



ENERGY SAVING

in

FURNACES

V. PARKASH & ASSOCIATES,
NEW DELHI

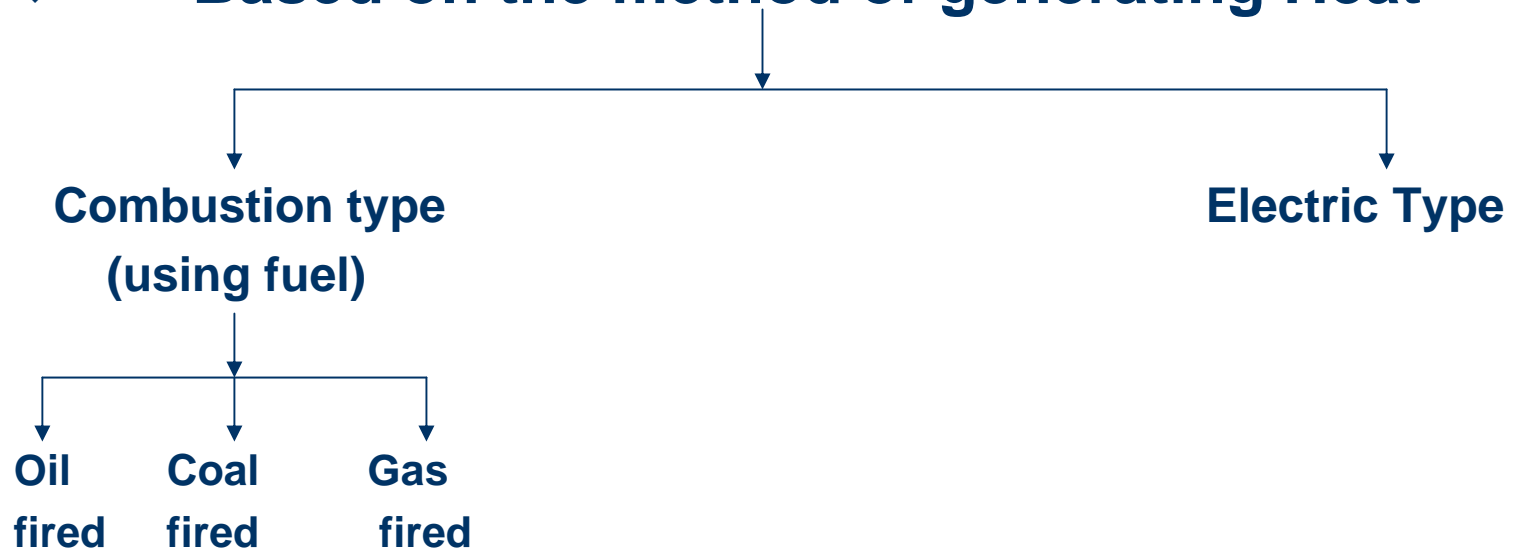
DEFINITION

FURNACE is an equipment to

- melt metals for casting
- heat materials for change of shape – rolling, forging etc.
- do heat treatment for change of properties – annealing

CLASSIFICATION

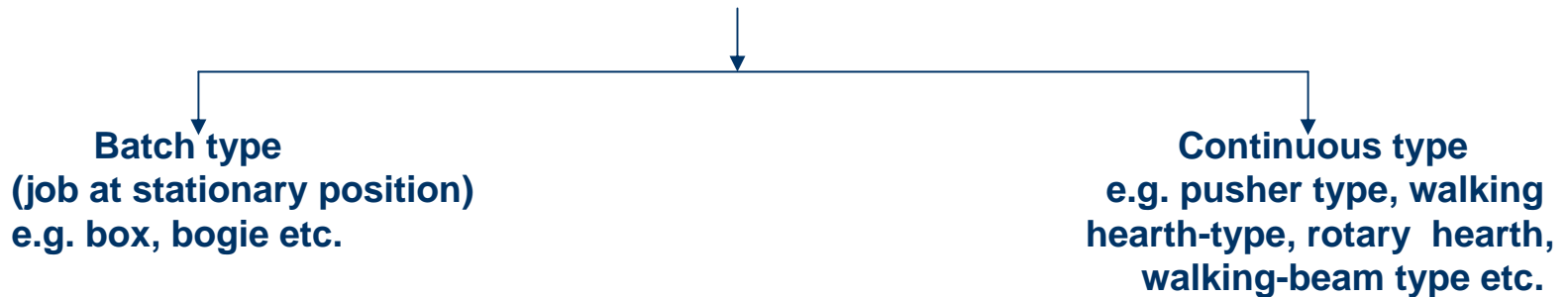
❖ Based on the method of generating Heat



