**CHAPTER-5**

**TRANSIENT CONDUCTION**

We now recognize that may heat transfer problems are time dependent.

Consider a hot metal ball that is removed from a furnace and exposed to a cool air stream. Energy is transferred by convection and radiation from its surface to the surroundings. Energy transfer by conduction also occurs from the interior of the metal to the surface, and the temperature at each point in the ball decreases until a steady-state condition is reached.

In order to analyze this transient process, we make an assumption; temperature gradient within the solid is neglected. This approach is named as “LUMPED CAPACITANCE METHOD”.

**Lumped Capacitance Method**

A simple, yet common, transient conduction problem is one for which a solid experiences a sudden change in its thermal environment.

=qconv

Total surface area of the ball is As

The reduction in T is due to convection heat transfer at the solid-liquid interface.

Hot metal ball

initially at Ti

immersed in a

liquid at T

The quenching started at t=0. Temperature of the solid will decrease for time t>0 until it reaches T

The essence of the lumped capacitance method is the assumption that the temperature of the solid is spatially uniform at any instant during the transient process.

From the Fourier’s Law, heat conduction in the absence of T gradient implies the existence of infinite thermal conductivity, k. Such a condition is clearly impossible. However, the condition is closely approximated if the resistance to conduction within the solid is small compared with the resistance to heat transfer between solid and its surroundings.

Rt,cond<< Rt,conv

Applying the energy balance for the metal:

(the energy leaves the system per unit time is by convection is equal to the decrease in energy stored within the system)

Substitute

Reorganize the equation:

Integrate and apply the initial BC (at t=0, T=Ti, ):

