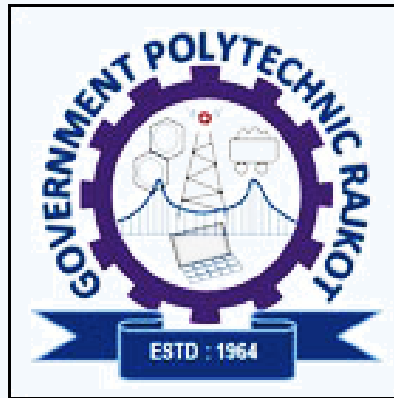


# Utilization of Electrical Energy

3340903



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*Unit - 2*

*Heating & Welding*

# Advantages of Electric Heating

- ❖ *Cleanliness*
- ❖ *Absence of flue gases*
- ❖ *Uniform heating*
- ❖ *Ease of control*
- ❖ *Quick process*
- ❖ *Efficiency*
- ❖ *Low maintenance*
- ❖ *Heating non-conductive material*
- ❖ *Heating in other medium*
- ❖ *Better working condition*
- ❖ *Suitability*
- ❖ *Less space*
- ❖ *Cheap*
- ❖ *Safe*

# Applications of Electrical Heating

- *Domestic*
  - *Cooking*
  - *Room Heater*
  - *Water Heater*
  - *Electric Toaster*
  - *Electric Iron*
  - *Electric Oven*
  - *Induction Plate*
  - *Hair Dryer*
  - *Hair Straightener*



# Applications of Electrical Heating

- Industrial
  - Melting of Metals
  - Hardening & Tempering
  - Moulding of Glass
  - Heat Treatment Process
  - Drying
  - Welding



# Mode of Heat Transfer



## Conduction

One molecule of the substance gets heated and transfer the heat to adjacent molecule



## Convection

heat transfer due to the bulk movement of molecules within fluids such as gases and liquids

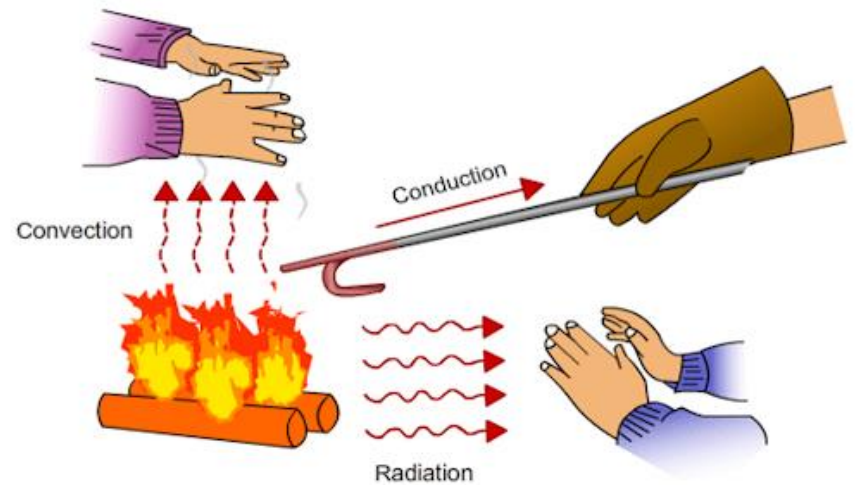
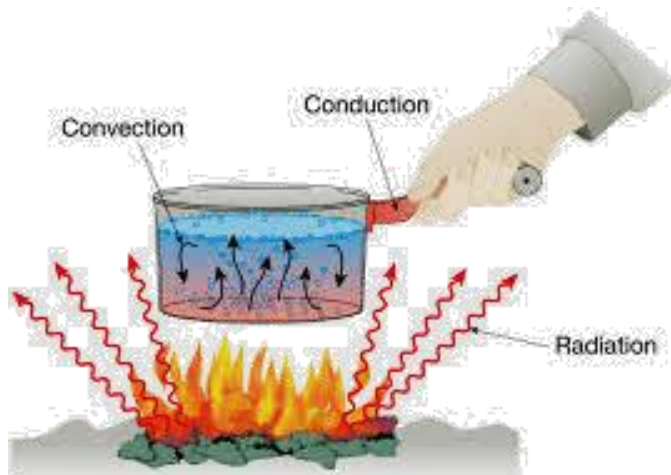


