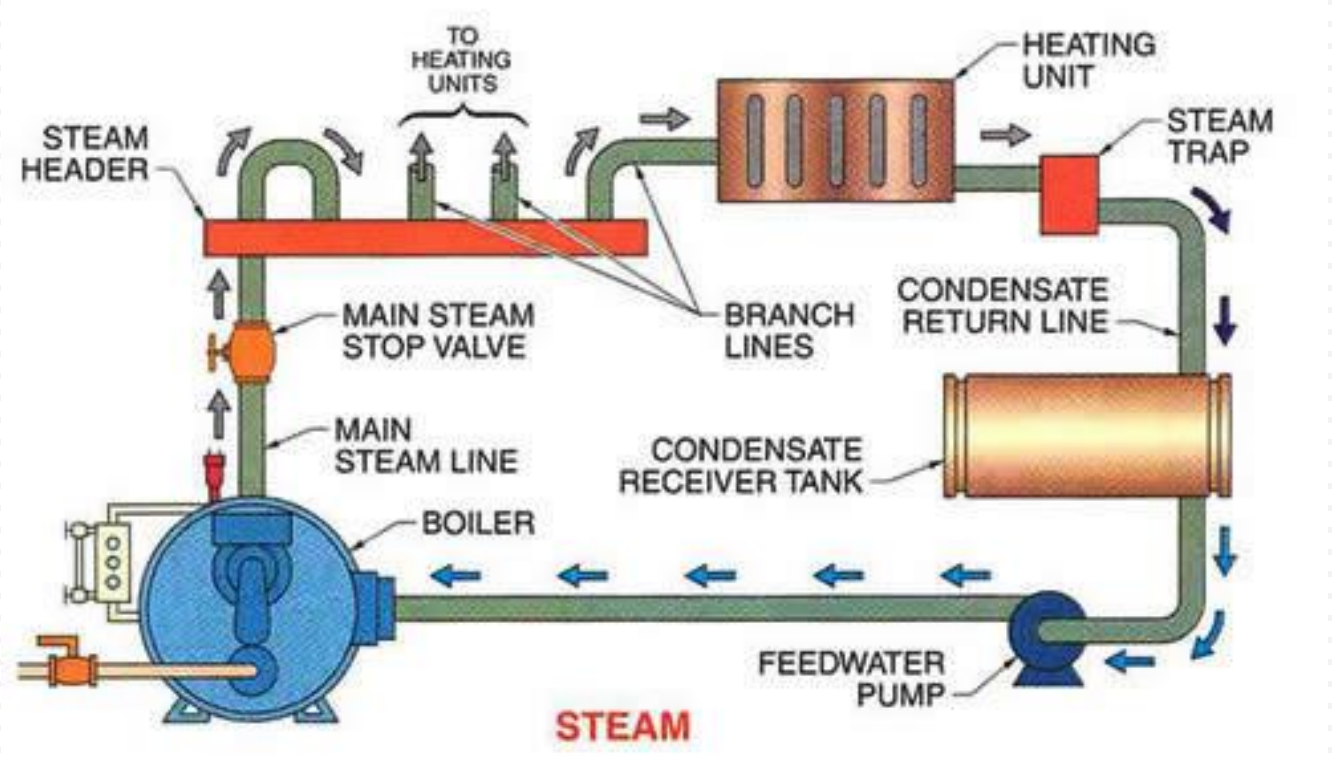
11th May 2018

ENERGY CONSERVATION IN STEAM SYSTEMS



CONFEDERATION OF INDIAN INDUSTRY
CII – GODREJ GREEN BUSINESS CENTRE
HYDERABAD, INDIA

Efficiency in Steam Systems can be Viewed

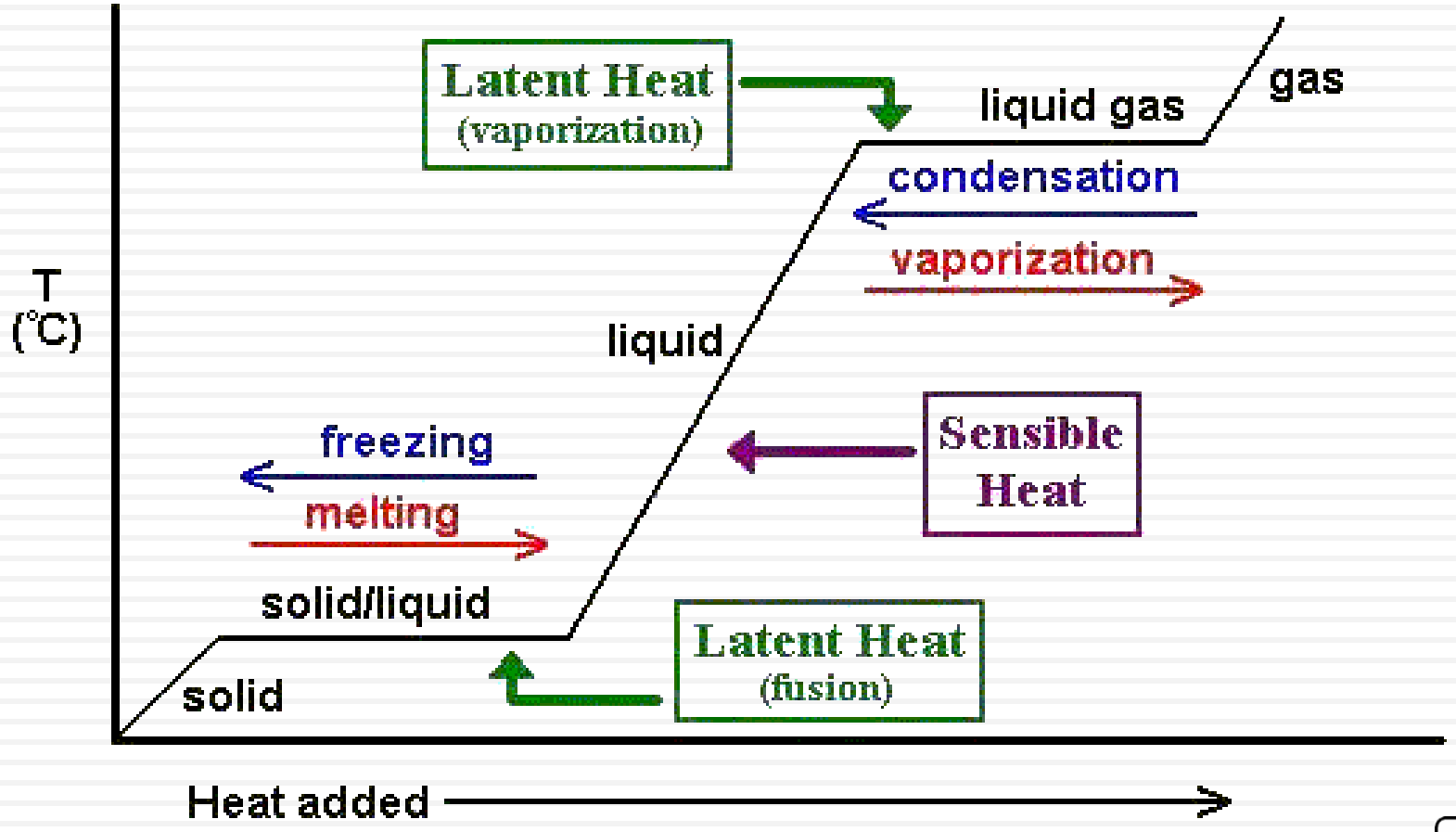
- Steam System working is critical
  - Process Importance
  - Cost Importance
- EE Approach
  - Generation
  - Distribution
  - Usage

