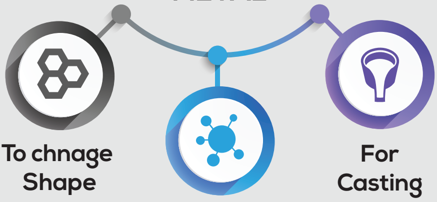
GEF - UNIDO - BEE PROJECT

on

"Promoting EE/RE in selected MSME Clusters in India"

FUEL FIRED FURNACES

USED TO MELT/ REHEAT METAL

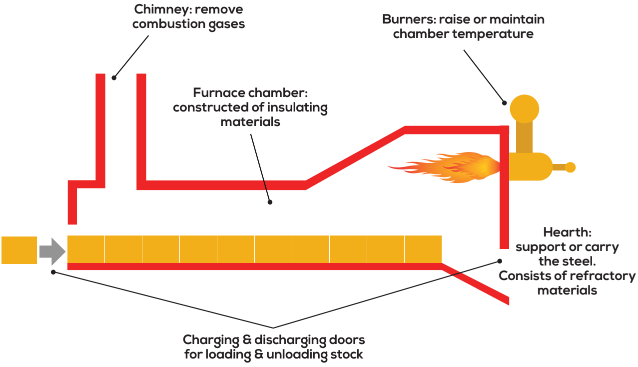


To chnage Shape

To chnage Properties

For Casting

COMPONENT OF FURNACE



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TYPES OF FURNACES

Forging Furnace

- Used to preheat billets/ingots
- Use open fireplace system with radiation heat transmission
- Temp 1200-1250 °C
- Operating cycle
  - Heat-up time
  - Forging time
  - Soaking time
- Fuel use: depends on material and number of reheats

Re-rolling Mill Furnace [Batch type]

- Box type furnace
- Used for heating up scrap/ingots/billets
- Manual charge / discharge of batches
- Temp 1200 °C
- Operating cycle: heat-up, re-rolling
- Output 10 - 15 tons/day
- Fuel use: 180-280 kg coal/ton material

Re-rolling Mill Furnace
[Continuous Pusher Type]

- Not batch, but continuous charge and discharge
- Temp 1250 °C
- Operating cycle: heat-up, re-rolling
- Output 20-25 tons/day
- Heat absorption by material is slow, steady, uniform

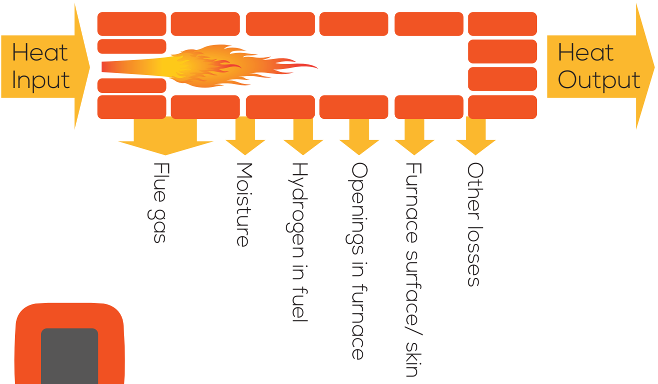
Other Furnaces are

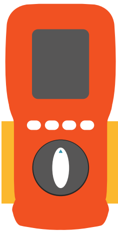
Continuous reheating furnace

- Pusher Type
- Walking beam type
- Walking hearth furnace
- Continuous recirculating Bogie furnace
- Rotary hearth Furnace

ASSESSMENT OF FURNACES

Heat Losses Affecting Furnace Performance





Instruments to Assess Furnace Performance

Parameters to be Measured	Location of Measurement	Instrument Required	Required Value
Furnace soaking zone temperature (reheating furnaces)	Soaking zone and side wall	Pt/Pt-Rh thermocouple with indicator and recorder	1200-1300°C
Flue gas temperature	In duct near the discharge end, and entry to recuperator	Chromel Alummel Thermocouple with indicator	700°C max
Flue gas temperature	After recuperator	Hg in steel thermometer	300°C (max)
Furnace hearth pressure in the heating zone	Near charging end and side wall over the hearth	Low pressure ring gauge	+0.1 mm of Wc
Oxygen in flue gas	In duct near the discharge end	Fuel efficiency monitor for oxygen and temperature	5% O_2
Billet temperature	Portable	Infrared pyrometer or optical pyrometer	--

Flue Gas Analyser for Flue gas temperature and O2 Analysis

IR Temperature Meter for surface temperature measurement

ASSESSMENT OF FURNACES

Calculating Furnace Performance

Direct Method

Thermal efficiency of furnace = Heat in the stock / Heat in fuel consumed for heating the stock

