53 (FPT 702) FPED

2014

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)* What type of materials are transported by screw conveyors ? Give various advantages of screw conveyor. 2+3=5

   (b) Explain briefly the construction and mechanisms of transport of the following conveyors

   (i) Screw conveyor

   (ii) Bucket conveyor 5+5=10

(c) A belt conveyor with an inclination of 15° to the horizontal is to be used for the transportation of iron ore from the mine to the washing plant. The iron ore properties are of size 10 to 30*mm* and of bulk density 2600kg/m^3. Production at the mine is 1600 *tonne/hr*. The materials with around 10% moisture may be taken as medium flowable. For a belt speed of 1·6*m/s*, calculate the width of the belt to be used for the above purpose. 5

Given data :

$$K_a = 0{\cdot}067,\ C_i = 0{\cdot}95$$

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

(b) Write short notes on Pneumatic Conveyor. 6

(c) 20 *tonne/hr* 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 = $1500 kg/m^3$

Filling coefficient = 0·135

$$\frac{\text{Lead of the screw (Screw pitch)}}{\text{Diameter of the screw}} = 0{\cdot}8$$

Speed of the screw shaft = 35*rpm* 8

3. (a) Explain briefly how will you clean grains by using a single drum rotary screen cleaner. 6

(b) During evaluation of an air screen grain cleaner with screen 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 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) What is a heat exchanger ? What are the heat transfer mechanisms involved during heat transfer from the hot to the cold fluid in a heat exchanger ? 2+2=4

(b) Draw the temperature profile diagrams $(T-X)$ of double pipe heat exchanger for parallel and counter flow indicating the inlet and outlet temperatures of hot and cold fluids. How does a cross flow heat exchanger differ from a counter flow one ? What is the difference between the mixed and unmixed fluids in cross-flow ? 2+2+2=6

(c) Derive an expression for the LMTD in a parallel flow heat exchanger. 10

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

(b) A counter-flow double-pipe heat exchanger is to heat water from 20° to 80°C at a rate of 1·2 kg/s. The heating is to be accomplished by geothermal water available at 160°C at a mass flow rate of 2kg/s. The inner tube is thin wall and has a diameter of 1·5cm. If the overall heat transfer coefficient of the heat exchanger is $640 W/m^2 °C$, determine —

(i) Outlet temperature of geothermal water and

(ii) The length of the heat exchanger required to achieve the desired heating.

Assume :

Specific heat of water and geothermal fluid are $4180 J/Kg°C$ and $4310 J/Kg°C$ respectively. 12

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

6. (a) Hot oil $(C_p = 2130 J/Kg°C)$ is to be cooled by water in a 1-shell-pass and 8-tube passes heat exchanger. The tubes are thin walled and are made of copper with an internal diameter of $1 \cdot 4cm$. The length of each tube passes in the heat exchanger is $5cm$ and the overall heat transfer coefficient is $310 W/m^2 °C$. Water flows through the tubes at a rate of $0 \cdot 2 Kg/s$, and the oil through the shell at a rate of $0 \cdot 3\ Kg/s$. The water and the oil enter at temperature of $20°C$ and $150°C$, respectively. Determine the rate of heat transfer in the heat exchanger and the outlet temperatures of the water and the oil. Take specific heat of water, $C_p = 4180 J/Kg°C$. 12

(b) A chemical having specific heat of $3{\cdot}3\,kJ/Kg.K$ at a rate of 20,000 kg/h enter a parallel flow heat exchanger at $120°C$. The flow rate of cooling water is 50,000 kg/h with an inlet temperature of $20°C$. The heat transfer area is $10m^2$ and overall heat transfer co-efficient is $1050\,W/m^2K$. Find

(i) The effectiveness of the heat exchanger.

(ii) Outlet temperature of water and chemical.

Take, C_p of water $4{\cdot}186\,kJ/kg.K$.

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