GATE 2024

प्रचण्ड Batch

→ Conduction-Convection HT Through Compsite wall

HMT

MODES OF HEAT TRANSFER

TIME- 4:30PM

YOGESH SIR

YouTube Classes Schedule

ENGINEERS

MECHANICAL ENGINEERING

EXAM TARGET	SUBJECT	TIME	FACULTY
ALL PSUs	ENGINEERING MATHS	10:00 AM	ANANT SIR
ALL PSUs	PRODUCTION	11:30 PM	GAURAV SIR
ALL PSUs	THERMODYNAMICS	1:00 PM	KANISTH SIR
GATE 2024-25	HMT	4:30 PM	YOGESH SIR
GATE 2024-25	SOM	9:00 PM	MUKESH SIR

PSU

FREE APP
CLASS SCHEDULE

MECHANICAL ENGINEERING

HMT	MONDAY Live @11AM	YOGESH SIR
PRODUCTION	TUESDAY Live @11AM	GAURAV SIR
SOM	WEDNESDAY Live @8PM	MUKESH SIR
THERMODYNAMICS	THURSDAY Live @11AM	KANISTH SIR
ENGINEERING MATHEMATICS	FRIDAY Live @11AM	ANANT SIR

GATE
11 to 2

8 to 10

आरंभ 2.0 BATCH

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27 APRIL
Thermodynamics
6 to 8 PM
Kaushik Sir

GATE 2024

MECHANICAL ENGINEERING

STARTING FROM 27 APRIL 2023

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Overall HT Coefficient :- (U)

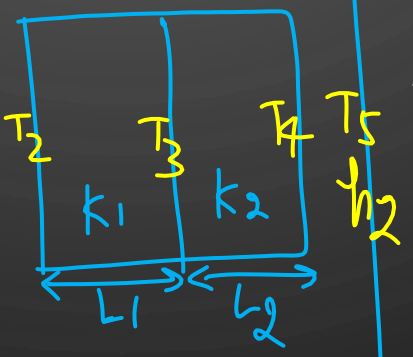
↳ The coefficient which takes into account all Modes of HT

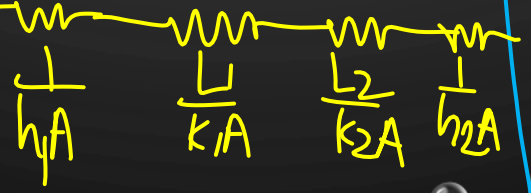
$$Q = UA\Delta T = \frac{\Delta T}{\left(\frac{1}{UA}\right)}$$

$$Q = \frac{\Delta T}{R_{th}}$$

$$R_{th} = \frac{1}{UA}$$

$$U \propto \frac{1}{R_{th}}$$



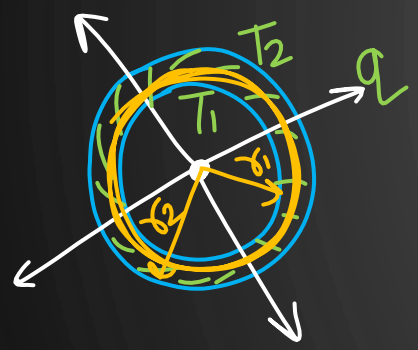


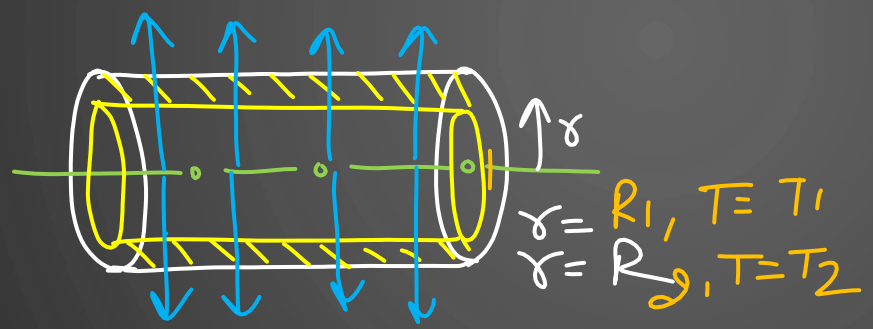
$$\Sigma R_{th} = \frac{1}{h_1A} + \frac{L_1}{k_1A} + \frac{L_2}{k_2A} + \frac{1}{h_2A}$$

$$\frac{1}{UA} = \frac{1}{h_1A} + \frac{L_1}{k_1A} + \frac{L_2}{k_2A} + \frac{1}{h_2A}$$

$$\boxed{\frac{1}{U_{Wall}} = \frac{1}{h_1} + \frac{L_1}{k_1} + \frac{L_2}{k_2} + \frac{1}{h_2}}$$