Importance of Steam

- **Steam as heat transfer medium**
  - **High specific heat capacity**
  - **High Latent heat capacity**
  - **Cheap and easily available**
  - **Non toxic and inert**
  - **High heat transfer coefficient**

Heat Energy Available in Steam

- Heat Available in steam is in two forms
  - Latent Heat
  - Sensible Heat

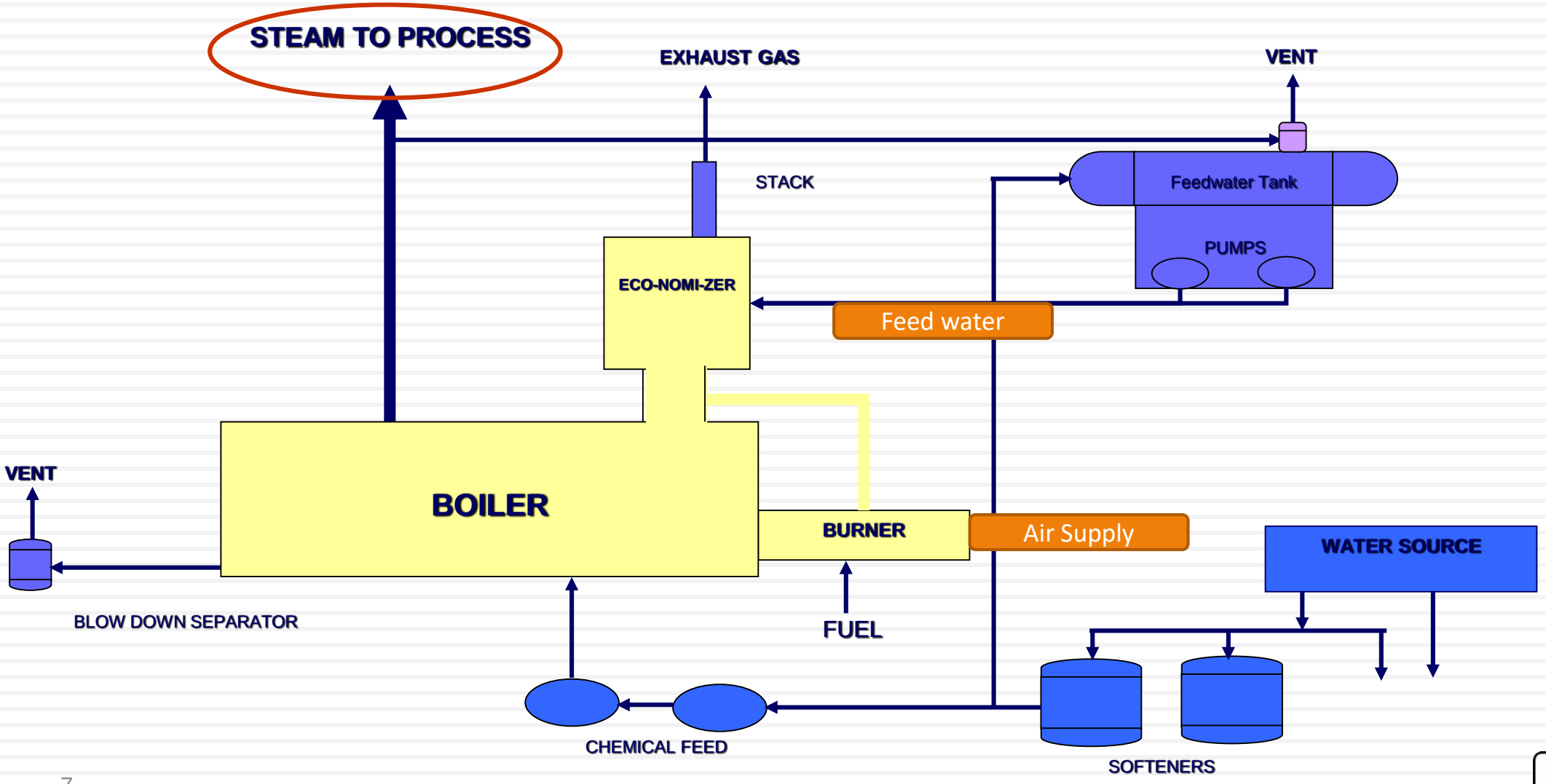


Energy Audit in Steam Systems

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

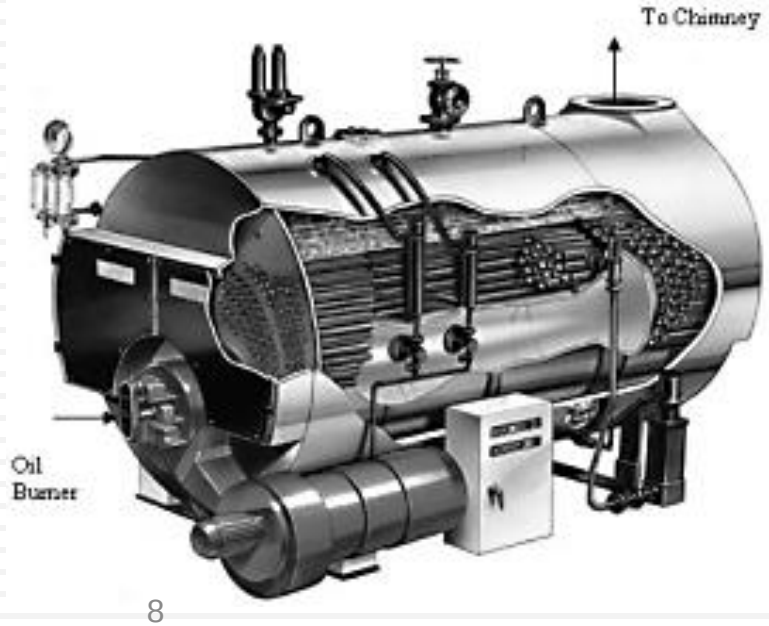
BOILER IMPROVEMENT OPPORTUNITIES

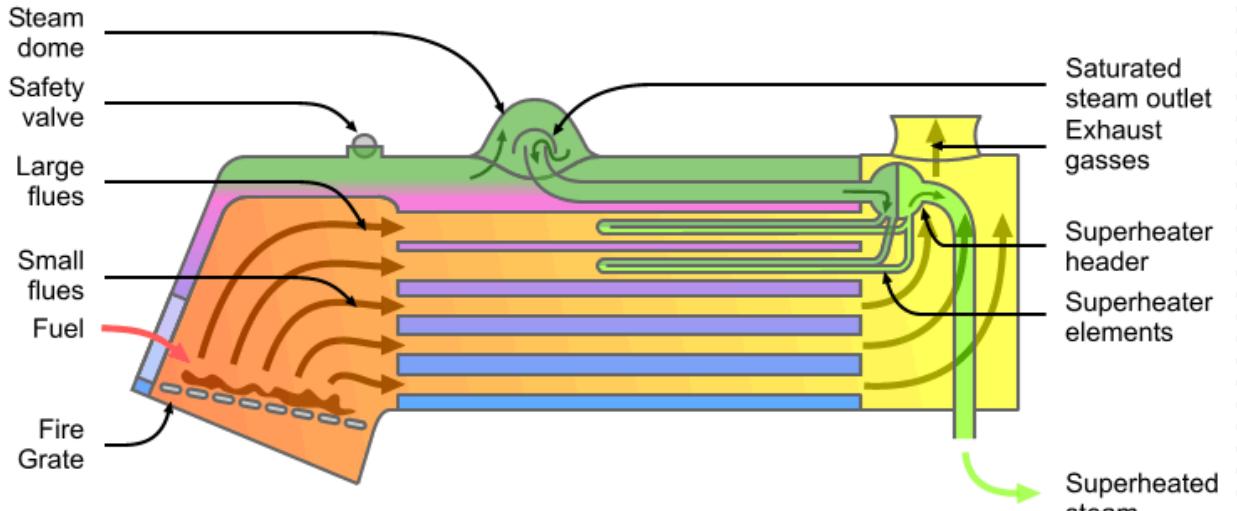
Typical Boiler System

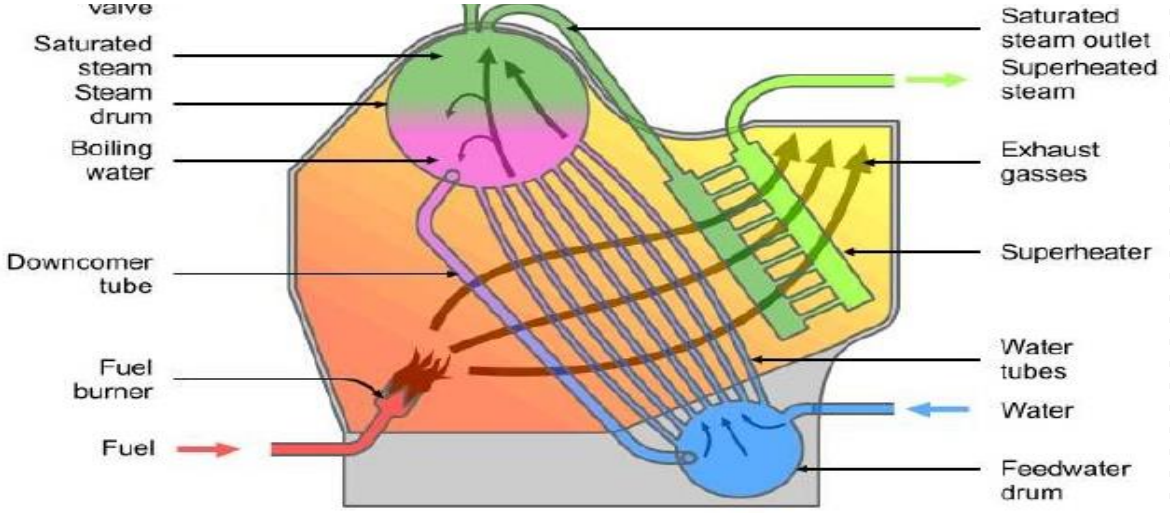


Classification of boilers

- General classification,
  - Fire in tube
  - Water in tube
  - Packaged Boilers



