53 (FPT 702) FPED

2014

FOOD PROCESS EQUIPMENT DESIGN

Paper : FPT 702

Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

INSTRUCTIONS :

* *Assume your data whenever, wherever applicable.*
* *Preferably, write the answers in sequential order.*

1. *(a)* Describe a belt conveyor with a neat diagram and its applications in Food processing. 10

(b) 15 *tons/hours* 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

Load of the screw / Dia of the screw = 0·8

Speed of the screw shaft = 30*rpm* 10

2. (a) Explain the criteria for selection of material handling / transportation equipment based on material characteristics. 10

(b) A belt conveyor with an inclination of 15° to the horizontal is to be used for the transportation of iron ore from the mines to the washing plant. The iron ore particles are of size 10-30 *mm* and of bulk density $2600\,kg/m^3$. Production at the micro is $1600\,ton/hour$. The materials with around 10% moisture may be taken as medium flowable. For a belt speed of 1·6 m/sec, calculate the width of the belt to be used for the mentioned purposes.

Data given :

Constant for flowability of the material $(Ka) = 0{\cdot}067$

Correction Factor $(C_i) = 0{\cdot}95$. 10

3. *(a)* What is a heat exchanger ? What are the heat transfer mechanisms involved during heat transfer from the hot to Cold-fluid in a heat exchanger ? 2+3

(b) A double-pipe heat exchanger is constructed of a copper $\left(K = 380\, W/m^{\circ}C\right)$ inner tube of internal diameter, $Di = 1{\cdot}2\, cm$ and external diameter. $D_o = 1{\cdot}6\, cm$. The Convection heat transfer Co-efficient is reported to be $hi = 700\, W/m^2{}^{\circ}C$ on the inner surface of the tube and $ho = 1400\, W/m^2{}^{\circ}C$ on its outer surface.

For a fouling factor

$R_f, i = 0{\cdot}0005\, m^2.\,{}^{\circ}C/W$ on the tube side

$R_f, i = 0{\cdot}002\, m^2.\,{}^{\circ}C/W$ on the shell side

Determine

(i) The thermal resistance of the heat exchanger per unit length and

(ii) Overall heat transfer Co-efficients $\left(U_i\right)$ and $\left(U_o\right)$ based on the inner and outer surface areas of the tube respectively. 15

4. *(a)* Define effectiveness of heat-exchanger. Under what conditions is the effectiveness NTU methods definitely preferred over the LMTD method in heat exchanger analysis ? 3

(b) Define heat capacity rate. 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. 5

(c) Hot oil $(Cp = 2130\, J/kg°C)$ 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 $5m$, and the overall heat transfer co-efficient is $310\ W/m^2°C$. Water flows through the tubes at a rate of $0{\cdot}2\, kg/sec$, and the oil through the shell at a rate of $0{\cdot}3\ kg/s$. The water and the oil enter at temperatures of $20°C$ and $150°C$ respectively. Determine the rate of heat transfer in the heat exchanger and the outlet temperatures of water and the oil. Take specific heat of water, $C_p = 4180\, J/kg°C$. 12

5. Write short notes on : 5+8+7

(a) Pneumatic Conveyor

(b) Shell-and-tube heat exchanger

(c) Air-operated screen cleaner.

6. (a) Explain briefly different types of Flanges used for pressure-vessels. 10

(b) Discuss the term "screening". During evaluation of an air screen grain cleaner with two screens, 250*gm* samples were collected for analysis of clean seed fraction from different outlets. Calculate the efficiency referring following data : 10

Sample fraction	Feed (*gm*)	Clean grain outlet (*gm*)	Blower outlet (*gm*)	Oversize outlet (*gm*)	Under size outlet (*gm*)
Cleaned seed	231·25	246·5	1·25	4·5	2·0
Impurities	18·75	3·5	248·75	245.5	248·0

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

(b) List out the different types of bucket elevator and their uses in Food processing plant. 6

(c) Differentiate the following : 4+4=8

(i) Grading & Sorting

(ii) Cleaning & Screening.