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1. Concept of heat transfer

Heat transfer seeks to predict the energy transfer that may take place between material bodies as a result of a temperature differences. Heat transfer may take place by one or more of three modes: conduction, convection and radiation

Conduction

Fourier's law of heat conduction

$$q_x = -k_A A \frac{dT_A}{dx}$$

Where k is thermal conductivity of the wall's material , (W/m.K)

A is area of the Wall, (m^2)

x is the heat flow direction , (m)

T is the temperature of the Wall , (°C)

Convection

Convection is the mode of heat transfer between a solid surface and the adjacent fluid which is in motion, The convective heat transfer is associated with the displacement of the fluid element. Convection is called forced convection if the fluid is forced to flow over the surface by a fan, wind, or the pump. In contrast, convection is called free convection if the fluid motion is caused by buoyancy force that is induced by density difference due to the variation of temperature in the fluid

Newton's law of heat convection

$$q_x = hA(T - Tw)$$

where h is convective heat transfer coefficient (W/m.K)

A is heat transfer area (m^2)

Tw is surface temperatures of the wall (°C)

T is the bulk fluid temperature (°C)

Radiation

Radiation is the energy emitted by matter in the form of electromagnetic waves as a result of the changes in the electronic configurations of the atoms or molecules. The maximum rate of radiation which can be emitted from a surface at an absolute temperature (Ts) is given by the *Stefan-Boltzmann law as:*

$$q_{emit} = \varepsilon \cdot \sigma \cdot A \cdot T_s^4$$

- Where = 5.67 × 10σ-8 W/m2.K4

is the *Stefan-Boltzmann constant and ε is the emissivity of* the surface. An idealized surface, which emits radiation at a maximum rate has ε = 1, is known as a *blackbody.*