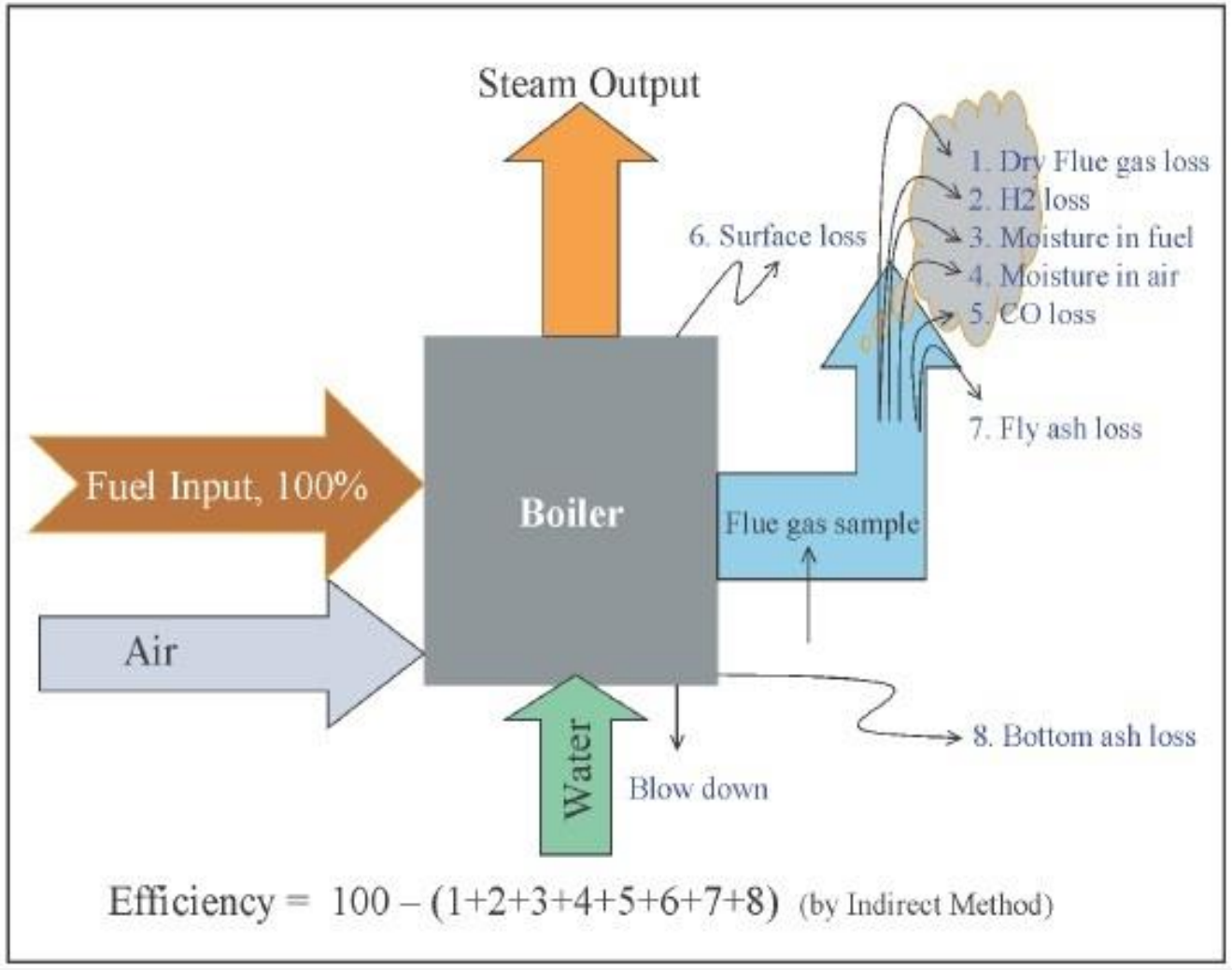




Boiler Efficiency

- Percentage of heat input that is effectively utilized in producing steam
  - Direct Method – Input Output Method
  - Indirect Method – Heat Loss Method

Indirect/ Heat Loss Method



- **Based on**
  - British standard BS 845
  - ASME PTC 4.1
- **Data required**
  - Ultimate Analysis of fuel
  - O_2% in flue gas
  - Flue Gas temperature
  - Ambient temp. and humidity
  - Un-burnt carbon in fly ash and bottom ash

ENERGY SAVING OPPORTUNITIES IN BOILERS

Energy saving Opportunities

- Stack temperature
- Feed water preheating
- Combustion air preheating
- Excess air control
- Radiation Losses
- Blow down Losses
- Condensate Recovery

Avoid excess supply of air to boilers

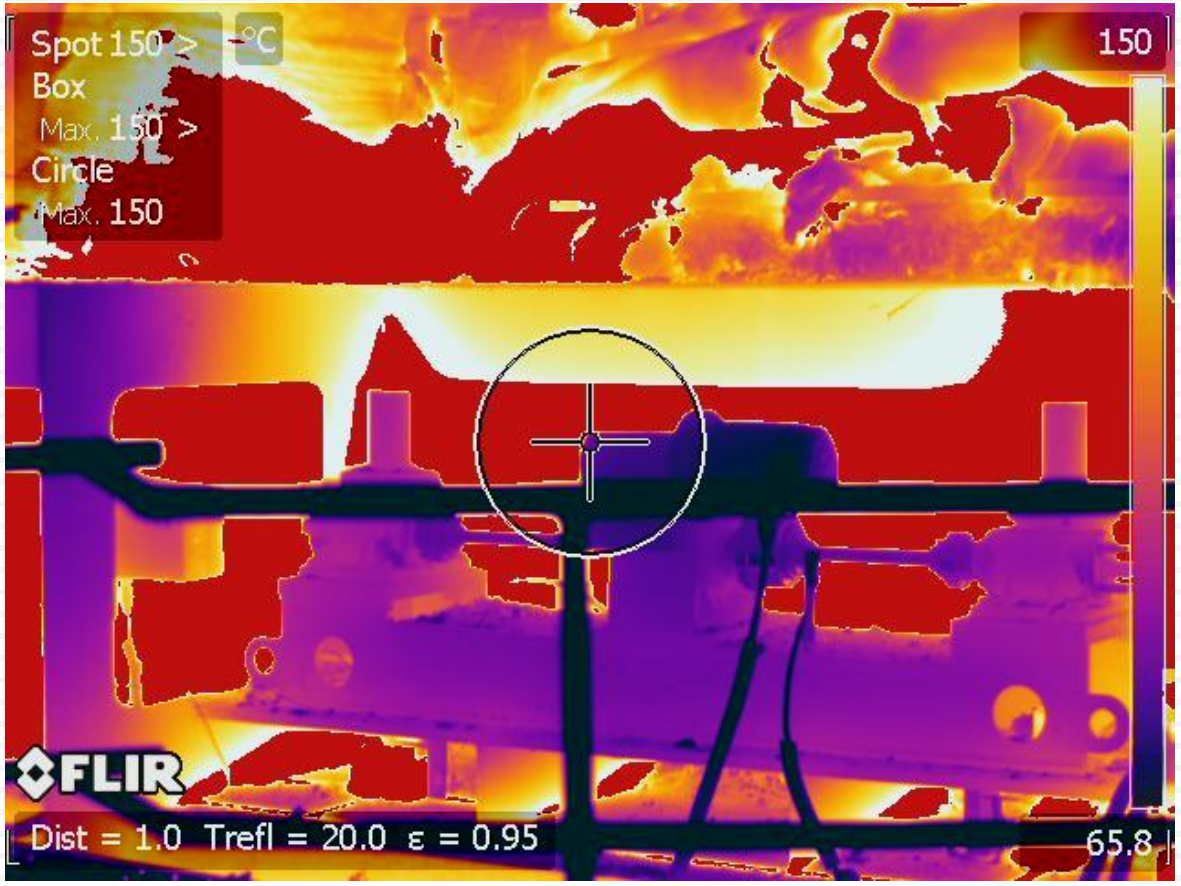
- O_2 levels at outlet of boilers on a higher side
  - Heat loss due to excess air – *dry flue gas losses*
  - Higher power consumption of FD fan
  - Online O_2 analyzer installed to monitor proper O_2 levels
  - VFD available on ID and FD fan
    - Operate FD fan with O_2 level as feedback
    - ID fan to be operated with furnace draft