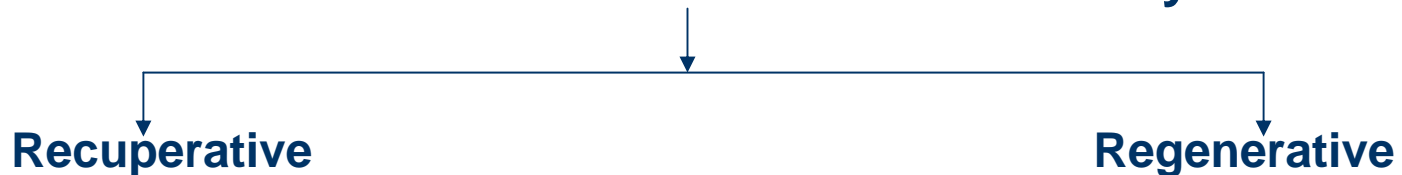
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❖ Based on mode of charging the material



❖ Based on mode of Waste Heat Recovery



FURNACE ENERGY SUPPLY

- As the products of these gases directly contact the stock, type of fuel chosen is of importance.
- Some materials will not tolerate sulphur in the fuel.
- Use of solid fuels will generate particulate matter, which may interfere with the stock placed inside the furnaces.
- VAST MAJORITY of the FURNACES USE LIQUID FUELS, GASEOUS FUELS or ELECTRICITY AS ENERGY INPUT
- Electricity, though very clean but very costly mode of heat energy, should be used for only special heating applications.

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- Fuels should be used directly to the extent possible.
- Many companies have charged over from electric heating to other fuels to reduce costs.

FURNACE BASIC FEATURES

- ❖ A refractory chamber constructed of insulating materials for retaining heat at the high operating temperature.
- ❖ A hearth to support & carry the stock
- ❖ Burners that use liquid or gaseous fuels to raise and maintain the temp. in the chamber.
- ❖ A method (stock) of removing the combustion exhaust gases from the chamber.
- ❖ A method of introducing & removing the stock from the chamber.

FURNACES OPERATING TEMPERATURES

- ❖ Furnaces operate at high temperatures to meet the required demand. For example, a furnace heating the stock to 1200 °c will have its exhaust leaving at least at plus 1200 °c.
- ❖ Typical operating temperatures of some common type furnace is given here

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Furnace	Operating Furnace Temp °C
- Forging Furnace	1200 - 1250
- Re rolling Mill, Furnace, Batch type	1150 - 1200
- Re rolling Mill Furnace, Continuous Pusher type	1200 - 1250
- Glass Tank Melting Furnace	1400 – 1450

HEAT LOSSES IN FURNACES

AS THE FURNACES ARE OPERATED AT ELEVATED TEMPERATURES, HEAT LOSSES ARE VERY HIGH

Typical losses in Furnaces are: -

(Losses on a/c of inefficient combination of fuel are not listed)

❖ Thermal Inertia Loss

The metal structure and insulation of the furnace must be heated so their interior surfaces are about the same temperature as the product they contain. This stored heat is held in the structure until the furnace shuts down, then it leaks to the surrounding area. The more frequently the furnace is cycled from cold to hot and back to cold gain, the more is the heat loss.

❖ Wall Losses

Wall or transmission losses are caused by the conduction of heat through walls, roof and floor of the furnace while it is in production. Once that heat reaches the outer skin of the furnace and radiates to the surrounding area or is carried away by air currents, it must be replaced by an equal amount taken from the fuel.

❖ Opening (Radiation losses)

Anywhere or anytime there is an opening in the furnace enclosure, heat is lost by radiation, often at a rapid rate.