## Radiation

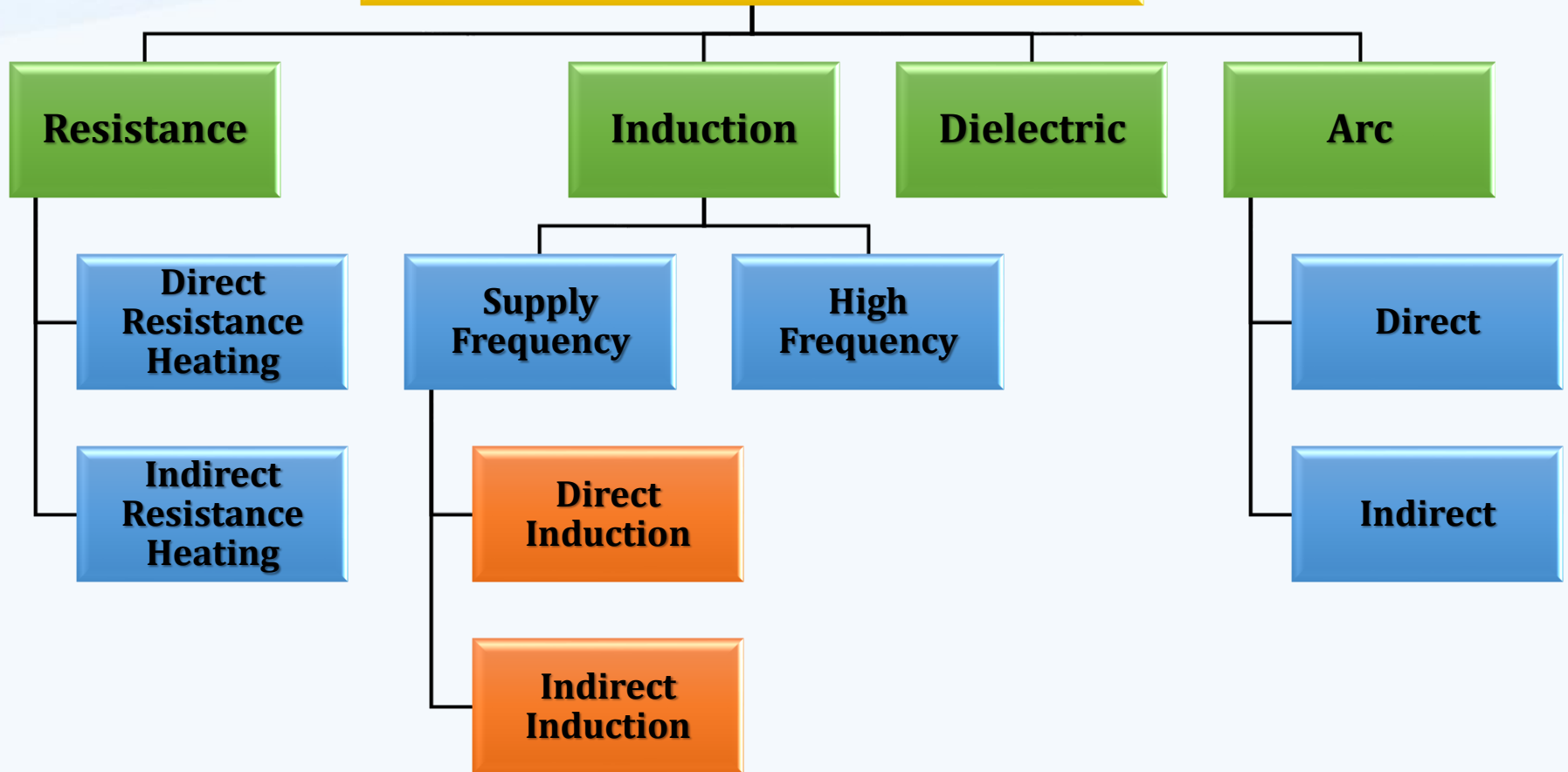
radiation is the emission or transmission of energy in the form of waves or particles through space or through a material medium