Reduce radiation losses in the boiler

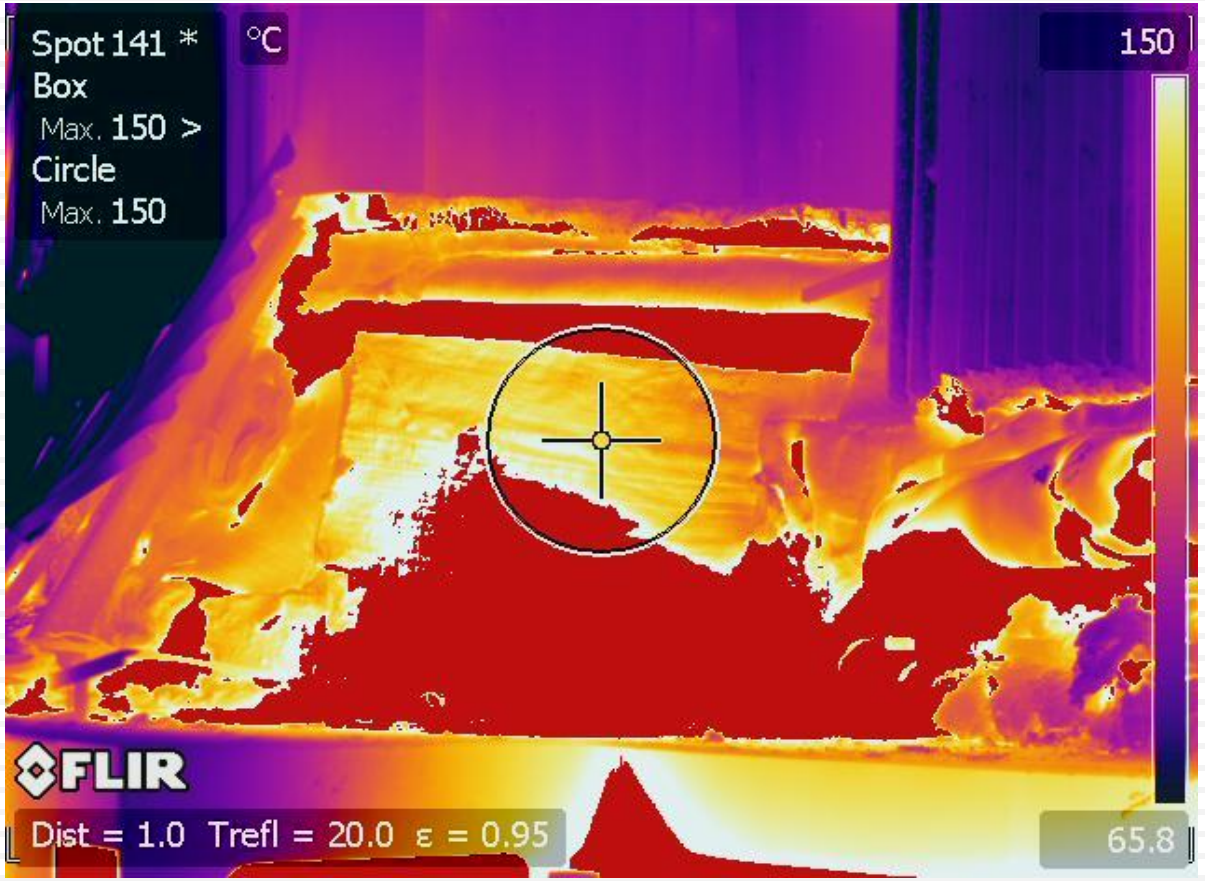
- **Thermo graphic study done to evaluate locations of high radiation,**

Area (m2)	Location	Temp (deg C)	Ambient Temperature (deg C)	kCal
Unit 2				
20	APH Losses	240	40	49998.71
12	Manholes (12 no's)	260	40	36028.74
40	Boiler Corners	230	40	90790.8
3	Extended Back pass Bellow	350	40	18215.47
Unit 1				
1	Spiral Water Wall (42m)	320	40	4887.41
Total Heat Loss				**199921.1**

