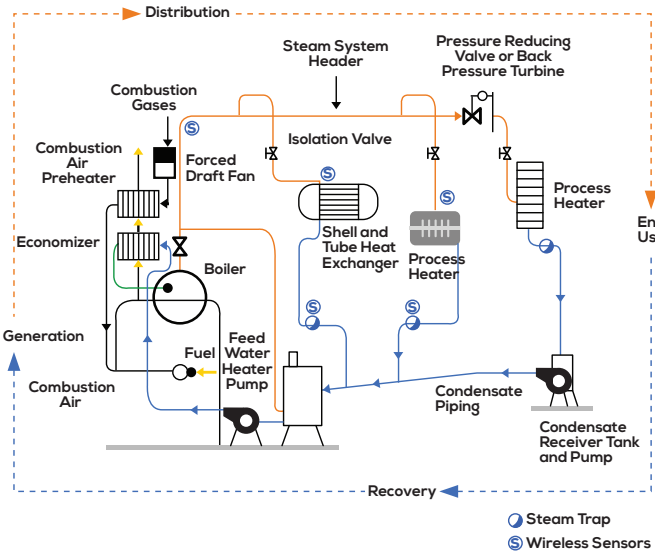
GEF - UNIDO - BEE PROJECT

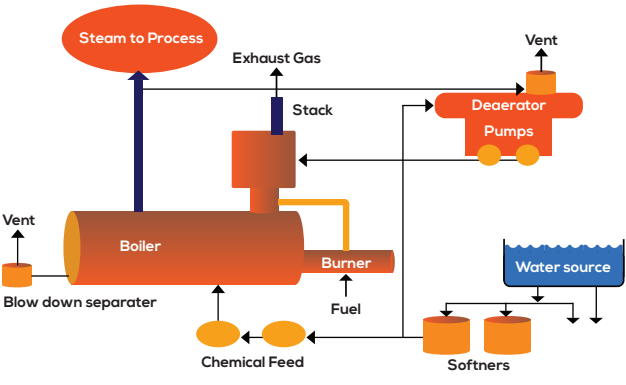
on

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

BOILER AND STEAM SYSTEMS



Typical Boiler System



Boiler system

- ✓ Feed water system
  - Condensate
  - Make-up water
- ✓ Steam system
- ✓ Fuel system

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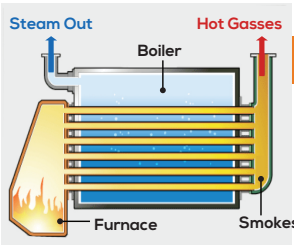
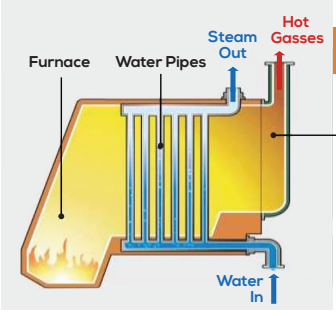
Classification of boilers



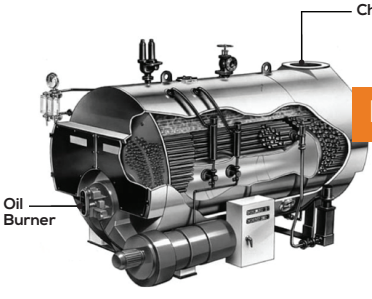
Fire in tube

- Contain long steel tubes through which the hot gasses from a furnace pass and around which the water to be converted to steam circulates.
- Lower initial cost, more fuel efficient and easier to operate
- Capacities of 25 tons/hr and pressures of 17.5ksc



Water Tube

- Water passes through the tubes and the hot gasses passes outside the tubes
- Built to any steam capacities and pressures, and have higher efficiencies than fire tube boilers



Packaged Boiler

- They are classified based on the number of passes ie. the number of times the hot combustion gases pass through the boiler
- Large number of small diameter tubes leading to good convective heat transfer
- Forced or induced draft systems resulting in good combustion efficiency