Heat in the stock Q: $Q = m \times Cp\,(t1 - t2)$

Q = Quantity of heat of stock in kCal
m = Weight of the stock in kg
Cp= Mean specific heat of stock in kCal/kg oC
t1 = Final temperature of stock in oC
t2 = Initial temperature of the stock before it enters the furnace

Indirect Method

Heat losses

a) Flue gas loss	= 57.29 %
b) Loss due to moisture in fuel	= 1.36 %
c) Loss due to H2 in fuel	= 9.13 %
d) Loss due to openings in furnace	= 5.56 %
e) Loss through furnace skin	= 2.64 %
Total losses	**75.98 %**

Furnace efficiency = Heat supply minus total heat loss
100% – 76% = 24%

Typical efficiencies for industrial furnaces

Furnace type	Furnace type
Low Temperature furnaces	
a. 540 – 980 °C (Batch type)	20-30
b. 540 – 980 °C (Continous type)	15-25
c. Coil Anneal (Bell) radiant type	5-7
d. Strip Anneal Muffle	7-12
High temperature furnaces	
a. Pusher, Rotary	7-15
b. Batch forge	5-10
Continuous Kiln	
a. Hoffman	25-90
b. Tunnel	20-80
Ovens	
a. Indirect fired ovens (20 oC –370 °C)	35-40
b. Direct fired ovens (20 oC –370 °C)	35-40

ENERGY EFFICIENCY OPPORTUNITIES

1. Operation at the optimum furnace temperature	2. Proper heat distribution
3. Operation at the optimum furnace temperature	4. Reducing heat losses from furnace openings
5. Maintaining correct amount of furnace draft	6. Optimum capacity utilization
7. Waste heat recovery from the flue gases	8. Minimize furnace skin losses

1 Complete combustion with minimum excess air

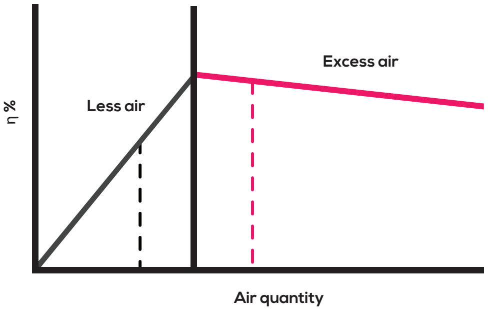
- **Importance of excess air**
  - Too much: reduced flame temp, furnace temp, heating rate
  - Too little: unburnt in flue gases, scale losses
- **Indication of excess air: actual air / theoretical combustion air**
- **Optimizing Excess Air**
  - Control air infiltration
  - Maintain pressure of combustion air
  - Ensure high fuel quality
  - Monitor excess air

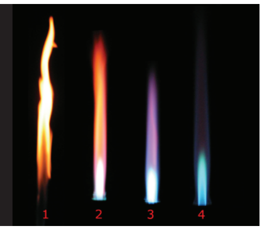
Air quantity for combustion

An important parameter for energy efficiency

- Theoretical air requirement can be estimated from combustion theory
- Excess air required
- Quantity of excess air depends on mixing capability of fuel
- Mixing capability
  - Solid < Liquid < Gas
- Lesser the mixing capability
  - more the quantity of excess air

Effect of air quantity on efficiency





Different flame types of a burner depend on oxygen supply. On the left a rich fuel with no premixed oxygen produces a yellow sooty diffusion flame; on the right a lean fully oxygen premixed flame produces no soot and the flame color is produced by molecular radicals, especially CH and C_2 band emission

ENERGY EFFICIENCY OPPORTUNITIES

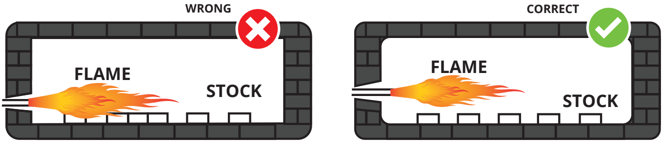
2 Proper heat distribution

When using burners

- Flame should not touch or be obstructed
- No intersecting flames from different burners
- Burner in small furnace should face upwards but not hit roof
- More burners with less capacity (not one big burner) in large furnaces
- Burner with long flame to improve uniform heating in small furnace

Hear distribution in furnace

Alignment of burners in furnace



3 Operation at the optimum furnace temperature

Operating at too high temperature: heat loss, oxidation, decarbonization, refractory stress

Automatic controls eliminate human error

Slab Reheating furnaces	1200°C
Rolling Mill furnaces	1200°C
Bar furnace for Sheet Mill	800°C
Bogie type annealing furnaces	650°C –750°C

4 Reducing heat losses from furnace openings

Heat loss through openings

- Direct radiation through openings
- Combustion gases leaking through the openings
- Biggest loss: air infiltration into the furnace

Energy savings methods

- Keep opening small
- Seal openings
- Open furnace doors less frequent and shorter

5 Maintaining correct amount of furnace draft

- Negative pressure in furnace: air infiltration
- Maintain slight positive pressure
- Not too high pressure difference: air ex-filtration

Heat loss only about 1% if furnace pressure is controlled properly!