Conduction HT Through a Hollow Cylinder :→





Assumptions

1. Steady Flow
2. $q \neq f(r)$
3. $q \neq f(time)$
4. $T \neq f(time)$
5. $T = f(r)$

$$Q = -kA\frac{dT}{dr}$$

$$\int_{r_1}^{r_2} Q\frac{dr}{r} = -\int_{T_1}^{T_2} k\,2\pi\cdot L\,dT$$

$$Q\ln\frac{r_2}{r_1} = -k2\pi L(T_2-T_1)$$

$$Q\ln\frac{r_2}{r_1} = k2\pi L(T_1-T_2)$$

$$\boxed{Q = \frac{2\pi kL(T_1-T_2)}{\ln r_2/r_1}}$$

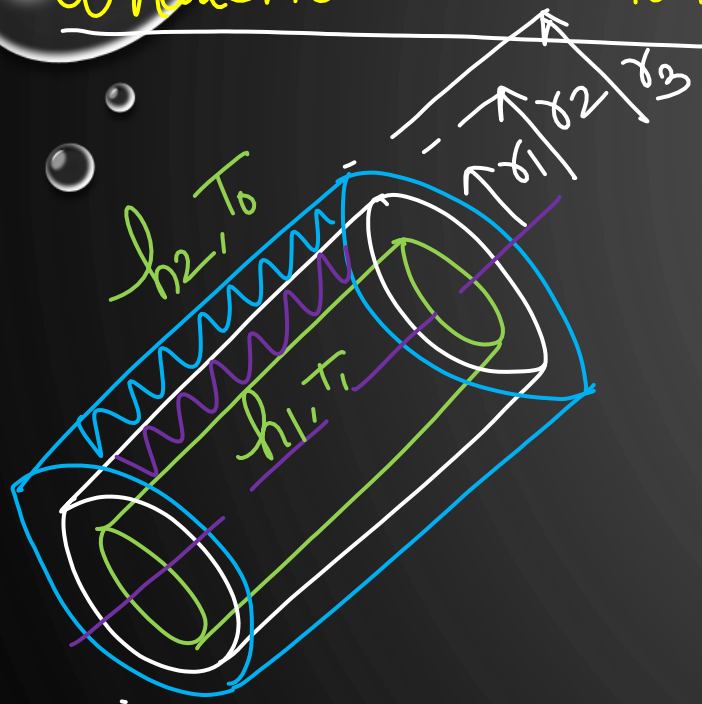
$$\boxed{Q = \frac{2\pi kL(T_1-T_2)}{\ln\frac{r_2}{r_1}}}$$

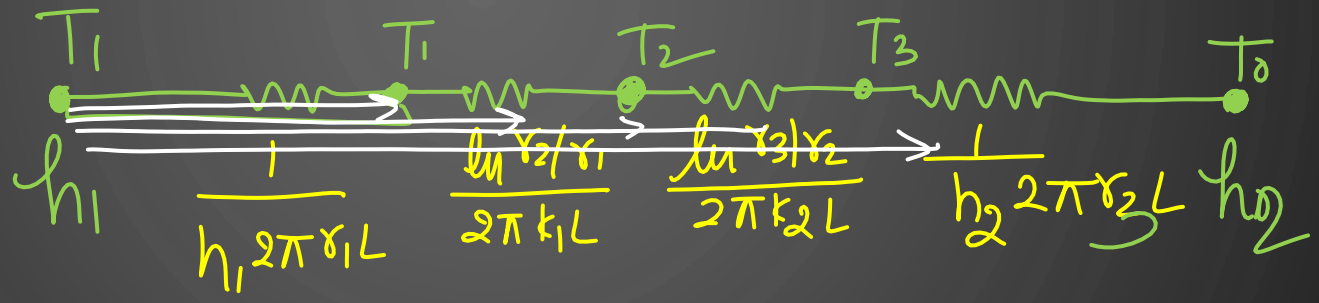
$$Q = \frac{\Delta T}{R_{th}} = \frac{\Delta T}{\ln(r_2/r_1)/2\pi kL}$$

$$R_{thcy} = \frac{\ln\left(\frac{r_2}{r_1}\right)}{2\pi kL}$$

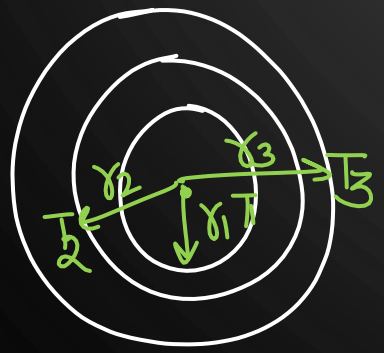
$r_2 \uparrow,\ R_{th} \uparrow,\ Q \downarrow$

Conduction-Convection HT Through a Composite Cylinder :→





$$Q = \frac{\Delta T}{R_{th}} = \frac{T_1 - T_0}{\frac{1}{h_1 2\pi r_1 L} + \frac{\ln r_2/r_1}{2\pi k_1 L} + \frac{\ln r_3/r_2}{2\pi k_2 L} + \frac{1}{h_2 2\pi r_3 L}}$$



$$= \frac{T_1 - T_1}{\frac{1}{h_1 2\pi r_1 L}} = \frac{T_1 - T_2}{\frac{1}{h_1 2\pi r_1 L} + \frac{\ln r_2/r_1}{2\pi k L}}$$

