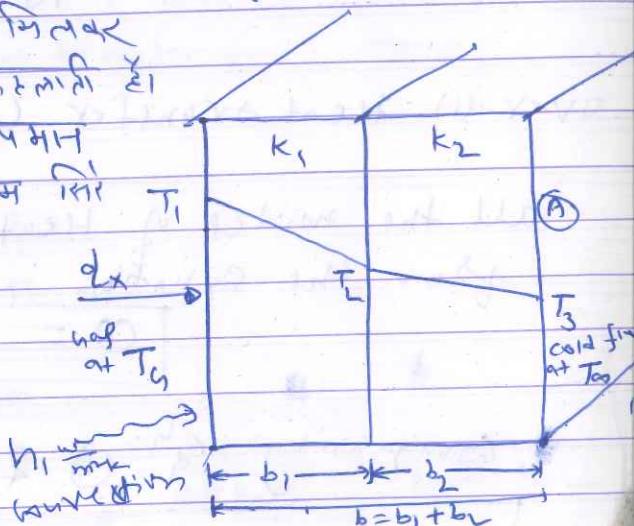


- Q. 1. संयोजित वैल्याकार सत्रा (composite cylinder) से घास (Conduction) से और रोटेशन (convection) द्वारा उष्मा छोड़ने की दर (Heat transfer rate) के लिए यह फूट प्रतिपादित कीजिये।
- Q. 2. संयोजित गोले (composite sphere) से घास से साथ ही उष्मा छोड़ने की दर के लिए यह फूट प्रतिपादित कीजिये।
- Q. 3. संयोजित / संयुक्त दीवार (compound wall/plates) के लिए overall heat transfer coefficient (युत उष्मा छोड़ने के पाइप) का यह फूट प्रतिपादित कीजिये।

Ans. 3. Conduction-convection heat transfer through compound wall
 दो या ज्यादा अलग गोले के बिच
 बीच के बीच संयुक्त दीवार कहलाती है।
 जहां कि दीवार के लिए सिर पर ग्राफ में
 T_1 व अंदर के ग्राफ में T_2 रोटेशन अलग होता है।
 पर T_3 है जो दीवार की तरफ उष्मा-छोड़ने की दर q_x है।

$$\text{At } x=0 \Rightarrow T = T_1 \quad (T_1 > T_2)$$

$$x=b \Rightarrow T = T_2$$



Assumption:-

1. Steady state heat transfer
 $\text{Temp} \neq f(\text{Time})$

2. 1-Dimensional conduction

3. Uniform thermal conductivity

$$k \neq f(x) \rightarrow$$

$$k \neq f(\text{temp.})$$

from Fourier's law of conduction

$$q = -KA \frac{dT}{dx}$$

where
 $h_1 \rightarrow$ convective heat transfer coefficient on gas side in $\text{W/m}^2\text{K}$

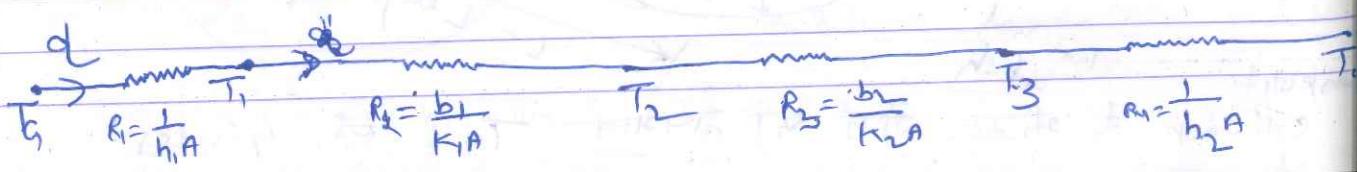
$h_2 \rightarrow$ convective heat transfer coefficient on cold fluid in $\text{W/m}^2\text{K}$

$k_1, k_2, k_3 \rightarrow$ Thermal conductivity materials

$T_1, T_2, T_3 \rightarrow$ temp. of solid boundary

$A \rightarrow$ Area L to direct
of heat trans

Thermal circuit



$$\dot{q} = \frac{T_g - T_{\infty}}{\epsilon R_{th}} = \frac{T_g - T_{\infty}}{R_1 + R_2 + R_3 + R_4}$$

$$\boxed{\dot{q} = \frac{T_g - T_{\infty}}{\frac{1}{h_1 A} + \frac{b_1}{k_1 A} + \frac{b_2}{k_2 A} + \frac{1}{h_2 A}}}$$

