SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
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DEPARTMENT OF MECHANICAL ENGINEERING

19FTT202 – HEAT AND MASS TRANSFER

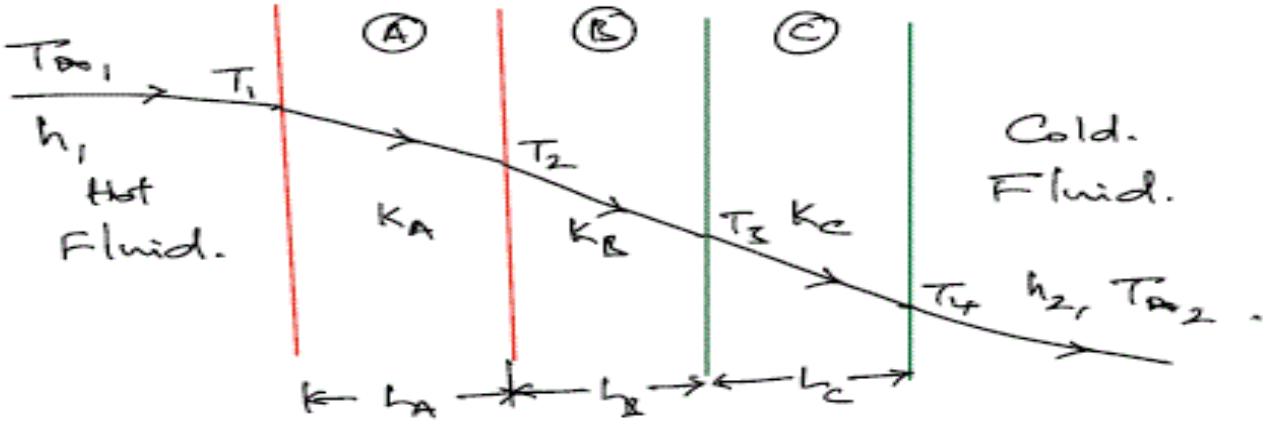
II YEAR IV SEM

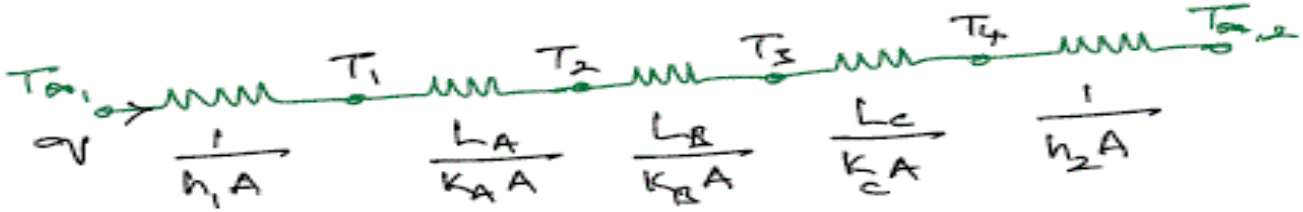
UNIT 1 – CONDUCTION

Topic 8 Composite Systems

Composite walls:

Thermal resistances in series:





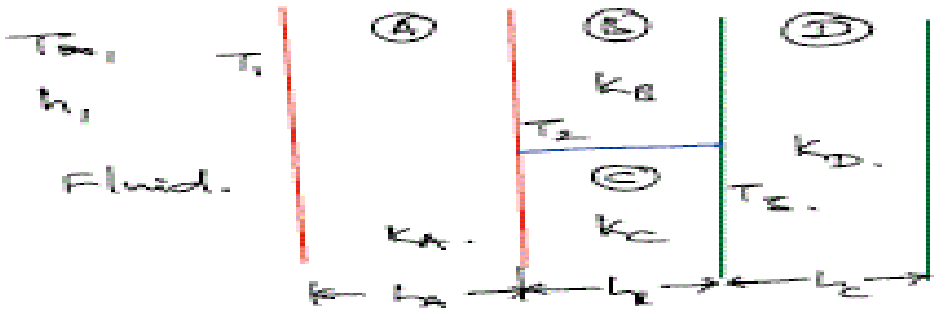
$$\therefore \quad q = \frac{T_{\infty,1} - T_{\infty,2}}{\frac{1}{h_1 A} + \frac{L_A}{K_A A} + \frac{L_B}{K_B A} + \frac{L_C}{K_C A} + \frac{1}{h_2 A}} = UA\Delta T$$

Composite Systems

where, $U = \frac{1}{R_{total} \cdot A}$ is the overall heat transfer coefficient,

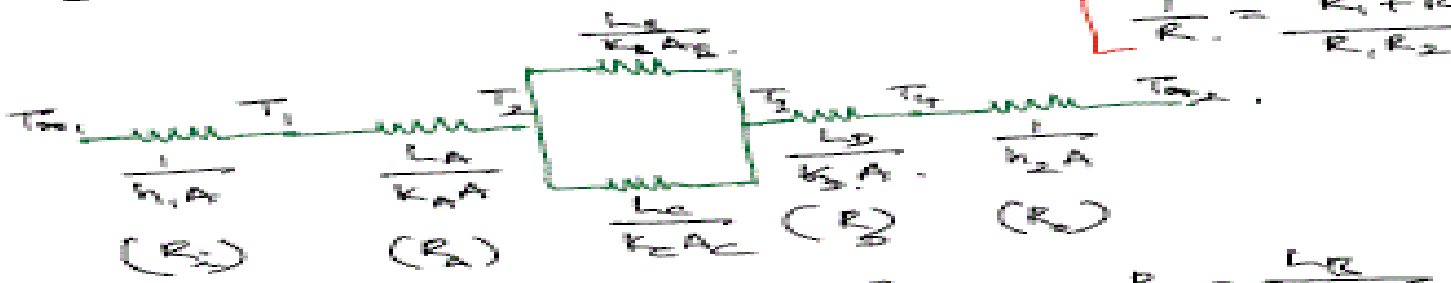
$$U = \frac{1}{\frac{1}{h_1} + \frac{L_A}{K_A} + \frac{L_B}{K_B} + \frac{L_C}{K_C} + \frac{1}{h_2}}$$