Overall heat xfer coefficient :→

$$\frac{1}{UA} = R_{th}$$

$$\frac{1}{U_i} = \frac{1}{h_i} + \frac{r_1}{k_1}\ln\frac{r_2}{r_1} + \frac{r_1}{k_2}\ln\frac{r_3}{r_2} + \frac{r_1}{r_3}\left(\frac{1}{h_o}\right)$$

$$\frac{1}{U_o} = \frac{r_3}{r_1}\left(\frac{1}{h_i}\right) + \frac{r_3}{k_1}\ln\frac{r_2}{r_1} + \frac{r_3}{k_2}\ln\frac{r_3}{r_2} + \frac{1}{h_o}$$

$\frac{1}{U} \propto R_{th}$

$$\frac{1}{U_i A_i} = \frac{1}{h_i A_i} + \frac{\ln r_2/r_1}{2\pi k_1 L} + \frac{\ln r_3/r_2}{2\pi k_2 L} + \frac{1}{h_o A_o}$$

$$\frac{1}{U_i} = \frac{1}{h_i} + \frac{2\pi r_1 L}{2\pi k_1 L}\ln\frac{r_2}{r_1} + \frac{2\pi r_1 L}{2\pi k_2 L}\ln\frac{r_3}{r_2} + \frac{2\pi r_1 L}{2\pi r_3 L}\frac{1}{h_o}$$

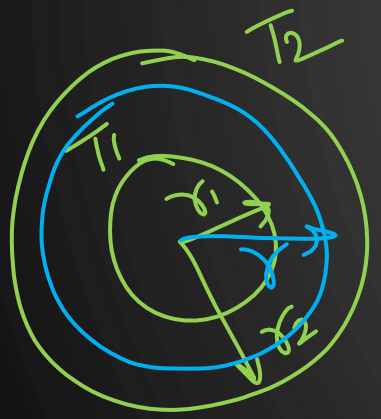
$$\frac{1}{U_0 A_0} = R_{th}$$

$$\frac{1}{U_0 A_0} = \frac{1}{h_1 A_1} + \frac{\ln r_2/r_1}{2\pi k_1 L} + \frac{\ln r_3/r_2}{2\pi k_2 L} + \frac{1}{h_0 A_0}$$

$$\boxed{\frac{1}{U_0} = \frac{r_3}{r_1}\left(\frac{1}{h_1}\right) + \frac{r_3}{k_1}\ln\frac{r_2}{r_1} + \frac{r_3}{k_2}\ln\frac{r_3}{r_2} + \frac{1}{h_0}}$$

✓✓

Conduction HT through a hollow sphere →



$Q \neq f(r)$

$Q \neq f(T)$

$T \neq f(\text{time})$

$T = f(r)$

$$Q = -kA\frac{dT}{dr}$$

$$Q = -K\,4\pi k r^2 \frac{dT}{dr}$$

$$Q\int_{r_1}^{r_2}\frac{dr}{r^2} = -\int 4\pi k\, dT$$

$$Q\left[\frac{1}{r_1}-\frac{1}{r_2}\right] = 4\pi k(T_1-T_2)$$

$$Q = \frac{4\pi k(T_1-T_2)}{\frac{1}{r_1}-\frac{1}{r_2}}$$

$$Q = \frac{4\pi k(T_1-T_2)\,r_1 r_2}{r_2-r_1}$$

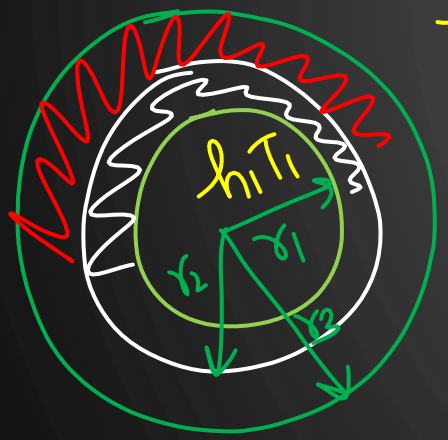
$$\boxed{Q = \frac{4\pi k r_1 r_2 (T_1-T_2)}{r_2-r_1}}$$

$$Q = \frac{\Delta T}{R_{th}} = \frac{\Delta T}{\frac{r_2-r_1}{4\pi k r_1 r_2}}$$

$$\boxed{R_{th} = \frac{r_2-r_1}{4\pi k r_1 r_2}}$$

Composite Sphere

h_2, T_0



$$Q = \frac{\Delta T}{R_{th}}$$

$$Q = \frac{T_1 - T_0}{\frac{1}{h_1 A_1} + \frac{r_2 - r_1}{4\pi k_1 r_1 r_2} + \frac{r_3 - r_2}{4\pi k_2 r_1 r_2} + \frac{1}{h_0 A_0}}$$

Tomorrow

4:30 PM

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