53 (FPT 702) FPED

2013

(December)

FOOD PROCESS EQUIPMENT DESIGN

Paper : FPT 702

Full Marks : 100

Pass Marks : 30

Time : Three hours

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

*Answer **any five** questions.*

1. *(a)* Name the common types of mechanical devices for grain handling 4

   (b) Give the important factors on which the selection of material handling machines and conveyors depend. 6

(c) Explain briefly the construction and mechanisms of transport of the following conveyors 5+5=10

(i) Belt Conveyor

(ii) Pneumatic Conveyor

2. (a) List the important factors on which the capacity of a belt conveyor depend. 6

(b) Explain the advantages and disadvantages of screw conveyor. 6

(c) 15 tonne/*h* of boiler ash is to be transported to the ash pond by a horizontal screw conveyor. With the following operational and material data, specify a suitable screw arrangement for the service.

Data :

Bulk density of the material = 1400 kg/m^3

Filling Co-efficient = 0.125

$$\frac{\text{Lead of the Screw (Screw pitch)}}{\text{Diameter of the screw}} = 0.8$$

Speed of the screw shaft = 30 *rpm* 8

3. *(a)* Briefly explain with neat diagram the working principle of vibratory air screen cleaner. 6

(b) During evaluation of an air screen grain cleaner with 2 screens 250*g* samples were collected for analysis of clean seed fraction from different outlets. The data are presented in the following table. Calculate the cleaning efficiency of the cleaner. 10

Sample fraction	Feed *g*	Clean grain outlet, *g*	Blower outlet, *g*	Oversize outlet, *g*	Undersize outlet, *g*
Cleaned Seed, *g*	231.25	246.5	1.25	4.5	2.0
Impurities *g*	18.75	3.5	248.75	245.5	248.0

(c) Name the two important factors which influence the design of an air screen grain cleaner. 4

4. *(a)* How are heat exchangers classified based on flow arrangement ? 4

(b) Derive an expression for the LMTD in a counter flow heat exchanger. 8

(c) Steam enters a counter flow heat exchanger, dry saturated at 10 bar and leaves at 350°C. The mass flow rate of the steam is 720*kg/min*. The hot gas enters the exchanger at 650°C with mass flow rate of 1320 *kg/min*. If the tubes are 30*mm* diameter and 3*m* long, determine the number of tubes required. Neglect the resistance offered by metallic tubes. Use following data : 8

For steam $T_{SAT} = 180^{\circ}C (\text{at } 10 \text{ bar})$

$C_{p,s} = 2.71 kJ/kg.K$, $h_i = 600\ W/m^2.K$

For gas $C_{p,g} = 1 kJ/kg.K$, $h_o = 250 W/m^2.K$

5. (a) Sketch the temperature variations in parallel flow and counter flow heat exchangers. 4

(b) What is fouling ? Why are fouling factors taken into account in the design of heat exchangers ? 4

(c) A two shell pass and four tube passes heat exchanger is used to heat glycerin from $20°C$ to $50°C$ by hot water, which enters thin walled $20mm$ diameter tube at $80°C$ and leaves at $40°C$. The total length of the tube in the heat exchanger is $60m$. The convection co-efficient on shell side is $25W/m^2.K$ and that on water (tube) side is $160\ W/m^2.K$. Calculate the rate of heat transfer in the heat exchanger

(i) For clean surfaces of tubes,

(ii) After fouling with fouling factor of $0.0006\ m^2.K/W$ on outer surface of tubes. 12

6. (a) What is effectiveness of a heat exchanger ? Give the expression for NTU. 4

(b) $1000\ kg/h$ of distilled water at $50°C$ enters a single Pass Cross-flow heat exchanger and leaves at $40°C$. The heat is transferred to raw water entering at $35°C$ and leaving at $40°C$. Calculate the area of the heat exchanger if the fluids on both sides are unmixed and the overall heat transfer co-efficient is $1000\ W/m^2.K$. 8

(c) A chemical having specific heat of $3.3\ kJ/kg.K$ at a rate of 20,000 kg/h enter a parallel flow heat exchanger at $120^{\circ}C$. The flow rate of cooling water is 50,000 kg/h with an inlet temperature of $20^{\circ}C$. The heat transfer area is $10m^2$ and overall heat transfer co-efficient is 1050 $W/m^2.K$. Find

(i) The effectiveness of the heat exchanger,

(ii) Outlet temperature of water and chemical,

Take C_p of water as 4.186 $kJ/kg.K$. 8

7. Write short notes on : 4×5=20

(i) Screw Conveyors

(ii) Shell and tube heat exchanger

(iii) Bucket Elevators

(iv) Seed grader