# Mode of Heat Transfer

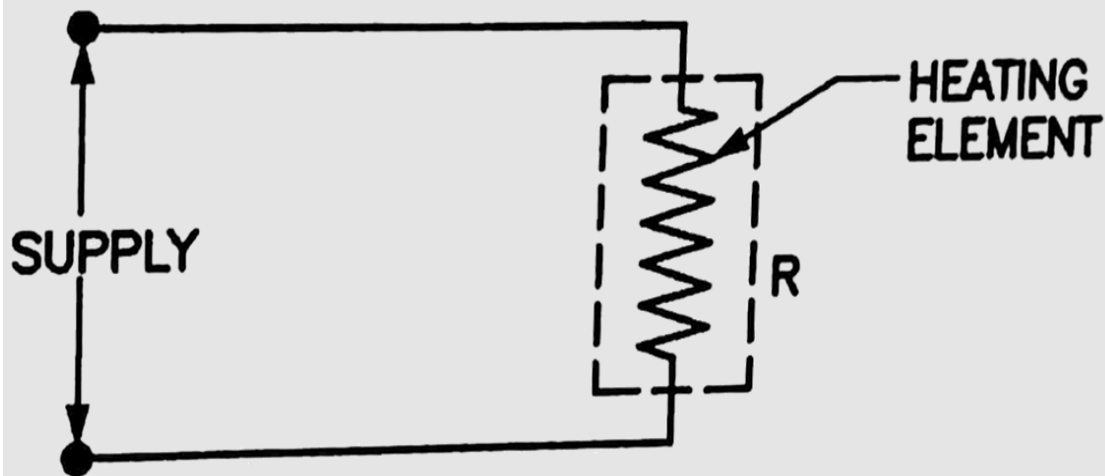


# Electric Heating





# Resistance Heating



❖ Working

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

# Resistance Heating

## Requirements of Heating Material

### + High Resistivity

small length of wire is required to produce a given amount of heat

### + High melting point

high temperature may be obtained

### + High mechanical strength



# Resistance Heating

## Requirements of Heating Material

+ **Free from oxidation**  
ensure long life

+ **Low temperature coefficient**  
resistance remains appreciably constant even  
with increase of temperature

+ **Non-corrosive**

+ **Economical**

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*Resistance  
Heating*

*Heating  
Materials*

**Nichrome**

**Kanthal**

**Cupronickel**

**Platinum**

# Resistance Heating

## Heating Materials

No.	Name of Material	Composition	Maximum Operating Temperature	Specific Resistance at 20° C	Specific Gravity
1.	Nickel - Chromium (Ni - Cr) (Nichrome)	Ni - 80 % Cr - 20 %	1150° C	109 $\mu\text{-}\Omega/\text{cm}^3$	8.36
2.	Nickel - Chromium - Iron (Ni - Cr - Fe)	Ni - 60 % Cr - 16 % Fe - 24 %	950° C	110 $\mu\text{-}\Omega/\text{cm}^3$	8.28
3.	Nickel - Copper (Ni - Cu) Eureka or Constantan	Ni - 45 % Cu - 55 %	400° C	49 $\mu\text{-}\Omega/\text{cm}^3$	8.88
4.	Iron - Chromium - Aluminum (Fe - Cr - Al) Kanthal	Fe - 70 % Cr - 25 % Al - 5 %	1200° C	140 $\mu\text{-}\Omega/\text{cm}^3$	7.2

