## 3.1 ROLE OF ELECTRIC HEATING FOR INDUSTRIAL APPLICATIONS

Electric heating is any process in which electrical energy is converted to heat. Common applications include heating of buildings, cooking, and industrial processes. An electric heater is an electrical appliance that converts electrical energy into heat. The heating element inside every electric heater is simply an electrical resistor, and works on the principle of Joule heating: an electric current through a resistor converts electrical energy into heat energy. Alternatively, a heat pump uses an electric motor to drive a refrigeration cycle, drawing heat from a source such as the ground or outside air and directing it into the space to be warmed. When current is passed through a conductor, the conductor becomes hot. When a magnetic material is brought in the vicinity of an alternating magnetic field, heat is produced in the magnetic material. Similarly, it was found that when an electrically insulating material was subjected to electrical stresses, it too underwent a temperature rise (dielectric heating). There are various methods of heating a material but electric heating is considered to be far superior for the following reasons:

(i) Cleanliness: Due to complete elimination of dust and ash, the charges to maintain cleanliness are minimum and the material to be heated does not get contaminated.

(ii) Ease of control: With the help of manual or automatic devices, it is possible to control and regulate the temperature of a furnace with great ease.

(iii) Uniform heating: Whereas in other forms of heating a temperature gradient is set up from the outer surface.

(iv) Low attention and maintenance cost: Electric heating equipments normally do not require much attention and maintenance is also negligible.

(v) Hence labour charges on these items are negligibly small as compared to alternative methods of heating.

**Heating is required for:**

(i) *DOMESTIC PURPOSES*

- Hot plates for cooking
- Immersion heaters for water heating
- Electric toasters
- Pop-corn plants
- Room heaters
- Electric irons
- Electric ovens for bakeries

(ii) *INDUSTRIAL PURPOSES*

- Melting of metals
- Moulding of glass
- Enameling of copper wires
- Heat treatment processes
- Baking of insulators
- Welding

The use of electrically produced heat is always economical proposition on account of the present low cost and availability of electrical energy. Practically, all heating requirements can be met by some form of electric heating equipment.

**Advantages of Electric Heating**

There are various methods of heating a material, but electric heating is considered to be far superior for the following reasons:

- ✓ Electric heating system is free from dirt. It is a clean system requiring minimum cost of cleaning.
- ✓ The system does not produce any flue gas. Since no flue gases are produced in electric heating, no provision has to be made for their exit.
- ✓ Simple and accurate temperature control can be either by manual or fully automatic switches.
- ✓ Electric heating is economical as electric furnaces are cheaper in initial cost as well in maintenance cost.

- ✓ Automatic protection against over-currents or over-heating can be provided through suitable switchgears.
- ✓ Special type of heating can be done very accurately by electric heating system.
- ✓ The overall efficiency of electric heating is much higher.
- ✓ Electric heating system provides better working conditions (since this system produces no irritating noise and also the radiating losses are low).
- ✓ Electric heating is quite safe and responds quickly.
- ✓ There is no upper limit to the temperature obtainable except the ability of the material to withstand heat.

**Modes of heat transfer**

- o Conduction
- o Convection
- o Radiation

**Requirement of Heating Material:**

*a) Low Temperature Coefficients of Resistance*

Resistance of conducting element varies with the temperature; this variation should be small in case of an element. Otherwise when switched ON from room temperature to go upto say 1200˚C, the low resistance at initial stage will draw excessively high currents at the same operating voltage.

*b) Resistance coefficient Positive*

If temperature is negative the element will draw more current when hot. A higher current means more voltage, a higher temperature or a still lower resistance, which can instability of operation.

*c) High Melting Point*

Its melting point should be sufficiently higher than its operating temperature. Otherwise a small rise in the operating voltage will destroy the element.

*d) High Specific Resistance*

The resistivity of the material used for making element should be high. This will require small lengths and shall give convenient size.

*e) High Oxidizing Temperature*

Its oxidizing temperature should higher than its operating temperature. To have convenient shapes and sizes, the material used should have high ductility and flexibility. It should not be brittle and fragile.

*f) Should with stand Vibration*

In most industrial process quiet, strong vibrations are produced. Some furnaces have to open or rock while hot. The element material should withstand the vibrations while hot and should not break open.

*g) Mechanical Strength*

The material used should have sufficient mechanical strength of its own.

TYPES OF HEATING

**i) Power Frequency Method:**

Direct resistance heating

Indirect resistance heating

Direct arc heating

Indirect arc heating.

**ii) High Frequency Heating:**

Induction heating

Dielectric heating.