

# ELECTRIC INDUCTION FURNACE

The electric induction furnace is a type of melting furnace that uses electric currents to melt metal. Induction furnaces are ideal for melting and alloying a wide variety of metals with minimum melt losses, however, little refining of the metal is possible.

## PRINCIPLE OF INDUCTION FURNACE

The principle of induction furnace is the induction heating.

### INDUCTION HEATING:

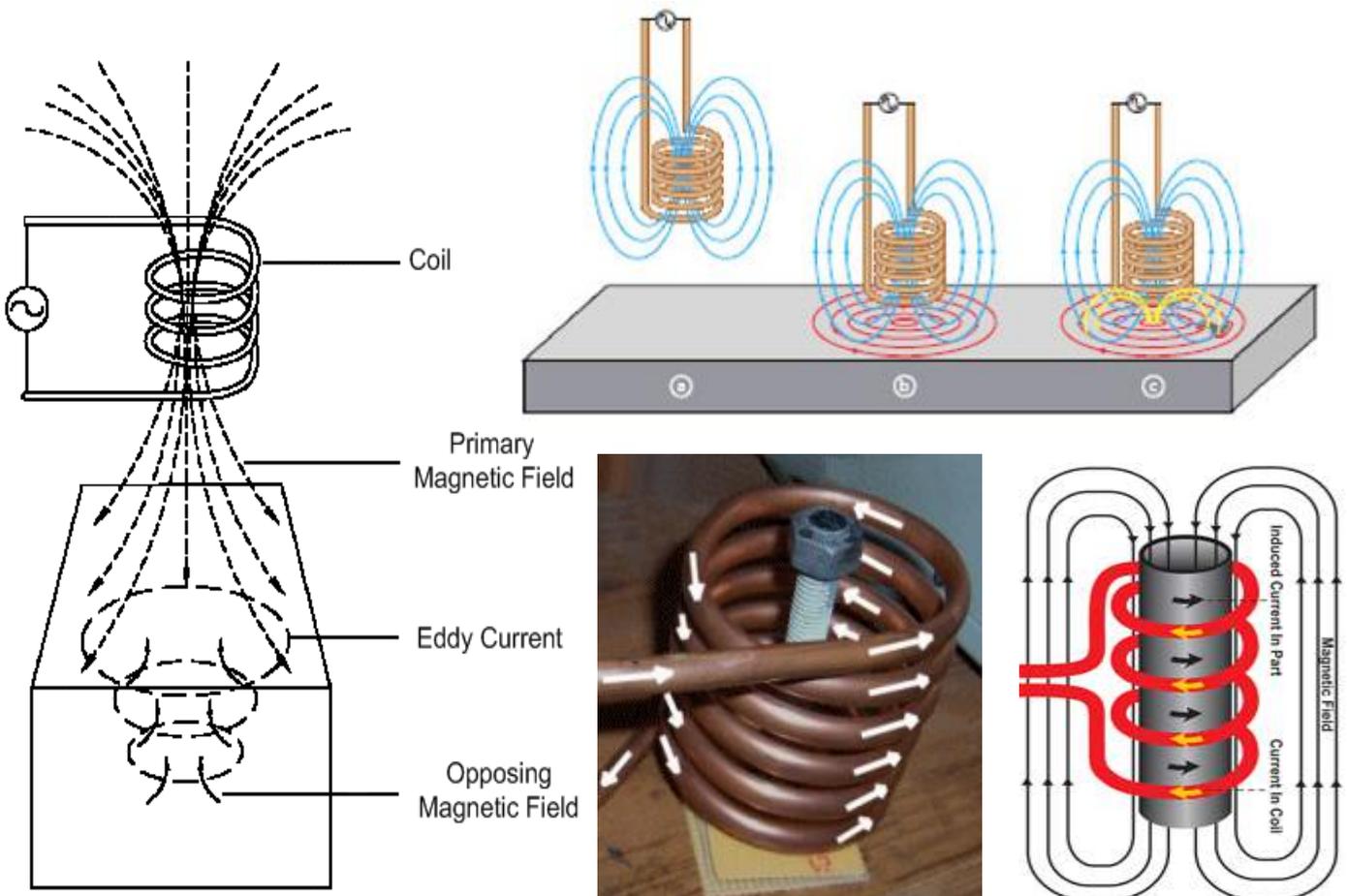
Induction heating is a form of non-contact heating for conductive materials.

The principle of induction heating is mainly based on two well-known physical phenomena:

1. *Electromagnetic induction*
2. *The Joule effect*

### 1) ELECTROMAGNETIC INDUCTION

The energy transfer to the object to be heated occurs by means of electromagnetic induction. Any electrically conductive material placed in a variable magnetic field is the site of induced electric currents, called eddy currents, which will eventually lead to joule heating.