Reduce radiation losses in the boiler

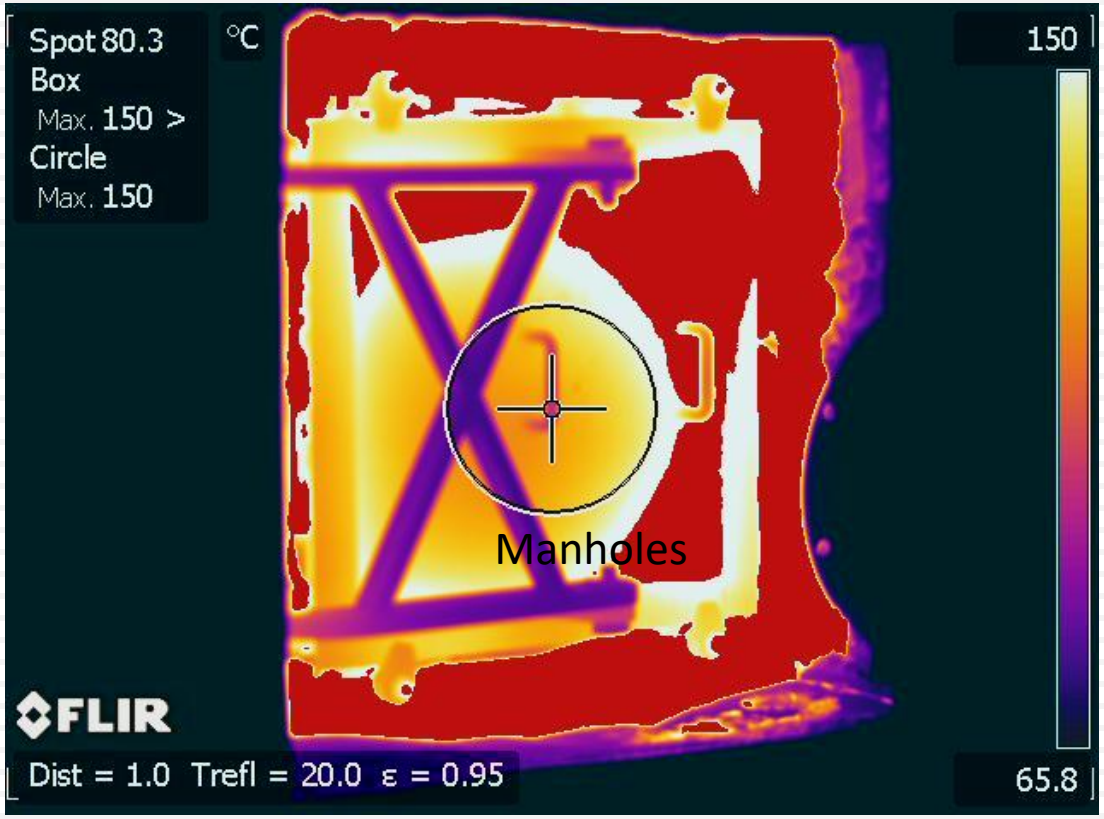


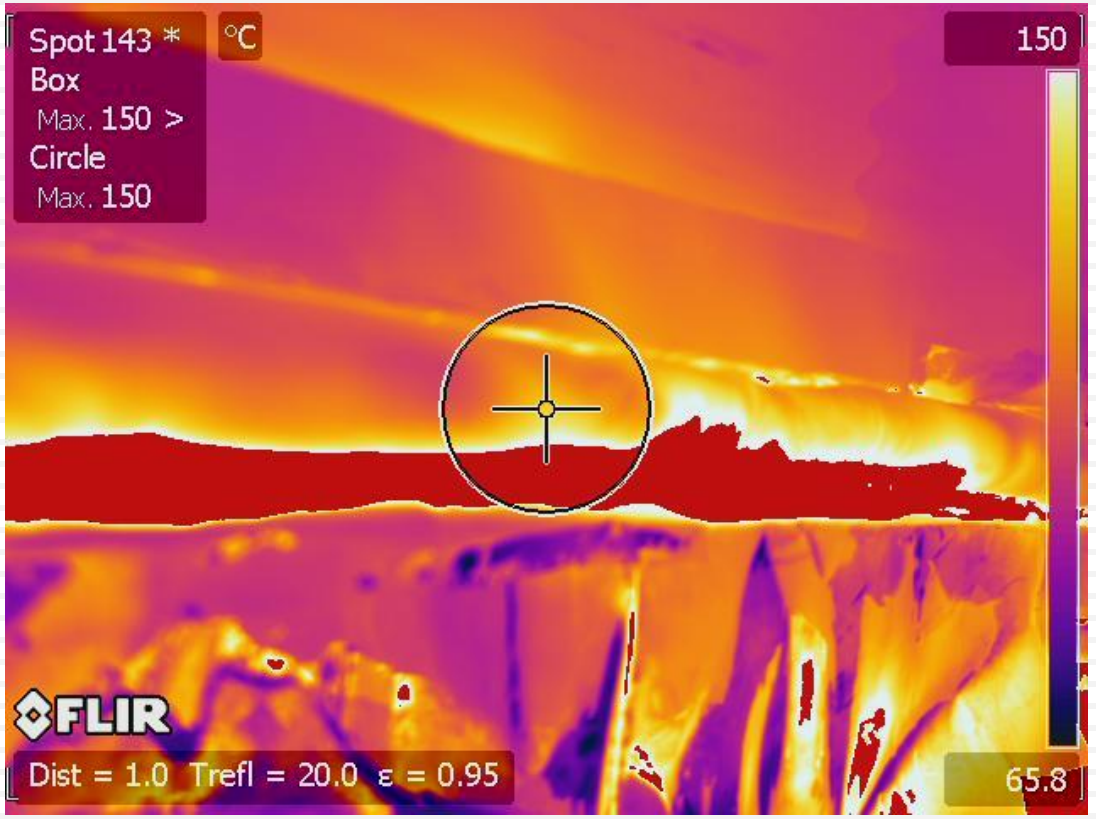
APH



BELLOW NEAR APH

Reduce radiation losses in the boiler





MANHOLES

FD BELLOW APH

Enhance combustion efficiency by increasing excess air

- O_2 % at Eco outlet 3.5%
  - CO content is 400 ppm at Eco out
  - Heat loss due to higher CO content is 0.58% which is high
- The quantity of air for combustion was increased,
  - CO levels reduced to 100 ppm at Eco out
  - Boiler efficiency improved by 0.4%
    - 14 kg/h of coal saving

STEAM DISTRIBUTION SYSTEM

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

Compensation to be kept for both

- **Generate and Distribute Steam at high pressure**
  - Steam Quality – dry saturated always
  - Smaller sized steam mains , resulting in low capital costs