Radiation is “line of sight” phenomenon i.e. if we can see an exposed hot surface, then radiation losses are taking place.

❖ Air Infiltration loss

Cold air infiltrate from the surrounding room if there is a negative pressure in the furnace. Because of the draft effect of hot furnace stocks, negative pressures are fairly common, and cold air slips past heavy door seals, cracks & other openings in the furnace.

❖ Material Handling Equipment Loses

Many furnaces use equipment like conveyor belts, product harness etc. to convey the work into and out of the heating chamber. Those equipments enter the heating chamber cold and leave at higher temperature.

Furnace Performance Test

Thermal Efficiency of a Furnace is the ratio of heat delivered to the stock (material) and the heat supplied to the furnace.

$$\text{Thermal Efficiency of Furnace} = \frac{\text{Heat in the stock}}{\text{Heat supplied to the furnace}}$$


Heat in the stock = Mass of the stock X Rise in temperature

If melting of the material is involved latent heat of fusion X mass is added to the above.

The Specific heat and latent heat of the material need to be obtained from a reference manual.

Thermal Efficiency of the Furnace can also be computed Indirect Method by computing.

- (i) sensible heat loss in flue gas
- (ii) loss due to evaporation of moisture present in fuel
- (iii) loss due to evaporation of water formed due to hydrogen in fuel
- (iv) heat loss due to openings
- (v) heat loss through skin of the furnace
- (vi) unaccounted loss



The Standard Books/Manuals on Furnace describe in detail the parameters to be noted and step by step procedures for computing various losses.

ENERGY SAVING MEASURES

❖ Efficient Combustion

- The Flue gasses leave furnace at very high temperature. More excess air for combustion means more loss of heat thro' the flue gasses.

- Heat loss in flue gas of 900 c with excess air for illustration.

Excess Air

% of total heat in fuel
carried by flue gas

25%

48%

50%

55%

To obtain complete combustion of fuel with minimum amount of air, it is necessary to control air infiltration, maintain pressure of combustion air, fuel supply and excess air monitoring.

❖ Proper Heat Distribution

- Flame not to touch stock to avoid deatomisation of fuel.
- If the flames impinge on refractories, the incomplete combustion products can settle and react with the refractory constituents at high flame temperatures.
- Flames of various burners not to intersect to avoid inefficient combustion.
- Use 3 or 4 burners than use burner of large capacity to contain flame within the furnace.

❖ Operation at optimum Temperature

- Operate the furnace at optimum temperature.
- Higher temperature lead to wastage over heating, excessive oxidation and overstressing of refractions.

❖ Minimize Furnace Openings

- Heat loss through openings take place by direct radiation and leakage of combustion gas if the furnace pressure is slightly higher than the outside air pressure (Ex-filtration is less serious than infiltration.)
- Keep the openings as small as possible and to seal them, to the extent possible

❖ Optimum Capacity Utilization

- Operate at full capacity as far as possible to get as high as utilization rate as possible.
- Holding periods can be kept to a minimum separate holding furnace can be considered.

❖ Minimizing Wall losses

- Refracting or insulation materials should be adequately chosen to minimize loss of heat
- Heat losses can be reduced by increasing the wall thickness or through the application of insulating bricks.
- Ceramic fibre is a low thermal mass refractory used in the hot face of the furnace and fastened to the refractory wall

❖ Flue gases Waste Heat Recovery

- Waste heat recovery should be considered after all other energy conservation measures have been taken. Minimizing the generation of waste heat should be the primary objective.
- The sensible heat in flue gas can be generally recovered by
 - **Charge (stock) preheating**
 - **Preheating of combustion air**

It is done by employing

- Recuperates where heat is transmitted the metallic or ceramic wall
- Regenerators where flue gas and air are passed alternatively through heat absorbing medium for heat transfer.
- Utilizing waste heat for other processes to generate steam or hot water by waste heat boiler.

THANK YOU

**V.PARKASH & ASSOCIATES
162, POCKET - B, SARITA VIHAR
NEW DELHI – 110076**

PH : 26946321, 26946805

V. PARKASH & ASSOCIATES,
NEW DELHI