Boiler operating parameters

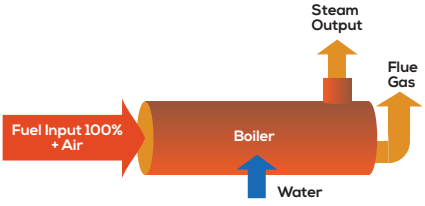
Type of Fuel

Pressure Requirement

Fuel Economics

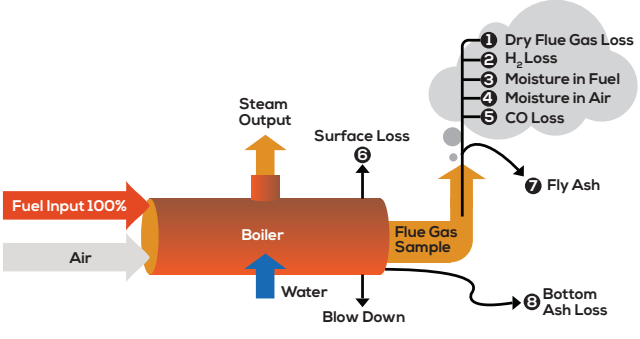
Turn Down Requirement

Boiler Efficiency



$$\text{Efficiency} = \frac{\text{Heat addition to steam} \times 100}{\text{Gross heat in fuel}}$$

$$\text{Boiler Efficiency} = \frac{\text{Steam flow rate} \times (\text{Steam enthalpy} - \text{feed water enthalpy})}{\text{Fuel firing rate} \times \text{Gross calorific value}} \times 100$$



Efficiency = 100 - (1+2+3+4+5+6+7+8)

Blow Down

- The Process in which certain volume of water is blown off/removed and is automatically replaced by feed water – thus maintaining the optimum level of total dissolved solids (TDS) in the boiler water.
  - Blow down is necessary to protect the surfaces of the heat exchanger in the boiler.

Excess Air Control

Excess air is required for

- ✔ Complete combustion
- ✔ To allow for the normal variations in combustion
- ✔ To ensure satisfactory stack conditions

Controlling excess air to an optimum level always results in reduction in flue gas losses; for every 1% reduction in excess air there is approximately 0.6% rise in efficiency.

Excess air levels for different fuels

Fuel	Type of Furnace of Burners	Excess Air (% by wt)
Pulverised coal	Completely water cooled furnace for slag-tap or dry-ash removal	15-20
	Partially water-cooled furnace for dry-ash removal	15-40
Coal	Spreader stoker	30-60
	Water-cooler vibrating-grate stokers	30-60
	Chain grate and traveling-gate stokers	15-20
	Underfeed stoker	20-50
Fuel Oil	Oil burners, register type	15-20
	Multi-fuel burners and flat flame	20-30
Natural Gas	High Pressure Burner	5-7
Wood	Dutch over(10=23% through grates) and Hofft type	20-25
Bagasse	All Furnaces	25-35
Black Liquor	Recovery furnaces for draft and soda-pulping processes	30-40

Steam Distribution System

✔ **Major Factors affecting Steam Distribution System**

- Maximum safe working pressure of boiler
- Minimum pressure required for user
  - Frictional pressure loss in the piping
  - Condensation within pipe work

✔ **Generate and Distribute Steam at high pressure**

- Steam Quality – dry saturated always
- Smaller sized steam mains, resulting in low capital costs

Compensation to be kept for both

✔ **Use Steam at lower Pressure**

- Lower Pressure results higher latent heat
- Leads to higher dryness at user

Boiler Energy Efficiency Measures

Blow Down
Check TDS for blow down, install Auto blow down saves 5% energy

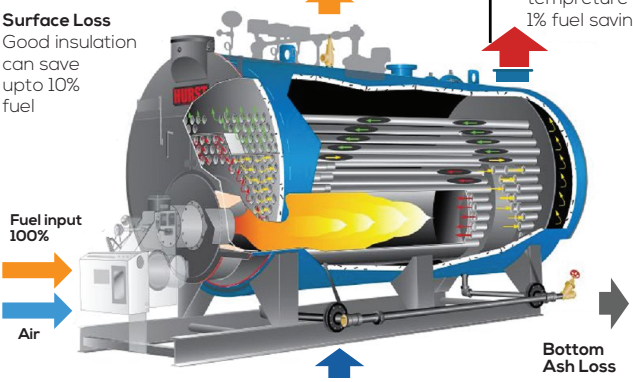
Good insulation can save upto 10% fuel

Steam Output

1. Dry Flue Gas Loss
2. H_2 Loss
3. Moisture in Fuel
4. Moisture in Air
5. CO Loss

22^0 reduction in Flue gas tempreture 1% fuel saving

Surface Loss
Good insulation can save upto 10% fuel



Fuel input 100%

Air

5% reduction in excess air increases boiler efficiencey by 1%or 1% reduction of residual oxygen in stack gas increases boiler efficiency by 1%

