# BASICS OF THERMAL PROPERTIES

Lecture 06
(PFE-2.4.5)

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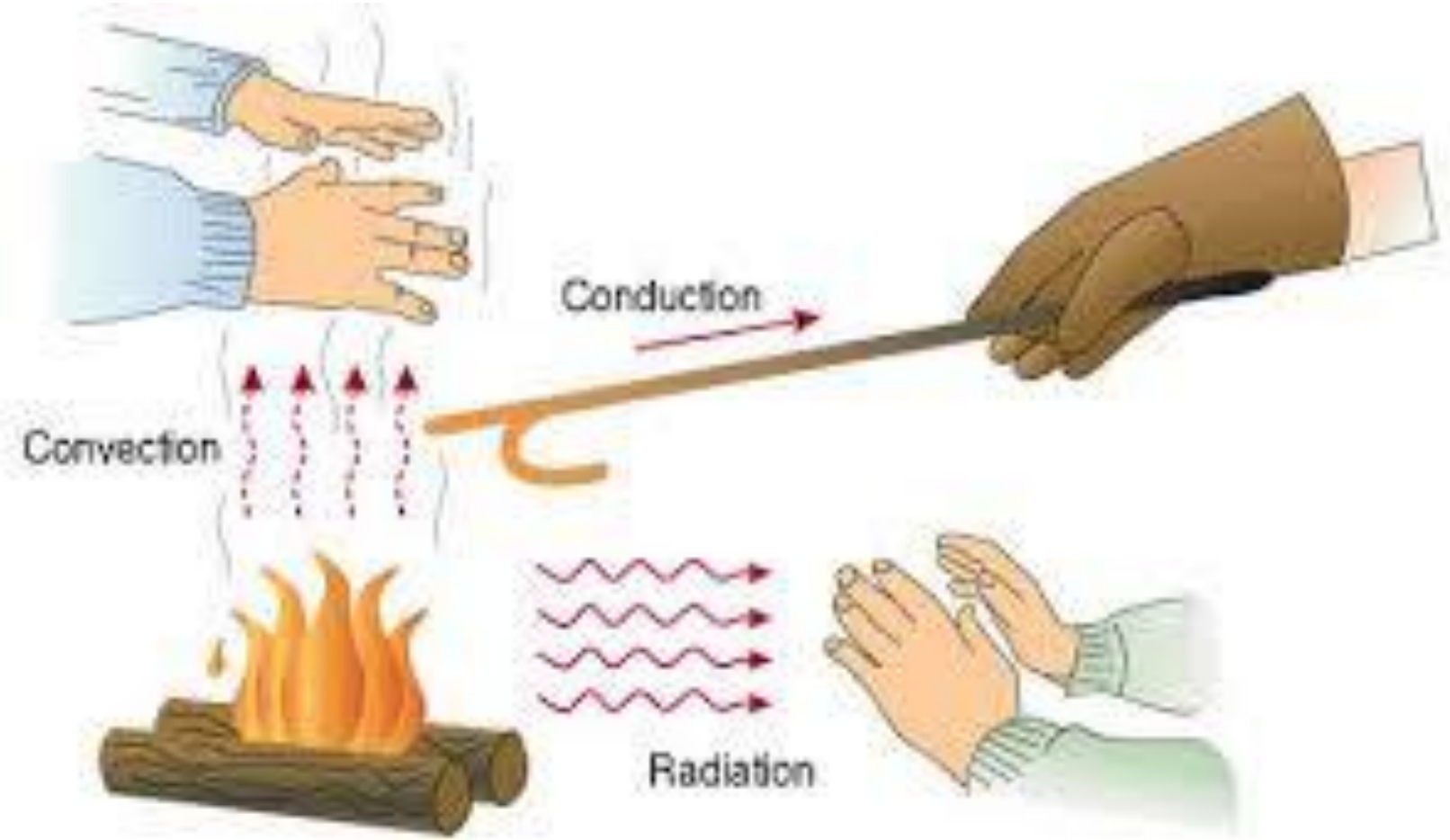
# Applications

- **extrusion cooking,**
- **Drying**
- **Sterilization**
- **Cooking**
- **thermal processing, in cooling or freezing** and in storage **operations**

# Modes of heat transfer



# Thermal properties

- **Specific heat:-**
- Heat required to raise the temperature by 1˚C for unit mass of the body.
- C = $\frac{q}{m\Delta T}$
- Where q= heat, kcal
  C = kcal/ kg˚C
- m= mass, kg
- T= temperature difference, ˚C

# Thermal Conductivity

- Thermal conductivity is the quantity heat that passes through a body (plate) of particular area & thickness when it's opposite faces difference in temperature.

- Q=- k $\frac{A(T1-T2)}{x} \times t$

# Thermal diffusivity

- It is rate at which heat is diffused out of the materials. It is the ratio between thermal conductivity to volumetric heat capacity.

$$\alpha = \frac{k}{PCp}$$

$$\frac{dt}{d\theta} = \alpha\left(\frac{d2t}{dx2} + \frac{d2t}{dy2} + \frac{d2t}{dz2}\right)$$

# Thermal Emissivity(E)

- It is a ratio of total Emissive power of a blackbody to the same temperature.
- This thermal constant is associated with the rate of heat transfer by radiation from a hot body to a cold body.
- $Q = A F_a F_e \sigma(T_1^4 - T_2^4)$
- Fe = 1 black body;  Fe<1 real object
- A= surface area
- $F_a$ = Angle factor, representing the angle that one body sees the other body.
- $F_e$ = Emissivity factor
- σ = Stefan Boltzmann constant

# Thermal Effusively

- Square root of the product of the materials thermal conductivity & Volumetric heat capacity.

$$e = (K \rho C_p)^{1/2}$$

# Arrhenius equation

- D= $D_0 e^{\frac{-E_a}{RT}}$

- $D_o$ = maximum diffusion coefficient at infinite temp.
- $E_a$ = activation energy
- T = Absolute temp, K
- R = universal gas constant

# Coefficient of Thermal expansion

$$\alpha_V = \left(\frac{1}{V}\right)\left(\frac{dV}{dT}\right)$$

- V=Volume of material,
- $\frac{dV}{dT}$ = Rate of volume
- $\alpha_V$=Volumetric thermal expansion

# Specific Heat calculation

- $C_{avg}$= $C_{ps}$= Sp. Heat of solid not Fat, $C_{pw}$= Sp. Heat of water
- $C_{pw}$ = 4186.8M, $C_{ps}$=837.36
- $C_{avg}$= 4186.8M+(1-M)837.36
- $C_{avg}$=3349M+837.36 J /(ag.k).....(1)
- $C_{pf}$ = Sp heat of fat = 1676.72
- $C_{avg}$ = 1674.72F + 7.36SNF + 4186.8M ($J/ng^0$).....(2)

# Boiling point Rise:-

- In liquid food boiling point rise refers to water evaporation in which water change from the liquid phase to steam or vapour phase, and water vapour pressure equals to the external pre liquid foods contain high molecules weight solids that cause the boiling point be evaluated above that of pane water. The boiling point rise ( ), is known as the increase in the boiling point over that of pure water in a given liquid food. As the vapour pressure of most aqueous solution is lower than that of water at the same temperature, the boiling temp(point) of the solution in higher than that of pure water.