# Resistance Furnace

Heat Dissipation

Indirect Resistance Furnace

Direct Resistance Furnace

Temperature Range

Low 300° C

Medium 1000° C

High 1350° C

Construction

Open Chamber

Muffle Chamber

Forced Convection

Immersed Element



# Resistance Heating

## Direct

- Current passed through body
- Direct heat

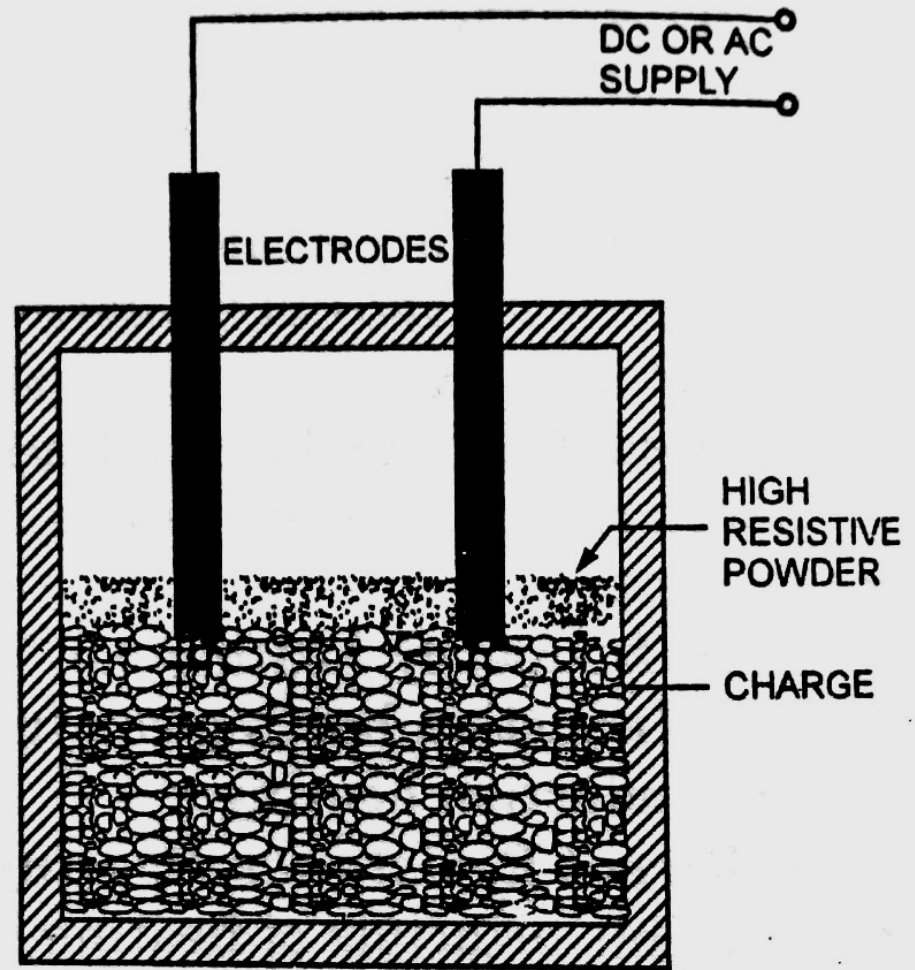
## Indirect

- Current passed through resistive element