Water

60^0C raice in feed water tempreture by economizer condensate recovery corrosponds to 1% saving in fuel consumption in boiler

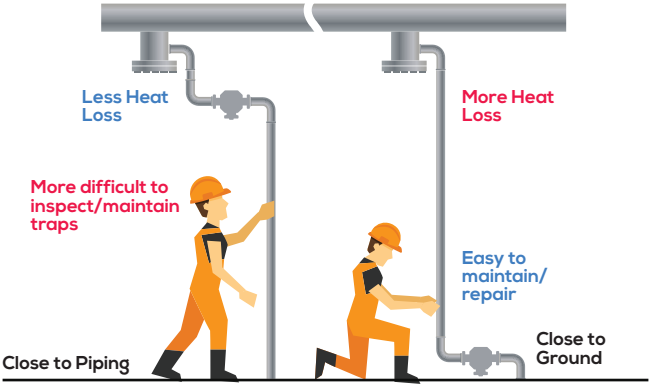
Bottom Ash Loss

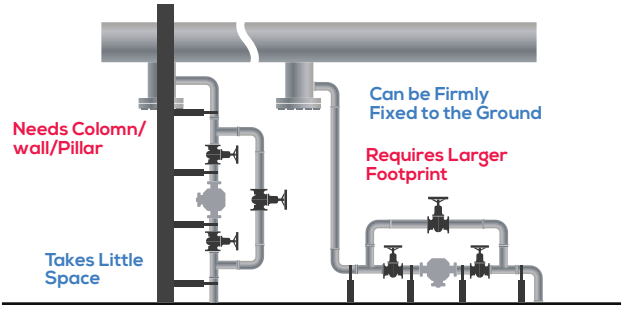
Check quality of the bottom ash for combustion quality

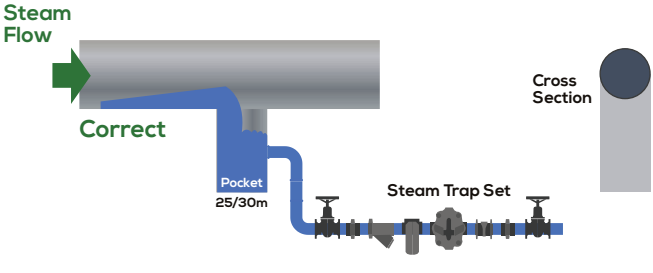
Energy Audit in Steam Systems

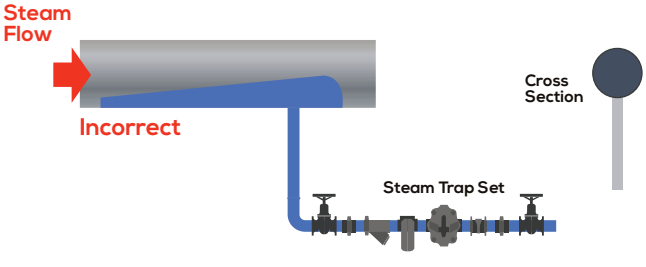
- Steam Distribution Scheme
- Study of Steam Traps
- Steam Leakages
- Flash steam utilization
- Condensate Recovery
- Installation of Air vents
- Study of Insulation

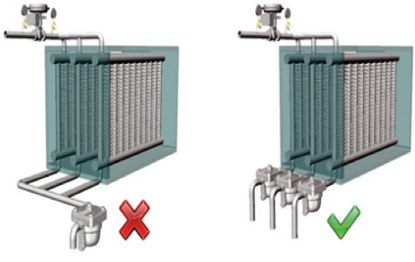
Installation tips for Steam Traps







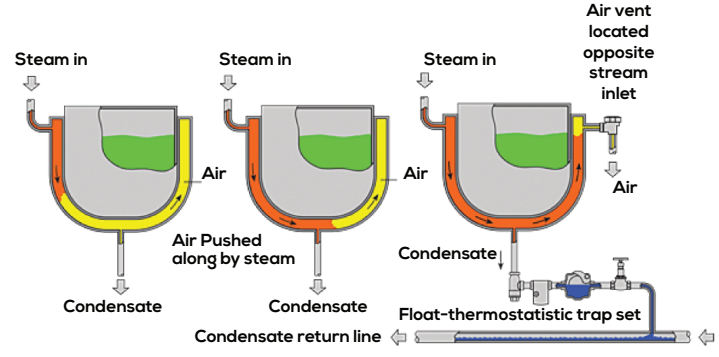




Air Vents in Steam Systems

- ✓ **Used for removal of air and non condensable gases**
  - Some non-condensable gases already present in feed water
    - Carryover to steam systems
  - During Shutdown steam condenses
    - Creating Vacuum – resulting in air infiltration in system
- ✓ **High resistance to heat transfer**