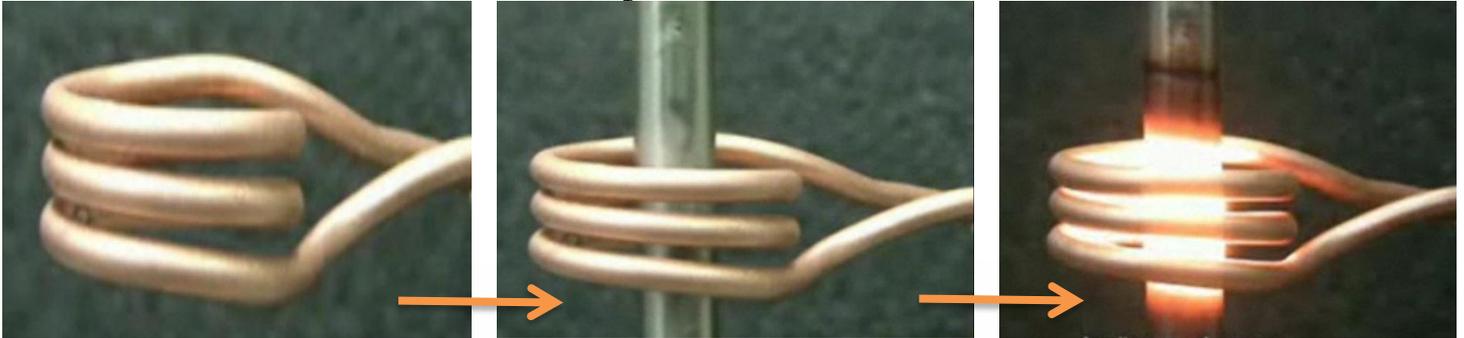


## 2) JOULE HEATING

**Joule heating**, also known as **ohmic heating** and **resistive heating**, is the process by which the passage of an electric current through a conductor releases heat.

The heat produced is proportional to the square of the current multiplied by the electrical resistance of the wire.

$$Q \propto I^2 \cdot R$$



- Induction heating relies on the unique characteristics of **radio frequency (RF) energy** - that portion of the electromagnetic spectrum below infrared and microwave energy. Since heat is transferred to the product via electromagnetic waves, the part never comes into direct contact with any flame, the inductor itself does not get hot and there is no product contamination.
- Induction heating is a rapid, clean, non-polluting heating.
- The induction coil is cool to the touch; the heat that builds up in the coil is constantly cooled with circulating water.

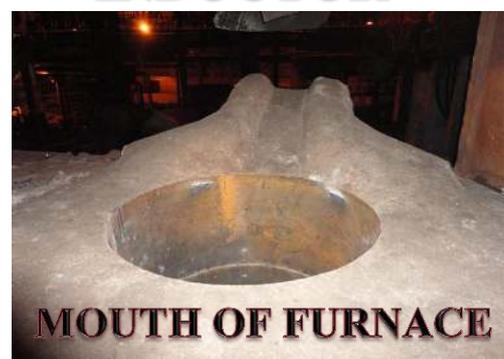
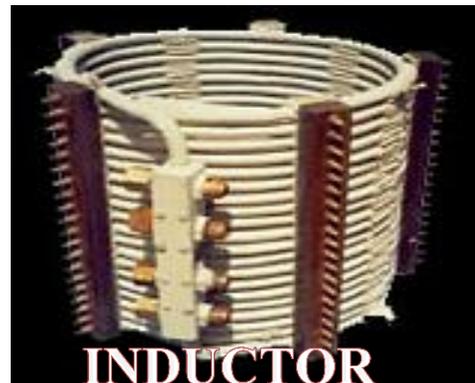
### FEATURES OF INDUCTION FURNACE

- An electric induction furnace requires an electric coil to produce the charge. This heating coil is eventually replaced.
- The crucible in which the metal is placed is made of stronger materials that can resist the required heat, and the electric coil itself cooled by a water system so that it does not overheat or melt.
- The induction furnace can range in size, from a small furnace used for very precise alloys only about a kilogram in weight to a much larger furnaces made to mass produce clean metal for many different applications.
- The advantage of the induction furnace is a clean, energy-efficient and well-controllable melting process compared to most other means of metal melting.
- foundries use this type of furnace and now also more iron foundries are replacing cupolas with induction furnaces to melt cast iron, as the former emit lots of dust and other pollutants.

- Induction furnace capacities range from less than one kilogram to one hundred tonnes capacity, and are used to melt iron and steel, copper, aluminium, and precious metals.
- The one major drawback to induction furnace usage in a foundry is the lack of refining capacity; charge materials must be clean of oxidation products and of a known composition, and some alloying elements may be lost due to oxidation (and must be re-added to the melt).

## CONSTRUCTION OF INDUCTION FURNACE

- There are many different designs for the electric induction furnace, but they all center around a basic idea.
- The electrical coil is placed around or inside of the crucible, which holds the metal to be melted. Often this crucible is divided into two different parts. The lower section holds the melt in its purest form, the metal as the manufacturers desire it, while the higher section is used to remove the slag, or the contaminants that rise to the surface of the melt.
- Crucibles may also be equipped with strong lids to lessen how much air has access to the melting metal until it is poured out, making a purer melt.

