

THERMAL PROPERTIES OF FOOD

Properties controlling the transfer of heat in a specified food

Thermal properties of foods and beverages must be known to:

- Perform the various heat transfer calculations, required in the **design** of storage and refrigeration equipment
 - Estimate the **process times** for refrigerating, freezing, heating, or drying foods and beverages.
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- Thermophysical properties of foods encompass a wide range of parameters associated with heat transfer operations in food processing.

Important thermal properties of foods



1. Specific heat capacity (C_p)

- The amount of **heat needed** to raise the temperature of one gram of a substance by one degree Celsius.
- **Unit-** J/kg K (SI system)
- Heldman (1975) proposed the following equation to estimate the specific heat of foodstuffs based on their mass fraction (water, protein, fat, carbohydrate, and ash).


$$c_p = 4.180X^w \text{ water} + 1.547X^w \text{ prot} + 1.672X^w \text{ fat} + 1.42X^w \text{ CHO} + 0.836X^w \text{ ash}$$

2. Thermal conductivity (k)

- It is the ability of a material to **conduct heat**.
- **Unit-** Watts per meter-kelvin (SI system)
- It determines how fast heat can be evenly transferred to the entire food mass, which in turn affects the quality of the final product.
- The thermal conductivity of a food product depends mainly on its chemical composition, molecular structure, and the temperature at which it is processed.

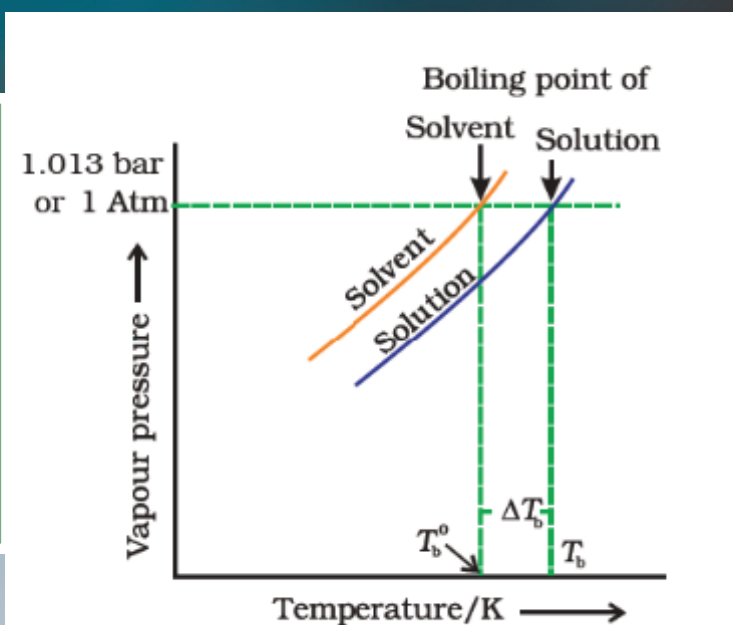
3. Thermal Diffusivity (α)

- It is rate at which **heat is diffused** out of the materials. It is the ratio between thermal conductivity to volumetric heat capacity.
- **Unit-** m^2/s (SI system)

4. Boiling Point Rise and Freezing Depression

- **Boiling point elevation** is the raising of a solvent's boiling point due to the addition of a solute.
- **Freezing point depression** is the lowering of a solvent's freezing point due to the addition of a solute.
- As the boiling point of a solvent increases, its freezing point decreases.
- **Ex;** Addition of salt to ice. The solute (salt) reduces the freezing point of the ice, which allows the ice to melt at a lower temperature.

The increase in the boiling point $\Delta T_b = T_b - T_{b0}$ is known as the elevation of boiling point. The elevation of boiling point (ΔT_b) is directly proportional to the lowering of vapour pressure (Δp).



- In general, thermophysical properties of a food or beverage are constant when its temperature is above its initial freezing point.
- However, below the initial freezing point, the thermophysical properties vary greatly because of the complex processes involved during freezing.
- Because the thermophysical properties of ice and water are quite different, thermophysical properties of frozen foods vary dramatically with temperature.

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