- Heat transmitted

# Resistance Heating

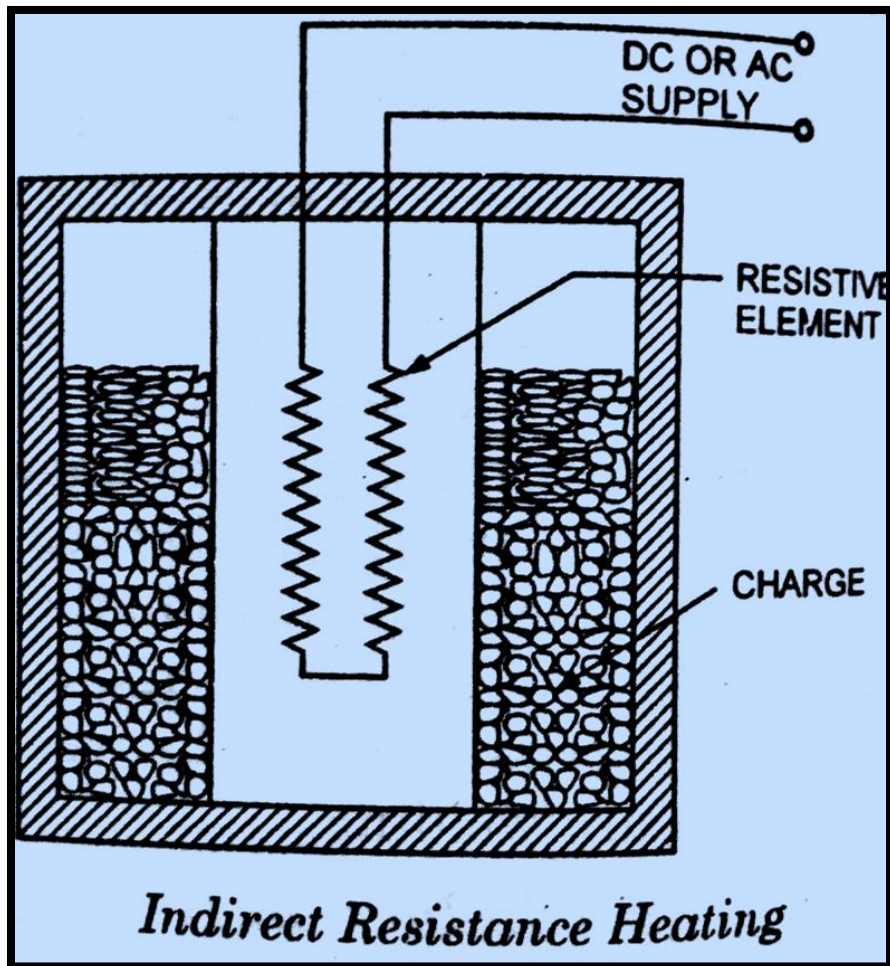
## Direct Resistance Heating

- Material/charge is taken as resistance and current is passed through it



*Direct Resistance Heating*

# Resistance Heating

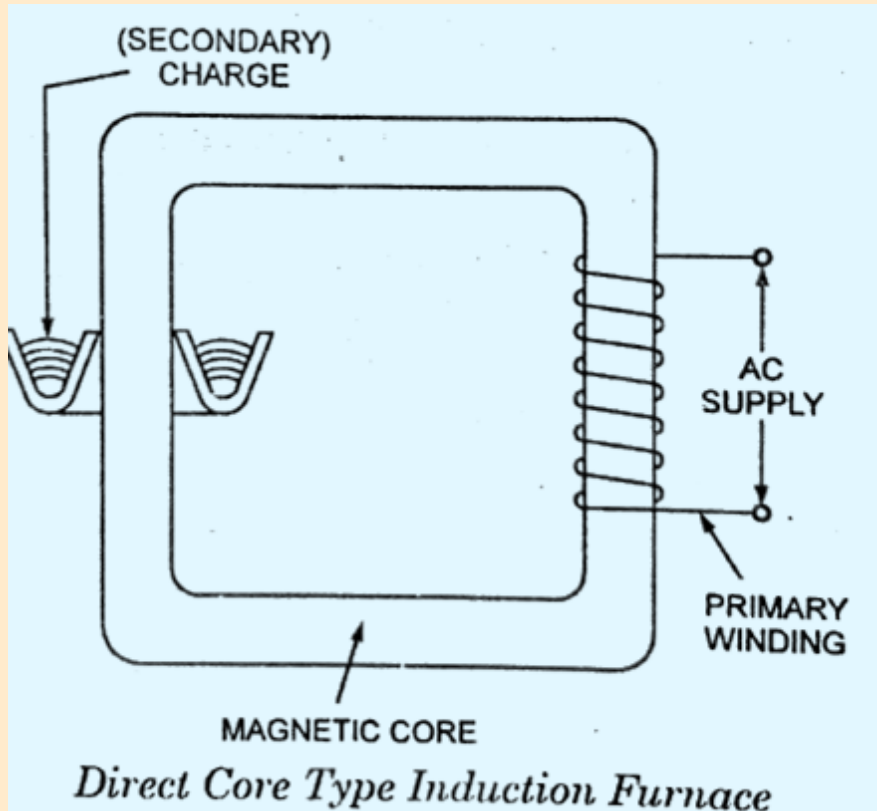


*Indirect*

*Resistance Heating*

- *Current is passed through heating element.*
- *Heating chamber is required*
- *Heat transferred by convection*