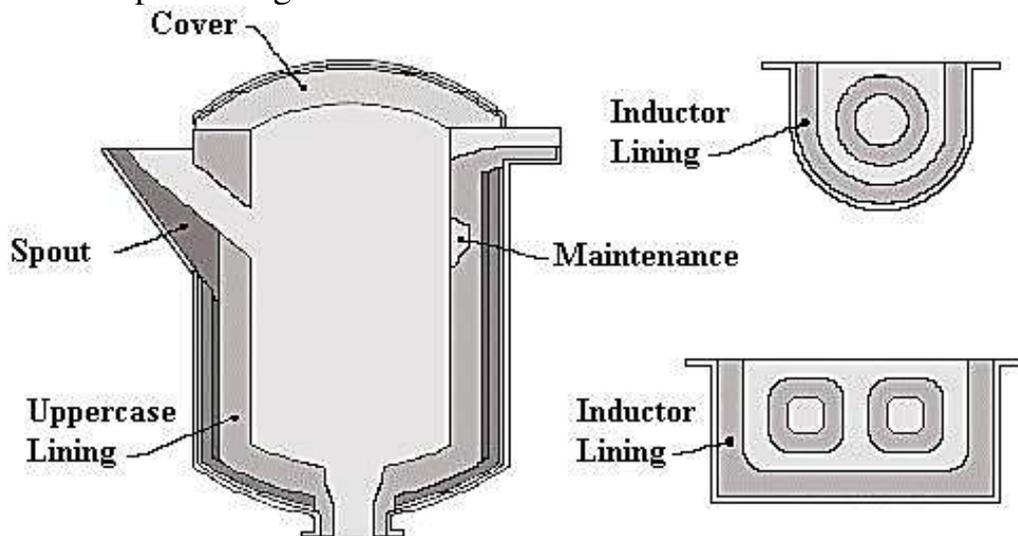


## TYPES OF INDUCTION FURNACE

There are two main types of induction furnace: coreless and channel.

### *Coreless induction furnaces*

- The heart of the **coreless induction furnace** is the coil, which consists of a hollow section of heavy duty, high conductivity copper tubing which is wound into a helical coil.
- Coil shape is contained within a steel shell.
- To protect it from overheating, the coil is water-cooled, the water being recirculated and cooled in a cooling tower.
- The crucible is formed by ramming a granular refractory between the coil and a hollow internal.
- The coreless induction furnace is commonly used to melt all grades of steels and irons as well as many non-ferrous alloys. The furnace is ideal for remelting and alloying because of the high degree of control over temperature and chemistry while the induction current provides good circulation of the melt.



### *Channel induction furnaces*

- The **channel induction furnace** consists of a refractory lined steel shell which contains the molten metal. Attached to the steel shell and connected by a throat is an induction unit which forms the melting component of the furnace.
- The induction unit consists of an iron core in the form of a ring around which a primary induction coil is wound.
- This assembly forms a simple transformer in which the molten metal loops comprises the secondary component.
- The heat generated within the loop causes the metal to circulate into the main well of the furnace.
- The circulation of the molten metal effects a useful stirring action in the melt.
- Channel induction furnaces are commonly used for melting low melting point alloys and or as a holding and superheating unit for higher melting point alloys such as cast iron.

## **ADVANTAGES OF INDUCTION FURNACE:**

Induction furnaces offer certain advantages over other furnace systems. They include:

**Higher Yield.** The absence of combustion sources reduces oxidation losses that can be significant in production economics.

**Faster Startup.** Full power from the power supply is available, instantaneously, thus reducing the time to reach working temperature. Cold charge-to-tap times of one to two hours are common.

**Flexibility.** No molten metal is necessary to start medium frequency coreless induction melting equipment. This facilitates repeated cold starting and frequent alloy changes.

**Natural Stirring.** Medium frequency units can give a strong stirring action resulting in a homogeneous melt.

**Cleaner Melting.** No by-products of combustion means a cleaner melting environment and no associated products of combustion pollution control systems.

**Compact Installation.** High melting rates can be obtained from small furnaces.

**Reduced Refractory.** The compact size in relation to melting rate means induction furnaces require much less refractory than fuel-fired units

**Better Working Environment.** Induction furnaces are much quieter than gas furnaces, arc furnaces, or cupolas. No combustion gas is present and waste heat is minimized.

**Energy Conservation.** Overall energy efficiency in induction melting ranges from 55 to 75 percent, and is significantly better than combustion processes.

## **DISADVANTAGES OF INDUCTION FURNACE**

1. Refining in Induction Furnace is not as intensive or effective as in Electric Arc Furnace (EAF).
2. Life of Refractory lining is low as compared to EAF.
3. Removal of S & P is limited, so selection of charges with less impurity is required.

### **Surprise Quiz:**

**1) Which one of the following is the best option for quick melting of scrap.**

- |  |   |
|--|---|
| <input type="checkbox"/> Cupola furnace    | <input type="checkbox"/> Electric arc furnace |
| <input type="checkbox"/> Induction furnace | <input type="checkbox"/> Blast furnace        |

**2) Define Them in your own words.**

- i. Joule Heating
- ii. Heat source of EAF
- iii. Charging sequence of Cupola Furnace