FURNACES

A furnace is a device used for heating. The name derives from Latin Fornax; oven.

- The Oxford English Dictionary defines a furnace as ‘an enclosed structure for intense heating by fire, esp. of metals, whereas a kiln is described as ‘as furnace or oven for burning, baking or drying, esp. for calcining lime or firing ceramics’.

- A furnace is an equipment to melt metals for casting or heat materials for change of shape (rolling, forging etc) or change of properties (heat treatment).

- A blast furnace performs basic melting (of iron ore) operation to get pig iron, cupola furnace is used for getting cast iron and an electric arc furnace is used for re-melting steel.

- Different furnaces are employed for melting and re-melting ferrous and nonferrous materials.

- A furnace contains a high temperature zone or region surrounded by a refractory wall structure which withstands high temperatures and being insulating minimizes heat losses to the surroundings.

- Since flue gases from the fuel come in direct contact with the materials, the type of fuel chosen is important. For example, some materials will not tolerate sulphur in the fuel. Solid fuels generate particulate matter, which will interfere the materials placed inside the furnace. For this reason:
  - Most furnaces use liquid fuel, gaseous fuel or electricity as energy input.
  - Induction and arc furnaces use electricity to melt steel and cast iron.
  - Melting furnaces for nonferrous materials use fuel oil.
  - Oil-fired furnaces mostly use furnace oil, especially for reheating and heat treatment of materials.
  - Light diesel oil (LDO) is used in furnaces where sulphur is undesirable.

The following are the factors which are responsible for the selection of furnace.

(i) Considerations of initial cost and cost of its operation.

(ii) Relative average cost of repair and maintenance.

(iii) Availability and relative cost of various fuels in the particular locality.

(iv) Melting efficiency, in particular speed of melting.

(v) Composition and melting temperature of the metal.
Characteristics of an Efficient Furnace

Furnace should be designed so that in a given time, as much of the charge as possible is melted with least possible fuel and labor used. To achieve this end, the following parameters can be considered.

- Determination of the **quantity of heat** to be imparted to the material or charge.
- **Liberation of sufficient heat** within the furnace to heat the stock and overcome all heat losses.
- Transfer of available part of that heat from the furnace gases to the surface of the heating stock.
- **Equalization** of the temperature within the stock.
- **Reduction of heat losses** from the furnace to the minimum possible extent.

**MAJOR PARTS OF A TYPICAL FURNACE**

- **Steel shell** constructed for supporting and casing.
- **Refractory chamber** constructed of insulating materials to retain heat at high operating temperatures.

- **Hearth** to support or carry the steel, which consists of refractory materials supported by a steel structure, part of which is water cooled.
• **Burners** that use liquid or gaseous fuels to raise and maintain the temperature in the chamber. Coal or electricity can be used in reheating furnaces.

• **Chimney** to remove combustion exhaust gases from the chamber
• **Charging and discharging** doors through which the chamber is loaded and unloaded.
• **Loading and unloading equipment** include roller tables, conveyors, charging machines and furnace pushers.

**Heat Transfer in Furnaces**

In simple terms, heat is transferred to the stock by:

- **Radiation** from the flame, hot combustion products and the furnace walls and roof.
- **Convection** due to the movement of hot gases over the stock surface

At the high temperatures, the dominant mode of heat transfer is wall radiation. Heat transfer by gas radiation is dependent on the gas composition (mainly the carbon dioxide and water vapors concentrations), the temperature and the geometry of the furnace.
CLASSIFICATION OF FURNACES

<table>
<thead>
<tr>
<th>Classification method</th>
<th>Types and examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of fuel used</td>
<td>Combustion Type</td>
</tr>
<tr>
<td></td>
<td>• Oil-fired</td>
</tr>
<tr>
<td></td>
<td>• Gas-fired</td>
</tr>
<tr>
<td></td>
<td>• Coal-fired</td>
</tr>
<tr>
<td></td>
<td>Electric Type</td>
</tr>
<tr>
<td>Mode of charging materials</td>
<td>Intermittent/Batch</td>
</tr>
<tr>
<td></td>
<td>Periodical</td>
</tr>
<tr>
<td></td>
<td>• Forging</td>
</tr>
<tr>
<td></td>
<td>• Re-rolling (batch/pusher)</td>
</tr>
<tr>
<td></td>
<td>• Pot</td>
</tr>
<tr>
<td></td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td>Pusher</td>
</tr>
<tr>
<td></td>
<td>Walking beam</td>
</tr>
<tr>
<td></td>
<td>Walking hearth</td>
</tr>
<tr>
<td></td>
<td>Continuous recirculating bogie furnaces</td>
</tr>
<tr>
<td></td>
<td>Rotary hearth furnaces</td>
</tr>
<tr>
<td>Mode of heat transfer</td>
<td>Radiation (open fire place)</td>
</tr>
<tr>
<td></td>
<td>Convection (heated through medium)</td>
</tr>
<tr>
<td>Mode of waste heat recovery</td>
<td>Recuperative</td>
</tr>
<tr>
<td></td>
<td>Regenerative</td>
</tr>
</tbody>
</table>

CLASSIFICATION OF MELTING FURNACES ACCORDING TO THEIR SOURCE OF HEAT

Oxy-fuel Furnace

- Uses a fuel gas such as propane, natural gas or acetylene
- Oxygen or atmosphere is blown in and combined with fuel
- Heat from combustion melts the charge
Resistance Furnace
- A current passed through a material resulting in ohmic heating
- Radiation heats charge material
- Some convection and conduction occurs

Induction Furnace
- A current is passed through a water cooled coil near or around the charge
- Eddy currents are produced in the charge material in response to the coil current
- Heat is generated through ohmic heating in the material

Electric Arc Furnace
- A current is passed from separate electrodes creating arcs of ionized gas
- Heat is transferred from the arc into the charge material
- Can be either DC or AC

Google it:
what equipment is used to measure the temperature of a furnace?
&
How does that equipment work?