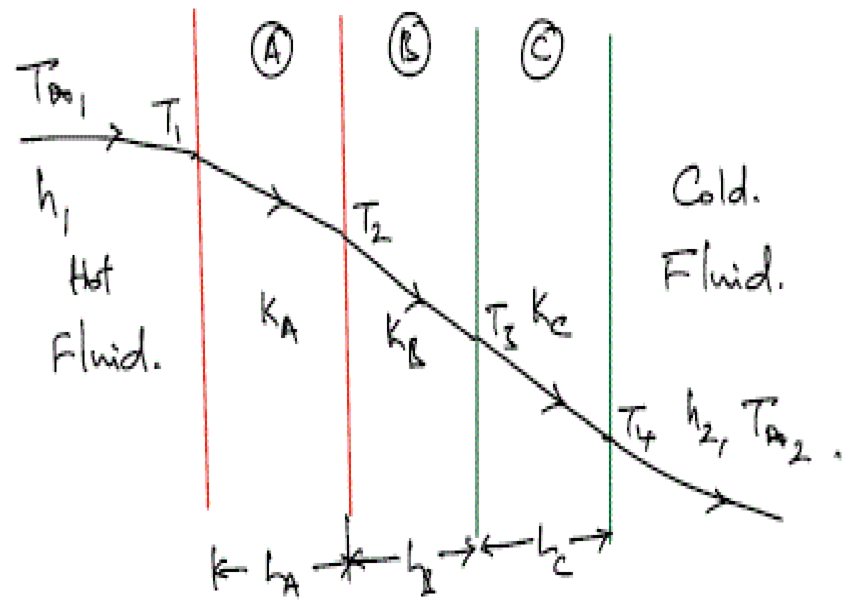
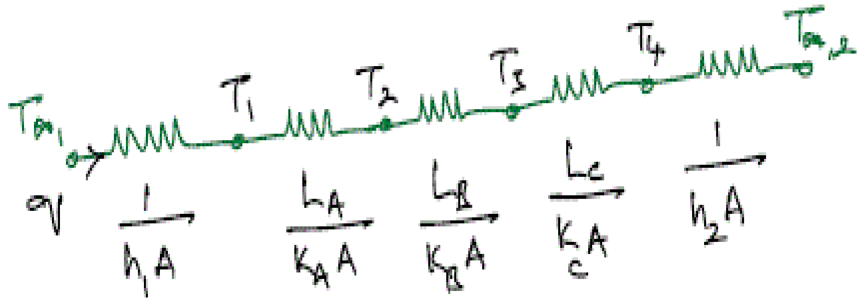
Composite walls:

Thermal resistances in series:



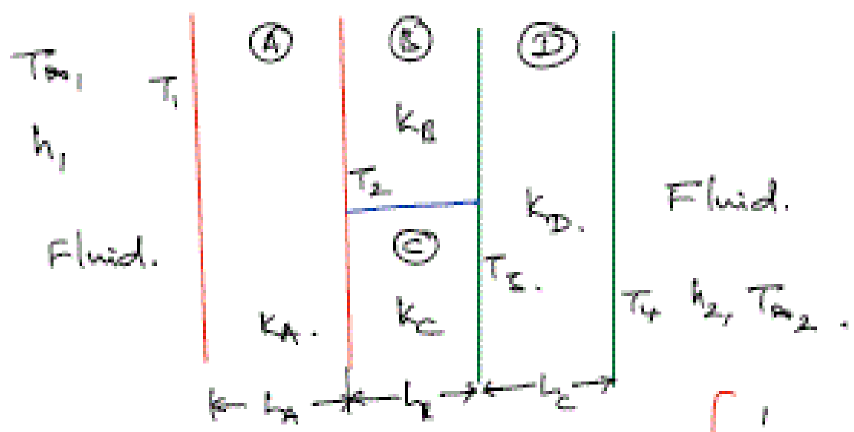


$$\therefore \quad q = \frac{T_{\infty_1} - T_{\infty_2}}{\frac{1}{h_1 A} + \frac{L_A}{K_A A} + \frac{L_B}{K_B A} + \frac{L_C}{K_C A} + \frac{1}{h_2 A}} = UA\Delta T$$

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

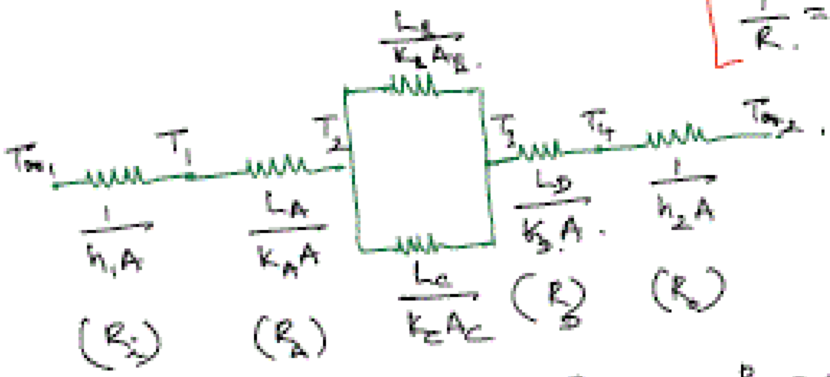
$$U = \frac{1}{\frac{1}{h_1} + \frac{L_A}{K_A} + \frac{L_B}{K_B} + \frac{L_C}{K_C} + \frac{1}{h_2}}$$

Series-parallel arrangement:



$$\boxed{\begin{aligned} \frac{1}{R} &= \frac{1}{R_1} + \frac{1}{R_2} \\ \frac{1}{R} &= \frac{R_1 + R_2}{R_1 R_2} \end{aligned}}$$

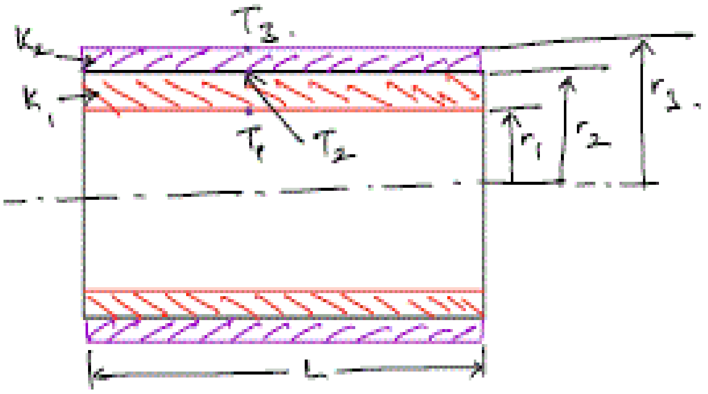
(a) $L_B = L_C$ (b) $A_B + A_C = A_A = A_D = A$.



$$\frac{1}{R_{parallel}} = \frac{1}{R_B} + \frac{1}{R_C} = \frac{R_B + R_C}{R_B \times R_C} \rightarrow \begin{aligned} R_B &= \frac{L_B}{K_B A_B} \\ R_C &= \frac{L_C}{K_C A_C} \end{aligned}$$

Composite cylinder:

Case 1: 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 $\rightarrow$ $T_1 \xrightarrow{Q} \underset{R_1}{\text{wwww}} \; T_2 \; \underset{R_2}{\text{wwww}} \; T_3$

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.

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

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

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