# Induction Heating



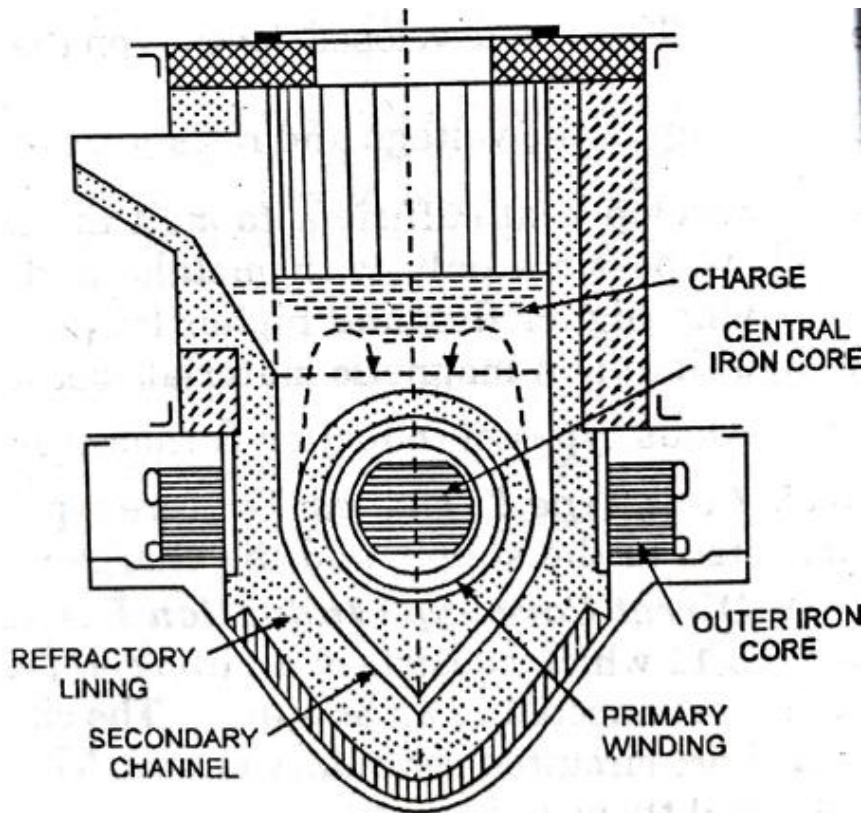
## Direct Core type Induction Furnace

- Iron core, crucible (Insulating material) and primary winding
- Charge is kept in the crucible

# Induction Heating

## Vertical Core type Induction Furnace

- Convection currents keep the circulation of molten metals round the V portion.