Heat transfer rate per unit area

$$\frac{\dot{q}}{A} = \frac{T_g - T_{\infty}}{\frac{1}{h_1} + \frac{b_1}{k_1} + \frac{b_2}{k_2} + \frac{1}{h_2}} \frac{\text{Watt}}{\text{m}^2} \quad \textcircled{1}$$

Overall heat transfer coefficient →

It takes in to account

all the modes of heat transfer & it is defined from the equation

$$\boxed{\dot{q} = UA \Delta T} \quad \textcircled{2}$$

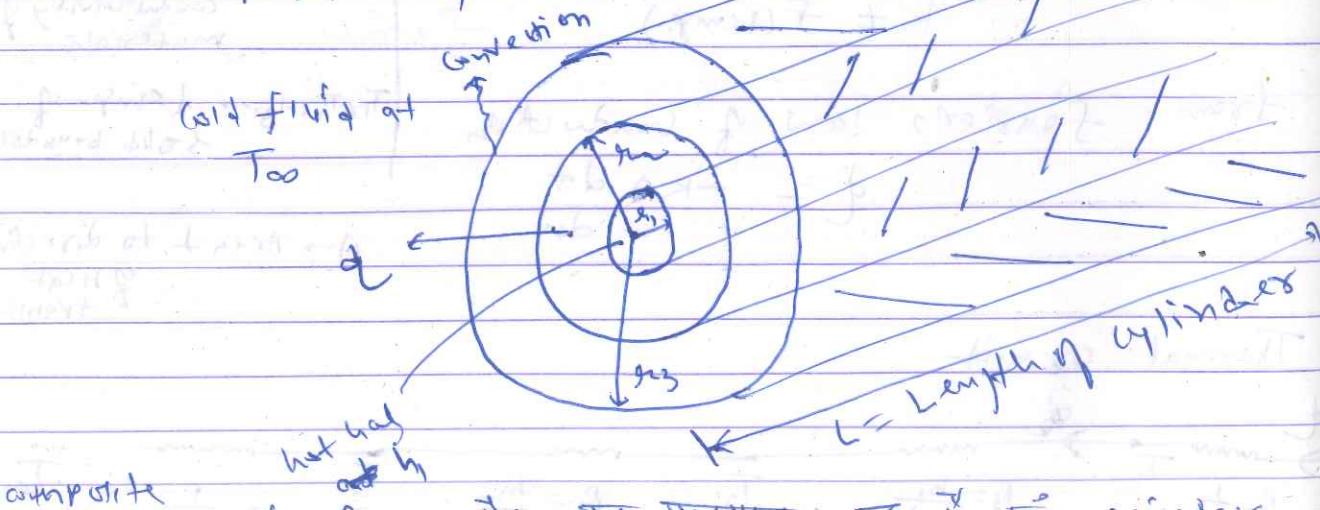
$$U \rightarrow \frac{W}{m^2 K}$$

Comparing $\textcircled{1}$ & $\textcircled{2}$

$$\boxed{\frac{1}{U} = \frac{1}{h_1} + \frac{b_1}{k_1} + \frac{b_2}{k_2} + \frac{1}{h_2}}$$

Ans 1.

Conduction-convection heat transfer through a composite cylinder →



$T_g \rightarrow$ Temp of gas

$T_{\infty} \rightarrow$ Temp of outside cold fluid

$h_1 \rightarrow$ Convection heat transfer coefficient on gas side ($\text{W/m}^2\text{K}$)

$h_2 \rightarrow$ Convection heat transfer coefficient on fluid side ($\text{W/m}^2\text{K}$)