ENERGY EFFICIENCY OPPORTUNITIES

6 Optimum capacity utilization

Optimum Load

- Under loading: lower efficiency
- Overloading: load not heated to right temp

Optimum Load Arrangement

- Load receives maximum radiation
- Hot gases are efficiently circulated
- Stock not placed in burner path, blocking flue system, close to openings

7 Waste Heat Recovery System

When do we recover waste heat?

- When exit temperature high
- When furnace runs on a continuous basis

Advantages of WHR

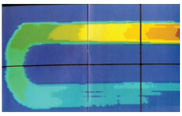
- Reduction in fuel loss
- Reduction in furnace heating time

Every 22°C drop = 1% efficiency increase

Advanced Burners

Recuperative Radiant Tube Heaters

- Good replacement for electrical heaters, where high temperature required
- Hot gas not in contact with stock
- Combustion air preheated-600 to 700 deg C
- Saving potential : 20 %



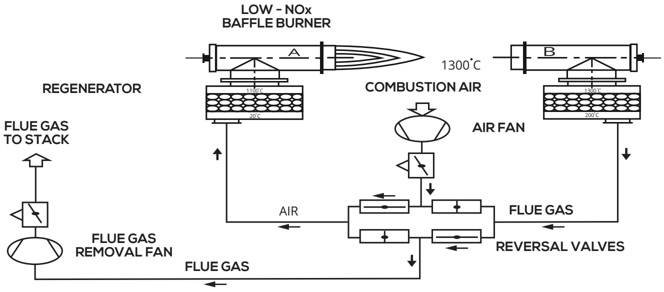
Regenerative burners

Saving potential

- higher than recuperative burners

  (since pre-heat temperature of air is higher-900 to 1100 °C)

Tailor-made to suit individual furnaces



ENERGY EFFICIENCY OPPORTUNITIES

8 Minimize furnace skin losses

- Choosing appropriate refractories
- Increasing wall thickness
- Installing insulation bricks (= lower conductivity)
- Planning furnace operating times
  - Under loading: lower efficiency
  - Overloading: load not heated to right temp

Insulation-How important ?

Adequate insulation - a must

What is the optimum surface temperature?

- 50 °C for electrical furnaces
- 60 °C for thermal furnaces
- Radiation loss at 150 °C : 1500 Kcal/m2/hr
- Radiation loss at 70 °C : 450 Kcal/m2/hr
- 3-fold decrease in losses

In batch type furnace insulation is even more important

Contributes to high Start-up losses

2 Most important requirements of good insulation?

- Low Specific Heat
- Low Density

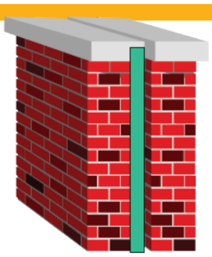
CERAMIC FIBRE

- Wonder refractory
- Specific heat -
  Comparable to refractory brick and insulating brick
  Installing insulation bricks (= lower conductivity)
- Density is very very low

Property	Ref.brick	Ins.brick	Ceramic fib.
SP. heat (Kcal/kg °C)	0.22	0.22	0.27
Ther. Condy (Kcal/m °C	0.22	0.20	0.20
Density (Kg/m³)	2000	1000	125

Ceramic Fibre

the Pros and Cons



- Can withstand upto 1425 °C
- Not affected by chemicals
- Cannot take mechanical stresses
- Cannot take flame impingement

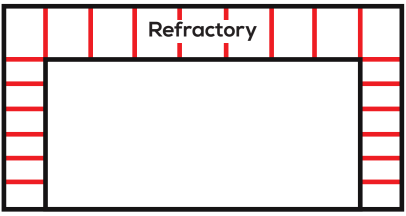
Ceramic fibre to be sandwiched between two layers of refractory

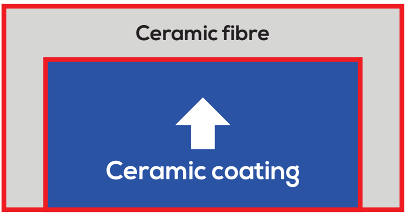
Replace existing refractory with Ceramic fibre

Background

Bell furnace

- Required temperature
  - 600 to 650°C
- Surface temperature
  - 150°C





ABOUT PROJECT

Promoting Energy Efficiency & Renewable Energy in Selected MSME Clusters in India

To develop and promote a market environment for introducing energy efficiency and enhanced use of renewable energy technologies in process applications in the selected energy-intensive MSME clusters under GEF UNIDO BEE project.
The main objective of the project is to increase the capacity building of suppliers of EE/RE product and service providers

Desclaimer

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