Total No. of Questions : 12]

SEAT No. :

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[Total No. of Pages : 4

[5154]-47

B.E. (Mechanical)

INDUSTRIAL HEAT TRANSFER EQUIPMENTS

(2008 Course) (Elective - IV) (402050) (Semester - II)

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Answer to the two sections should be written in separate answer books.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables, Mollier charts, electronic pocket calculator, Psychrometric charts and steam tables is allowed.***
5) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Classify heat exchanger based on transfer processes and geometry of construction. **[6]**

b) A 15ºC of hot water temperature drop is allowed while heating cold water with a flowrate of 4500 kg/hr from 25ºC to 40ºC. Hot water inlet temperature is 135ºC. A 3.5m double-pipe heat exchanger of 3 inch (ID = 0.0779m) by 2 inch (ID = 0.0525m, OD = 0.0603m) is used for this purpose. Hot water flows through the inner tube.

Assume that the pipe is made up of carbon steel (K = 54 W/mk). Neglect heat loss if any and Find: **[12]**

i) The hydraulic diameter (D_h)

ii) The equivalent diameter (D_e)

iii) Heat Transfer coefficient in annulus (h_o)

iv) Clean overall heat transfer coefficient (u_o)

for fully developed turbulent flow, pr > 0.5

$$Nu_b = \frac{(f/2)Re_b\, Pr_b}{1+8.7(f/2)^{1/2}\cdot(Pr_b-1)}$$ where 'f' is flonenko friction factor given by

$f = (1.58\ Ln(Re) - 3.28)^{-2}$.

P.T.O.

Properties of water at 127.5ºC:

ρ = 936.5 kg/m^3, C_p = 4.266 kJ/kgK, K = 0.687 W/mk

μ = 0.207 × 10^{-3} Pa-S, Pr = 1.343

at 32.5ºC:

ρ = 997.5 kg/m^3, C_p = 4.178 kJ/kgK, K = 0.609 W/mK,

μ = 0.841 × 10^{-3} Pa-S, Pr = 5.68

OR

Q2) a) Enumerate various criteria for selection of Heat exchanger. **[6]**

b) What is fouling? How does it affect the performance of heat exchanger? Explain analytically. **[4]**

c) Outline step-by-step procedure for thermal design of Double-pipe Heat Exchanger. **[8]**

Q3) a) What are the various leakage & bypass streams on the shellside. How do they affect the performance of STHE? **[8]**

b) Explain stepwise the procedure of heat exchanger design using Bell-Delaware method. **[8]**

OR

Q4) a) Explain how a decision of allocating streams is made in STHE. **[6]**

b) Crude oil at a flowrate of 63.77 kg/s enters the heat exchanger at 102ºC and leaves at 65ºC. The heat will be transferred to 45 kg/s of tube side water coming from the supply at 21ºC. The exchanger data is given below. **[10]**

3/4" OD 18BWG tubes (OD = 0.0191m, ID = 0.01776m) on a 1 inch square pitch. Tube material is carbon steel (K = 43W/mK). The Heat exchanger has one shell of ID 0.889m. Baffle spacing is 275mm. No. of tubes is 845 with single pass calculate the length of heat exchanger for clean surfaces. The following properties are given.

	Shell side	Tube side
Specific heat (J/kgK)	2177	4186.8
Dynamic Viscosity (Ns/m^2)	0.00189	0.00072
Thermal conductivity (w/mK)	0.122	0.605
Density (kg/m^3)	786.4	995
Prandtl Number	33.73	6.29
Dynamic Viscosity of Shellside fluid at 59°C = 0.00196Ns/m^2		

$$\frac{hoDe}{k}=0.36\left(\frac{DeGs}{\mu}\right)^{0.55}\left(\frac{\mu C_p}{k}\right)^{1/3}\left(\frac{\mu_b}{\mu_w}\right)^{0.14} \quad \text{for } 2\times10^3 < Re < 10^6.$$

Gnielinski's correlation for $Re > 10^4$ is given by

$$Nu=\frac{(f/2)(Re-1000)pr}{1+12.7\left(f/2\right)^{1/2}\left(Pr^{2/3}-1\right)} \quad \text{and } f=(1.58\ LnRe-3.28)^{-2}.$$

Q5) a) What are the characteristics of compact heat exchanger? **[8]**

b) What are the salient features of plate fin Heat exchanger (PFHE). **[8]**

OR

Q6) a) What are different forms of individually finned tubes? **[8]**

b) "Brazed Aluminium PFHE are an obvious choice for cryogenic applications"-Comment. **[8]**

SECTION - II

Q7) a) What is the purpose of providing a vent on condensers? **[4]**

b) Explain the types of baffles commonly used in shell and tube condensers. **[6]**

c) Comment upon choice of vertical shell side condensers. **[6]**

OR

Q8) a) Write explanatory note on 'Reflux Condenser'. **[6]**

b) Explain different considerations while designing/selecting a condenser. **[10]**

Q9) a) Explain salient features of hyperbolic cooling tower with the help of a neat diagram. **[6]**

b) Warm water at 45ºC enters a cooling tower @6kg/S. An ID fan draws $10m^3/S$ of air through the tower and absorbs 4.9 kW. The air enters the tower at 20ºC and 60% relative humidity and leaves saturated at 26ºC. Calculate the final temperature of water and the amount of make-up water required per hour. State clearly the assumptions made. **[12]**

OR

Q10)a) What is meant by carry over loss? Explain different methods used to reduce the same. **[6]**

b) Explain the following terms mentianing their significance w.r.t. cooling tower: **[8]**

i) Approach

ii) Range

iii) Cooling duty

iv) Effectiveness

c) Following observations are recorded on a cooling tower of an industrial site: cooling water flow = $5000m^3/h$ water inlet temperature = 42ºC, Water outlet temperature = 36ºC, WBT = 29ºC. What is the effectiveness of this cooling tower? **[4]**

Q11)a) With the help of a neat labelled diagram explain construction of a heat pipe heat exchanger. **[8]**

b) Explain the common methods of condensate return in heat pipes **[4]**

c) Suggest suitable method for cooling of PCB. **[4]**

OR

Q12)a) Enumerate the desired characteristics of working fluid for heat pipes.**[6]**

b) Explain different configurations of heat sinks. **[4]**

c) Describe any one applicatioon of heat pipe giving a neat sketch of proposed layout. **[6]**