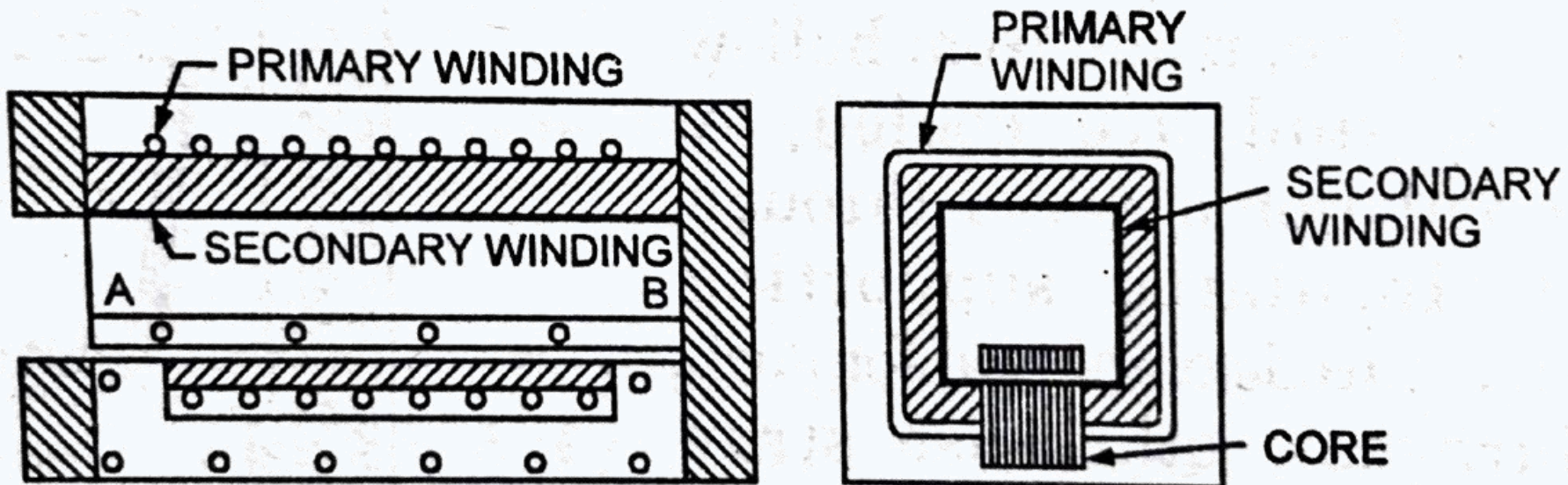


*Ajax Wyatt Vertical Core Furnace*



# Induction Heating

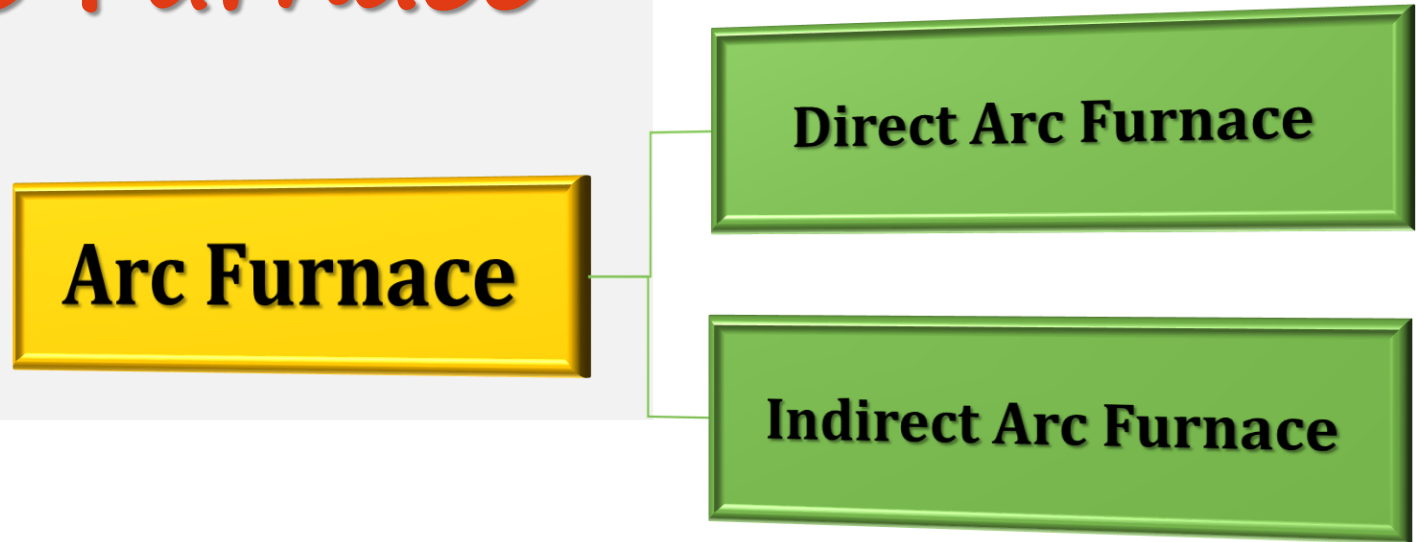
- + Indirect Core type Induction Furnace
- + Heat transfer by Radiation



*Indirect Core Type Induction Furnace*



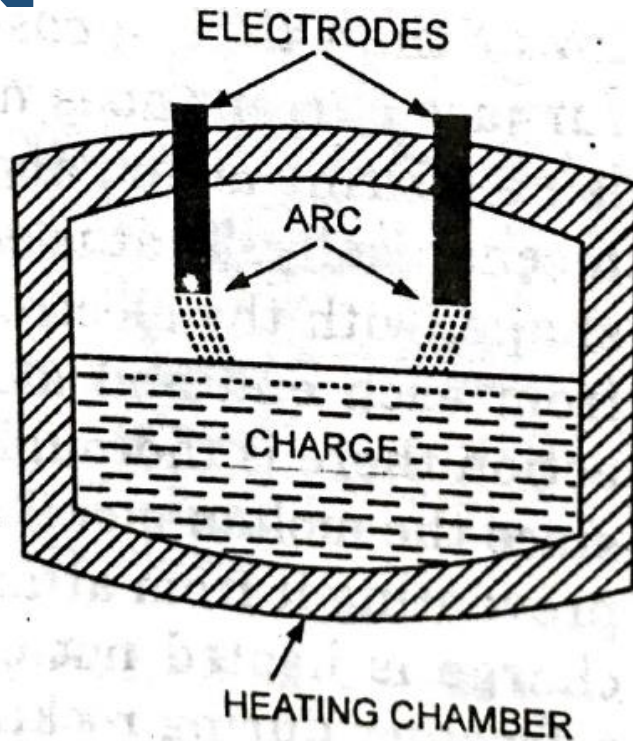
# Arc Furnace



When a high voltage is applied across an airgap it gets ionized under the influence of electrostatic forces and becomes conducting medium.