Steam Distribution System Cont..

- **Use Steam at lower Pressure**
  - Lower Pressure results higher latent heat
  - Leads to higher dryness at user

Features of Efficient Steam Piping

- Shortest possible distance
- Proper draining of condensate (drain points at every 30-45 meters)
- Proper slope (not less than 125 mm for 30 meters)
- Branch Lines to users (should be connected at top)
- Proper Supports to avoid sagging
- Proper expansion loops
- Minimum pipe redundancy

Steam Traps

- **Steam Traps**
  - **Removal of condensate and non condensable gases**
  - **minimum loss of steam**

Types of Steam Traps

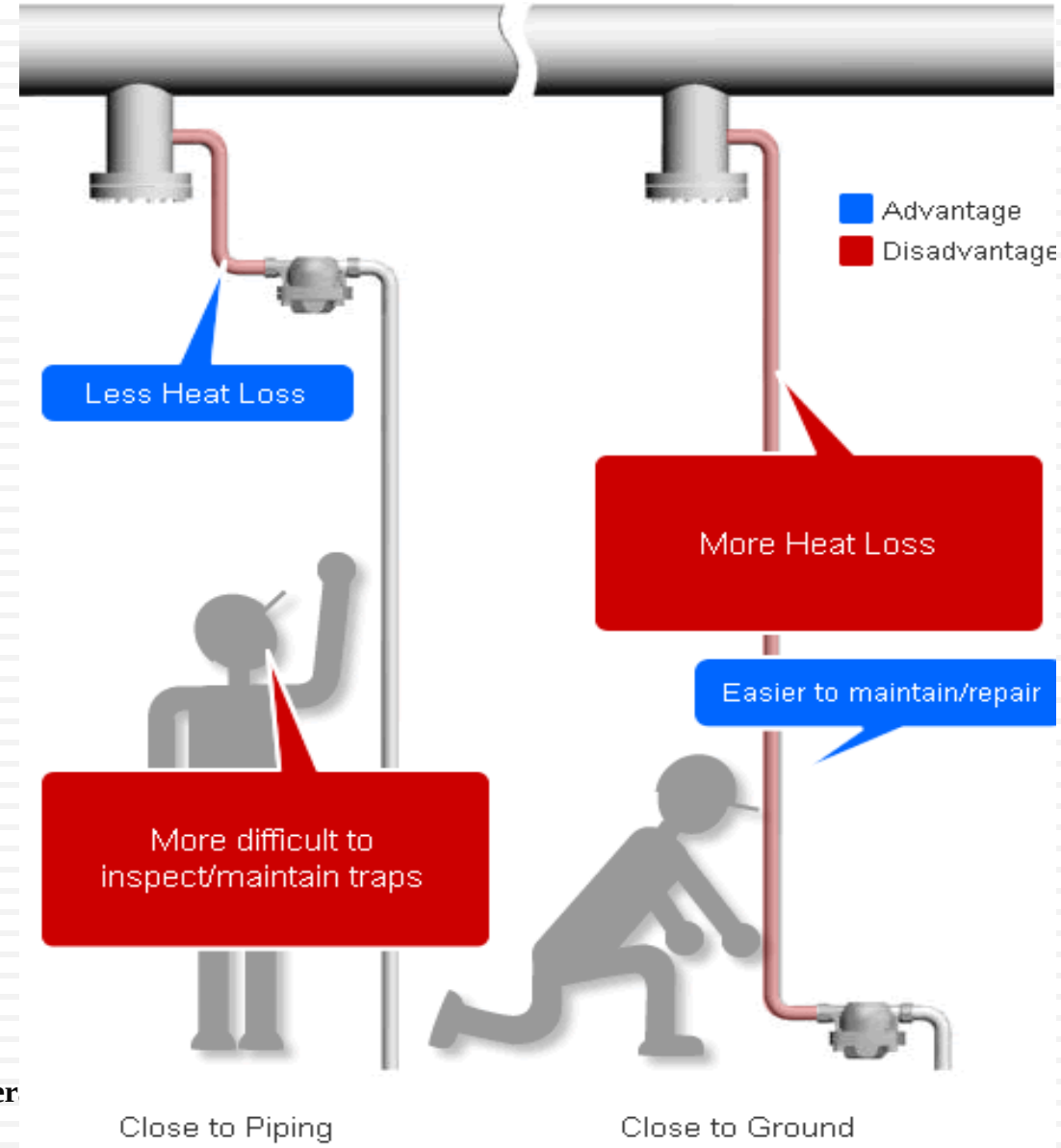
Mechanical Stem Traps	Thermodynamic Steam Traps	Thermostatic Steam Traps
• Buoyancy	• Difference in thermodynamic properties of condensate and steam	• Difference in temperature of steam and condensate