Location of Air Vent



Insulation in Steam Systems

- ✓ **Insulation critical for efficient performance of steam systems**
- ✓ **Required for better control of process parameters**
- ✓ **Typical Insulation material**
  - Glass Wool
  - Calcium Silicate
  - Cladding Sheets
- ✓ **Poor Insulation leads to higher heat loss**

Difference in tempreture (°C)	Heat Loss (kCal/m²/h)
50	500
100	1350
200	3790
400	13640

Insulation in Steam Systems Best Practices

Proper Insulation at Bends

Proper Insulation at Steam Lines

Proper Insulation at Valves

Proper Insulation at Steam Distribution

Recovery of Flash Steam

- ✔ **Flash Steam produced when steam at high pressure is released to a lower pressure**
- ✔ **Cost of Flash Steam = 95% of Live Steam**
- ✔ **% of Flash Steam Generated =** $\frac{S1 - S2}{L2}$

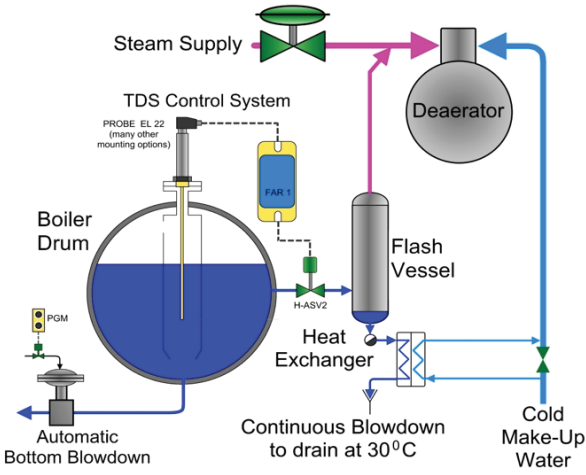
Where,

S1 = Sensible heat of high pressure Condensate

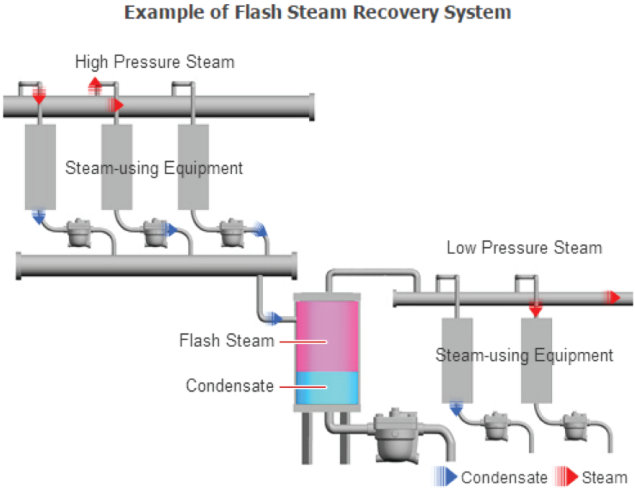
S2 = Sensible heat of steam at Lower pressure

L2 = Latent Heat of Flash Steam

Flash Steam Recovery - Examples



Flash Steam recovery in Blowdown system

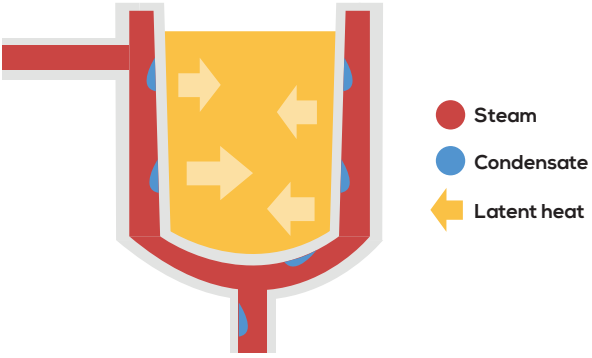


Flash Steam recovery for Steam using devices

Condensate Recovery

- ✓ Condensate is the liquid formed when steam passes from vapour to the liquid state
- ✓ With Condensate recovery Sensible heat can be recovered from the water (condensate)

Example of Steam Heating Process



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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