MODE OF HEAT TRANSFER

There are three common modes of heat transfer—conduction, convection, and radiation.

Conductive Heat Transfer

Conduction is the mode of heat transfer in which the transfer of energy takes place at a molecular level. There are two commonly accepted theories that describe conductive heat transfer.

According to one theory, as molecules of a solid material attain additional thermal energy, they become more energetic and vibrate with increased amplitude of vibration while confined in their lattice. These vibrations are transmitted from one molecule to another without actual translatory motion of the molecules. Heat is thus conducted from regions of higher temperature to those at lower temperature.

The second theory states that conduction occurs at a molecular level due to the drift of free electrons.

These free electrons are prevalent in metals, and they carry thermal and electrical energy. For this reason, good conductors of electricity such as silver and copper are also good conductors of thermal energy.

Note that in conductive mode, there is no physical movement of the object undergoing heat transfer. Conduction is the common mode of heat transfer in heating/cooling of opaque solid materials.

Convective Heat Transfer

When a fluid (liquid or gas) comes into contact with a solid body such as the surface of a wall, heat exchange will occur between the solid and the fluid whenever there is a temperature difference between the two. During heating and cooling of gases and liquids the fluid streams exchange heat with solid surfaces by convection.

The magnitude of the fluid motion plays an important role in convective heat transfer. For example, if air is flowing at a high velocity past a hot baked potato, the latter will cool down much faster than if the air velocity was much lower.

Radiation Heat Transfer

Radiation heat transfer occurs between two surfaces by the emission and later absorption of electromagnetic waves (or photons). In contrast to conduction and convection, radiation requires no physical medium for its propagation—it can even occur in a perfect vacuum, moving at the speed of light, as we experience everyday solar radiation. Liquids are strong absorbers of radiation. Gases are transparent to radiation, except that some gases absorb radiation of a particular wavelength (for example, ozone absorbs ultraviolet radiation). Solids are opaque to thermal radiation. Therefore, in problems involving thermal radiation with solid materials, such as with solid foods, our analysis is concerned primarily with the surface of the material. This is in contrast to microwave and radio frequency radiation, where the wave penetration into a solid object is significant.