Non-Newtonian fluids along with the graph showing the flow types. 8

(c) Explain the Newton's law of viscosity. 8

3. (a) Explain the time smoothed equations of change for incompressible fluids. 13

(b) Write about the shell momentum balances. 7

4. (a) Write down the derivation of equations of momentum transfer. 16

(b) Consider a fluid is flowing through two plates, in which the distance between two plates is $\Delta_y = 0.6cm$, $\Delta V_z = 20cm/s$ with the viscosity of $0.0254g/cm.s$. Calculate the shear stress and the velocity gradient or shear rate. 4

5. (a) Write short notes on : 4+6

   (i) Fourier's law of heat conduction

   (ii) Thermal conductivity.

   (b) Derive the equations for the heat conduction through a hallow cylinder and a hollow sphere. 10

6. (a) Derive the equation for Log Mean Temperature Difference (LMTD). 10

   (b) Determine the steady state heat transfer rate per unit area through an 80 *mm* thick slab with its two faces maintained at uniform temperatures of $300k$ and $340k$ respectively. The thermal conductivity of the material is $0.20w/(mk)$. 4

   (c) A cold storage room is constructed of an inner layer of 15*mm* of pine, a middle layer of 120 *mm* of cork board

and an outer 75 *mm* of concrete. The wall surface temperature in 250*k* inside the cold room and 300*k* outside surface of concrete. Conductivity values for pine, 0.151; for cork board, 0.0433; and for concrete; 0.762*w/mk*. Calculate the heat loss in *W* for $1m^2$.

6

7. *(a)* Write about Fick's law for molecular diffusion. 7

   (b) What do you mean by convective mass transfer coefficient ? 3

   (c) Write short notes on the diffusion of gases A and B plus convection. 10