Series-parallel arrangement:



(a) $L_B = L_C$ (b) $A_B + A_C = A_A = A_D = A$.

$$\left[\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \qquad \frac{1}{R} = \frac{R_1 + R_2}{R_1 R_2}\right]$$

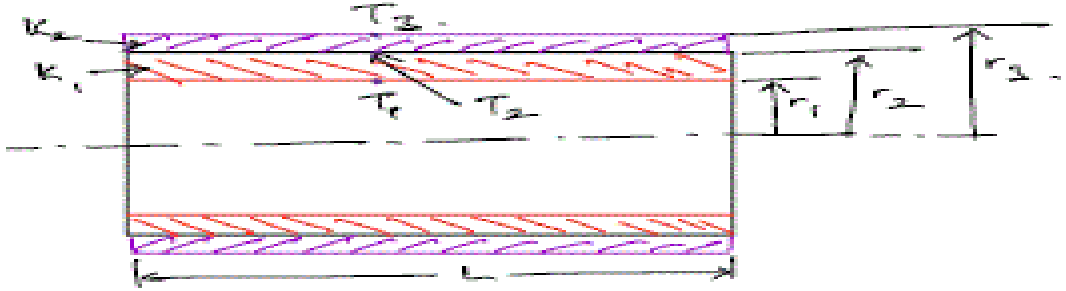


$$\frac{1}{R_{Parallel}} = \frac{1}{R_B} + \frac{1}{R_C} = \frac{R_B + R_C}{R_B \times R_C} \rightarrow \quad R_B = \frac{L_B}{K_B A_B} \qquad R_C = \frac{L_C}{K_C A_C}$$

Composite Systems

Composite cylinder:

Case1: No convective BC's.



$$R_1 = \frac{\ln\left(\frac{r_2}{r_1}\right)}{2\pi k_1 L}$$

$$R_2 = \frac{\ln\left(\frac{r_3}{r_2}\right)}{2\pi k_2 L}$$

Resistance circuit →

Total resistance $R_{total} = R_1 + R_2$

$$R_{tot} = \frac{\ln\left(\frac{r_2}{r_1}\right)}{2\pi k_1 L} + \frac{\ln\left(\frac{r_3}{r_2}\right)}{2\pi k_2 L}$$

Heat transfer.

$$Q = \frac{(T_1 - T_2)}{R_1} = \frac{(T_2 - T_3)}{R_2}$$

$$R_1 = \frac{(T_1 - T_2)}{Q} \quad ; \quad R_2 = \frac{(T_2 - T_3)}{Q}$$

$$\therefore \quad Q = \frac{(T_1 - T_3)}{R_{tot}} = \frac{(T_1 - T_3)}{\frac{\ln\left(\frac{r_2}{r_1}\right)}{2\pi k_1 L} + \frac{\ln\left(\frac{r_3}{r_2}\right)}{2\pi k_2 L}}$$

1. Which of the following is a case of steady state heat transfer

A. I.C. engine

B. Air preheaters

C. Heating of building in winter

D. None of the above

Answer D

2. Metals are good conductors of heat because

A. Their atoms collide frequently

B. Thier atoms are relatively far apart

C. They contain free electrons

D. They have high density

Answer : A

3. Which of the following is expected to have highest thermal conductivity

A. Steam

B. Solid ice

Use HMT data book and find the answer

C. Melting ice

D. Water

Answer : B

4. Thermal conductivity of water at 20°C is of the order of

A.0.1

B.0.23

C.0.42

D.0.51

Use HMT data book and find the answer

Answer : D

5. When a composite wall of three layers in series having thermal resistances R1, R2 and R3 respectively. The heat transfer takes place normal to the surface of the layers. How is the total thermal resistance of the composite system calculated?

a. 1 / (R1 + R2 + R3)

b. ((1 / R1) + (1 / R2) + (1 / R3))

c. (R1 + R2 + R3)

d. none of the above

ANSWER: c. (R1 + R2 + R3)

6. What does a composite wall mean?

a. two walls of different materials are connected in series without any gap between them

b. three walls of different materials are connected in series without any gap between them

c. more than three walls of different materials are connected in series without any gap between them

d. all of the above

b. ANSWER: d. all of the above

References

Book references:

- Frank P. Incropera and David P. DeWitt, “Fundamentals of Heat and Mass Transfer”,John Wiley and Sons, New Jersey,6th Edition1998(Unit III, IV, V)
- Ozisik M.N, “Heat Transfer”, McGraw-Hill Book Co., New Delhi, 3th Edition 1994(Unit I, II, III).
- Sachdeva R C, “Fundamentals of Engineering Heat and Mass Transfer” New Age International, New Delhi, 4th Edition 2010(Unit I, II, III).

Web sources:

- https:/11/11www.sanfoundry.com/11heat-transfer-questions
- https:/11/11nptel.ac.in/11courses/11112/11101/11112101097/11
- https:/11/11nptel.ac.in/11courses/11112/11108/11112108149/11
- https:/11/11nptel.ac.in/11content/11syllabus_pdf/11112101097.pdf