Submission 1 - Technical Environmental Systems

Tuesday, October 8, 2019 9:28 AM

1. **Summary - Conductive Heat Transfer**

Conduction refers to the mono-dimensional transfer of heat through a material. In the case of buildings, for example, the walls transfer heat from the outside to the inside, or vice versa depending on the temperature difference. This heat transfer through the wall of a building is known as Conductive Heat Transfer, which can be considered as steady and mono-dimensional.

$$\dot{Q}_{in}\ \text{(Rate of Heat transfer into the wall)} - \dot{Q}_{out}\ \text{(Rate of Heat transfer out of the wall)} = \frac{\mathrm{dE}}{\mathrm{dT}}\ \text{(Rate of change of energy of the wall)}$$

Since the heat transfer through the wall is modelled to be steady, $\frac{\mathrm{dE}}{\mathrm{dT}} = 0.$

Fourier's Law of Heat Conduction:

Rate of Heat Transfer, $\dot{Q} = -kA\frac{dT}{dx}$, *where* $k - \text{Thermal conductivity of the material},$

A - Area of the wall surface which transfers heat

dT - Temperature difference

dx - Thickness of the wall

Under steady conditions, dT/dx=constant

For a wall of thickness L, $\dot{Q} = kA\frac{T1-T2}{L}\ [W]$

Thus, rate of heat conduction through a plane wall is directly proportional to the thermal conductivity, area of the wall surface and the temperature difference, while inversely proportional to the wall thickness.

Comparing the situation to the flow of electric current,
Thermal Resistance of the wall can be considered as analogous to electric resistance.

$$\dot{Q} = kA\frac{T1-T2}{L} \Rightarrow \dot{Q} = \frac{T1-T2}{R} \left(\sim I = \frac{V1-V2}{R_e}\right)$$

Thus, $R = \frac{L}{kA}\ °C/W$

2. **Find the rate of heat trasfer through the wall if L= 0.4 m, A= 20 m2, DeltaT= 25, and k= 0.78 W/m K using both simple method and using the resistance concept.**

Simple Method:

$$\dot{Q} = kA\frac{T1-T2}{L} = \frac{0.78*20*25}{0.4} = \mathbf{975\ W}$$

Resistance Concept:

$$R = \frac{L}{kA} = \frac{0.4}{0.78*20} = 0.02564\ °C/W$$

$$\dot{Q} = \frac{T1-T2}{R} = \frac{25}{0.02564} = \mathbf{975.04\ W}$$