— 3

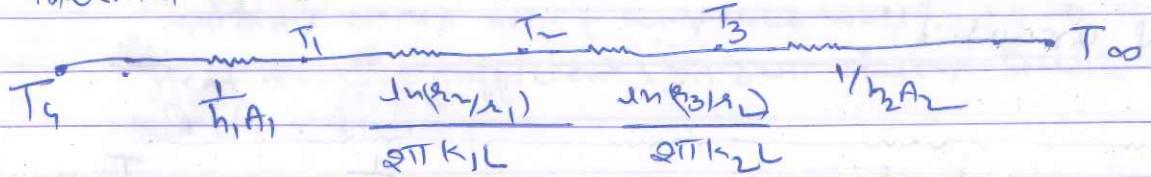
Assumptions -

1) Steady state heat transfer

2) 1-D, Radial Heat Transfer

3) K is Uniform

Thermal circuit



$A_1 \rightarrow$ Inside convection heat transfer area = $2\pi r_1 L$

$A_2 \rightarrow$ Outside convection heat transfer area = $2\pi r_2 L$

- Heat transfer rate

$$q = \frac{T_g - T_{\infty}}{\sum R_{th}}$$

$$q = \frac{T_g - T_{\infty}}{\frac{1}{h_1 \cdot 2\pi r_1 L} + \frac{1}{h_2 \cdot 2\pi r_2 L} + \frac{1}{\frac{1}{2\pi k L} + \frac{1}{h_1 \cdot 2\pi r_1 L} + \frac{1}{h_2 \cdot 2\pi r_2 L}}}$$

Ans. 2.

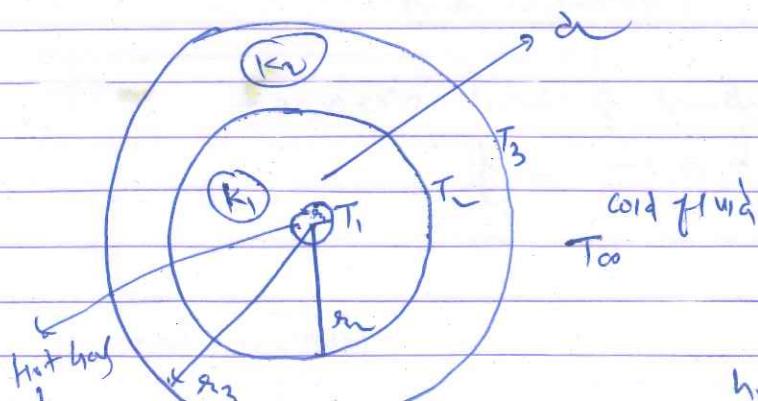
Conduction - Convection Heat transfer through a composite sphere →

$\nabla \text{At } r = r_1 \Rightarrow T = T_1$

$r = r_2 \Rightarrow T = T_2$

$r = r_3 \Rightarrow T = T_3$

$T_g > T_1 > T_2 > T_3 > T_{\infty}$



$k_1 \text{ & } k_2 \rightarrow$ Thermal Conductivity of material

$h_1 \text{ & } h_2 \rightarrow$ Convection heat

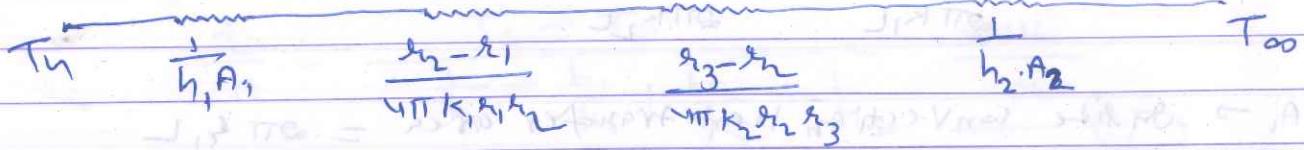
Assumptions

1) Steady-state Heat transfer

2) 1-D Radial heat transfer (laboratory)

3) K is uniform

Thermal circuit



Heat transfer rate

$$q = \frac{T_q - T_\infty}{\epsilon R_{th}}$$

$$\frac{1}{R_{th}} = \frac{1}{h_1 A_1} + \frac{r_2 - r_1}{4\pi k_1 r_1} + \frac{r_3 - r_2}{4\pi k_2 r_2} + \frac{1}{h_2 A_2}$$

where

$A_1 \rightarrow$ Inside convection heat transfer area of sphere
 $= 4\pi r_1^2$

$A_2 \rightarrow$ outside convection Heat transfer area of sphere
 $= 4\pi r_3^2$