# Arc Furnace

+ **Direct Furnace**

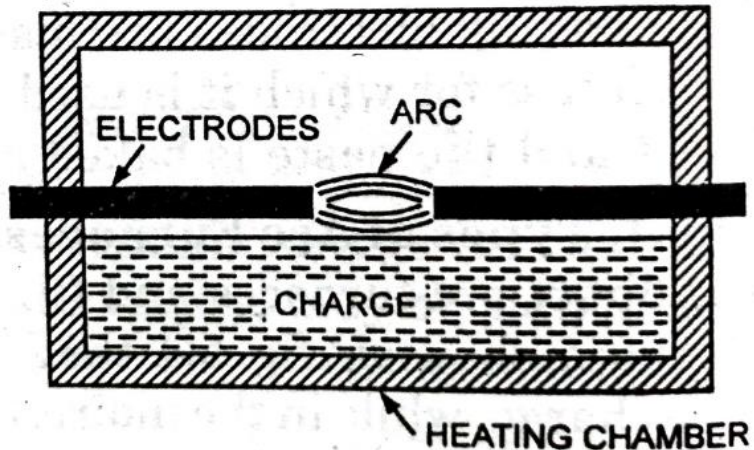


- Arc is produced between electrode and charge
- Advantages
  - Better temperature control
  - Heat is produced by two actions, Arc &  $I^2R$
  - Cheaper process
  - Automatic stirring due to electromagnetic forces

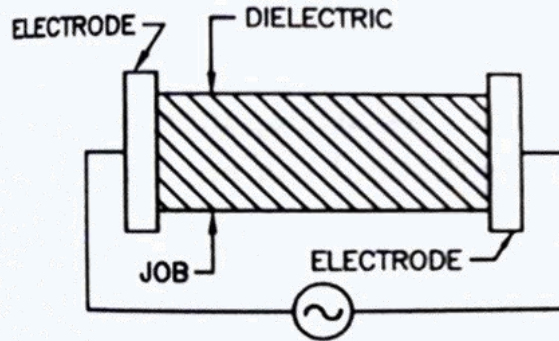
# Arc Furnace

## + Indirect Furnace

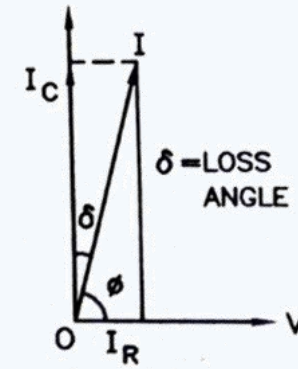
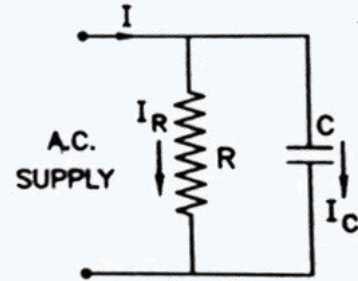
- Arc is produced between electrodes
- Advantages
  - Flexibility
  - High melting speed
  - Sound casting
  - Low metal losses
  - Economical



# Dielectric Heating



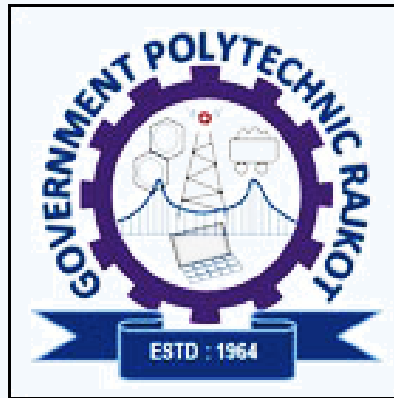
HIGH FREQUENCY SUPPLY



- Two conducting plates are separated by an insulating material with high frequency supply.
- Application
  - Plastic industry
  - Wood industry
  - Food processing
  - Foundry
  - Medical
  - Textile
  - Electronic sewing
  - Rubber
  - Drying



# Thank You



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