UNIT V – TOPIC 2

Ohmic & Di-electric Heating

Both **Ohmic Heating** and **Dielectric Heating** (including **Microwave & Radio Frequency Heating**) are **electrothermal technologies** used in food processing. They differ in their heating mechanisms and applications.

---

1. Ohmic Heating (Joule Heating)

Principle:

- **Direct resistance heating** where an **electric current** passes through the food, generating heat due to its **electrical resistance** (Joule effect).
- Requires the food to be an **electrical conductor** (e.g., liquids, semi-solids with ionic content).

Key Features:

✔ **Uniform heating** – minimizes hot/cold spots.
✔ **Rapid heating** – faster than conventional methods.
✔ **No heat transfer surfaces** – reduces fouling.
✔ **Preserves nutrients & sensory qualities** – less thermal degradation.

Applications:

- **Pasteurization & Sterilization** (fruit juices, milk, liquid eggs).
- **Cooking & Thawing** (meats, vegetables).
- **Extraction & Fermentation** (enhances yields).

Challenges:

- Requires **conductive foods** (not suitable for dry or non-conductive materials).
- **Electrode corrosion** over time.
- **Non-uniform heating** in heterogeneous foods.

2. Dielectric Heating (Microwave & Radio Frequency Heating)

Principle:

- Uses **electromagnetic waves** to generate heat by **molecular friction**:
  - **Microwave (MW) Heating** (300 MHz – 300 GHz): Polar molecules (e.g., water) rotate, creating heat.
  - **Radio Frequency (RF) Heating** (1–300 MHz): Ionic conduction and dipole rotation.

Key Features:

✔ **Volumetric heating** – heats food from inside out.
✔ **Fast & energy-efficient** – reduces processing time.
✔ **Selective heating** – depends on dielectric properties.

Applications:

- **Drying & Dehydration** (fruits, snacks).
- **Pasteurization & Sterilization** (packaged foods).
- **Baking & Cooking** (ready-to-eat meals).
- **Thawing & Tempering** (meat, seafood).

Challenges:

- **Uneven heating** (hot spots due to wave interference).
- **Limited penetration depth** (especially in microwaves).
- **Safety concerns** (leakage, metal interference).

Comparison Table: Ohmic vs. Dielectric Heating

Feature	Ohmic Heating	Dielectric Heating (MW/RF)
Heating Mechanism	Electrical resistance (Joule effect)	Electromagnetic waves (dipole rotation/ionic conduction)

Feature	Ohmic Heating	Dielectric Heating (MW/RF)
Energy Source	Alternating Current (AC)	Microwave (MW) or Radio Frequency (RF) waves
Suitable Foods	Conductive liquids/semi-solids	Wide range (depends on dielectric properties)
Heating Uniformity	High (if homogeneous)	Can be non-uniform (hot spots)
Penetration Depth	Depends on conductivity	MW: Shallow; RF: Deeper
Applications	Pasteurization, extraction	Drying, thawing, cooking

---

Conclusion

- **Ohmic Heating** is ideal for **conductive liquid foods**, offering rapid, uniform heating.
- **Dielectric Heating (MW/RF)** is better for **bulk and packaged foods**, providing fast volumetric heating.
- Both technologies reduce processing time and improve food quality compared to conventional methods.