Selection of steam Trap

Application	Feature	Suitable trap
Steam mains	- Open to atmosphere, small capacity - Frequent change in pressure - Low pressure - high pressure	Thermodynamic type
Equipment • Reboiler • Heater • Dryer • Heat exchanger etc.	- Large capacity - Variation in pressure and temperature is undesirable - Efficiency of the equipment is a problem	Mechanical trap, Bucket, Inverted bucket, float
• Tracer line • Instrumentation	- Reliability with no over heating	Thermodynamic & Bimetallic

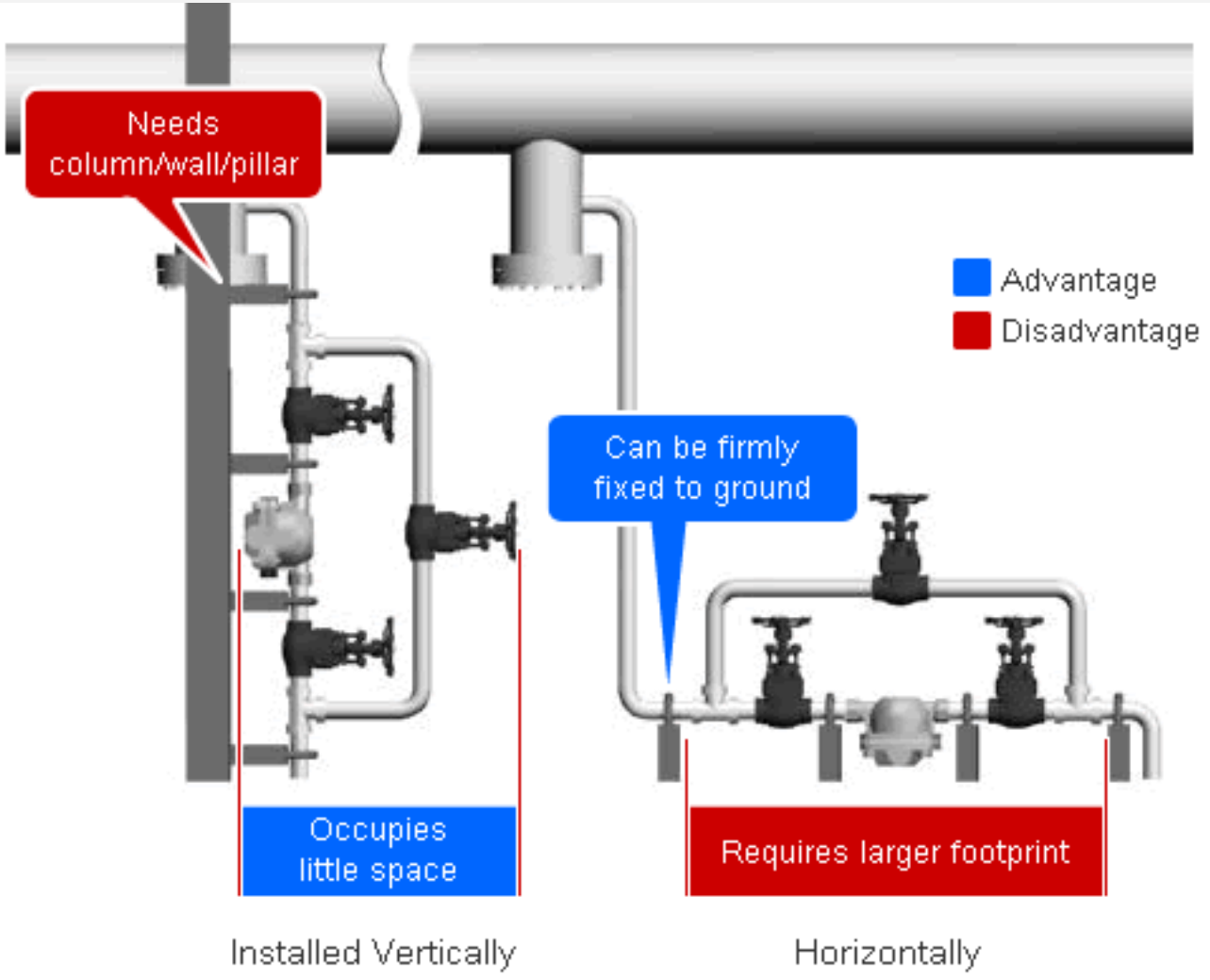
Installation tips for Steam Traps

- **Trap Location: Close to Piping or Ground?**

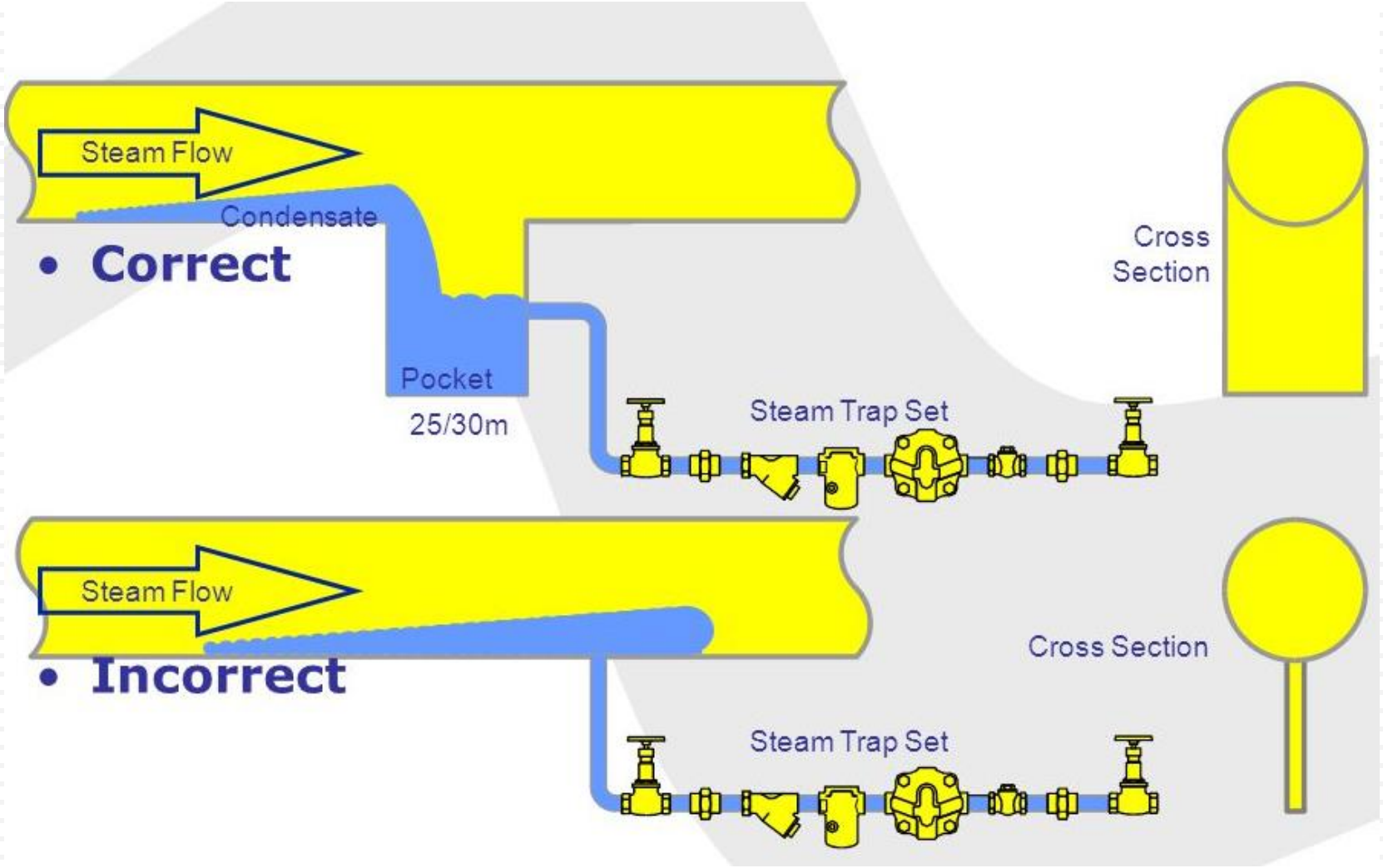


Installation tips for Steam Traps

- **Trap Orientation:**
  Vertical or Horizontal?



Installation tips for Steam Traps



Installation tips for Steam Traps

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

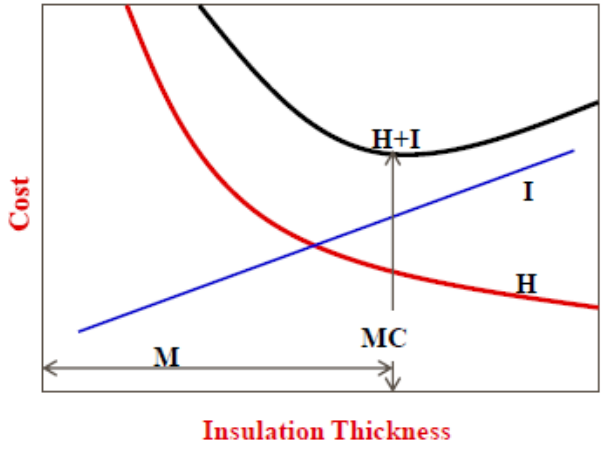
