Code: 9A23501 **R09**

B.Tech III Year I Semester (R09) Supplementary Examinations June 2017

HEAT TRANSFER IN BIOPROCESSES

(Biotechnology)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

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1 (a) What are the three modes of heat transfer? Discuss their mechanisms with the help of schematic diagram.

(b) Consider a 0.8 m high and 1.5 m wide double-pane window consisting of two 4 mm thick layers of glass ($k = 0.78\, W/m℃$) seperated by a 10 mm wide stagnant air space ($k = 0.026 \frac{W}{m℃}$). Determine the steady rate of heat transfer through this double-pane window. The temperature of the inner surface temperature of the windon is 20℃ and that of outer surface temperature of the window is -10℃.

2 (a) Show that for heat transfer through pipes:

$$\bar{r}_L = \frac{r_0 - r_i}{l_n\left(\frac{r_0}{r_i}\right)}$$

Where $\bar{r}_L$ is logarithmic mean radius

r_0 is outside radius of cylinder.

r_i is inside radius of cylinder.

(b) Describe the concept of log mean radius for heat transfer through pipes.

3 (a) Show that $N_u = f_n(Re, Pr)$ for forced convection heat transfer in circular pipes.

(b) Warm water is required at the rate of 500 kg/h for washing filter cake, and it is decided to use a 25 mm steam heated tube for the purpose. The tube wall temperature is maintained at 130℃ by condencing steam on the outside surface. Calculate the heat transfer coefficient. The inner diameter of the tube is 21.2 mm. $\mu = 6.82 \times 10^{-4}\ \frac{kg}{m.s}$, ($k = 0.026 \frac{W}{m℃}$) $C_p = 4.174 \frac{KJ}{kg℃}$. State the assumptions made.

4 (a) Discuss the various correlations for evaluating natural convection heat transfer coefficients.

(b) Explain the mechanism of film & nucleate boiling.

5 (a) Draw the pool boiling curve and label the different regimes.

(b) Differentiate drop wise and film condensations.

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6 (a) Draw the schematic diagram of a double pipe heat exchanger label the salient parts. Explain its functioning.

(b) A concentric tube heat exchanger is used to cool lubricating oil for a large diesel engine. The inner tube is constructed of 2 mm wall thickness stainless steel ($k = 16 \frac{W}{m.K}$). The flow rate of oil through the tube ($r_0 = 50\ mm$) is $0.15 \frac{kg}{s}$. Assume fully developed flow, if the oil cooler is to be used to cool oil from 90℃ to 50℃ using water available at 10℃. Calculate LMTD for: (i) Parallel flow. (ii) Counter flow. The cutlet temperature of water is 20.2℃.

7 (a) Explain various feedings of a multiple effect evaporator system with the help of schematic diagrams.

(b) What are the principal measures of the performance of steam heated tubular evaporators. Define each of them.

8 (a) Write the principles in the design of continuous sterilizers.

(b) Explain continuous heat sterilization of liquids with help of figures.

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