Heat Losses at different Surface Temperatures

Difference in temperature between ambient & surface (^oC)	Heat loss ($kCal/m^2/h$)
50	500
100	1350
200	3790
400	13640

Economic thickness of Insulation

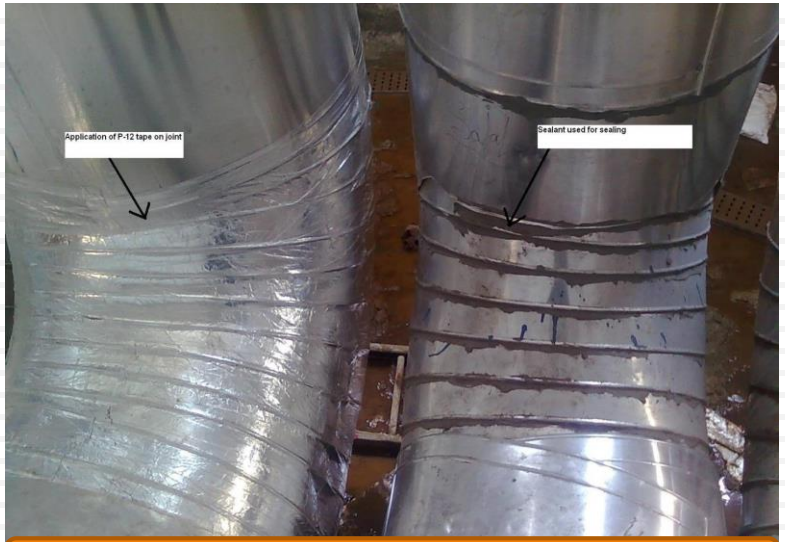
- Cost of Increase in Thickness of insulation should justify fuel savings
- Beyond certain value further increase in insulation is not economical
- Concept of “Economic Thickness of Insulation”

The *Economic Thickness* of insulation is that thickness at which the costs of heat loss, plus the installed cost is at minimum.



Where :
I = Cost of Insulation
H = Cost Of Heat Loss
I+H= Total Cost
M = Economic Thickness
MC= Minimum Cost

Insulation in Steam Systems – Best Practices



Proper Insulation at Bends

Proper Insulation at Steam Lines

Proper Insulation at Valves

Proper Insulation at Steam Distribution

Steam Leakages

Through Instrumentation

Through Valve passing

Through Flanges

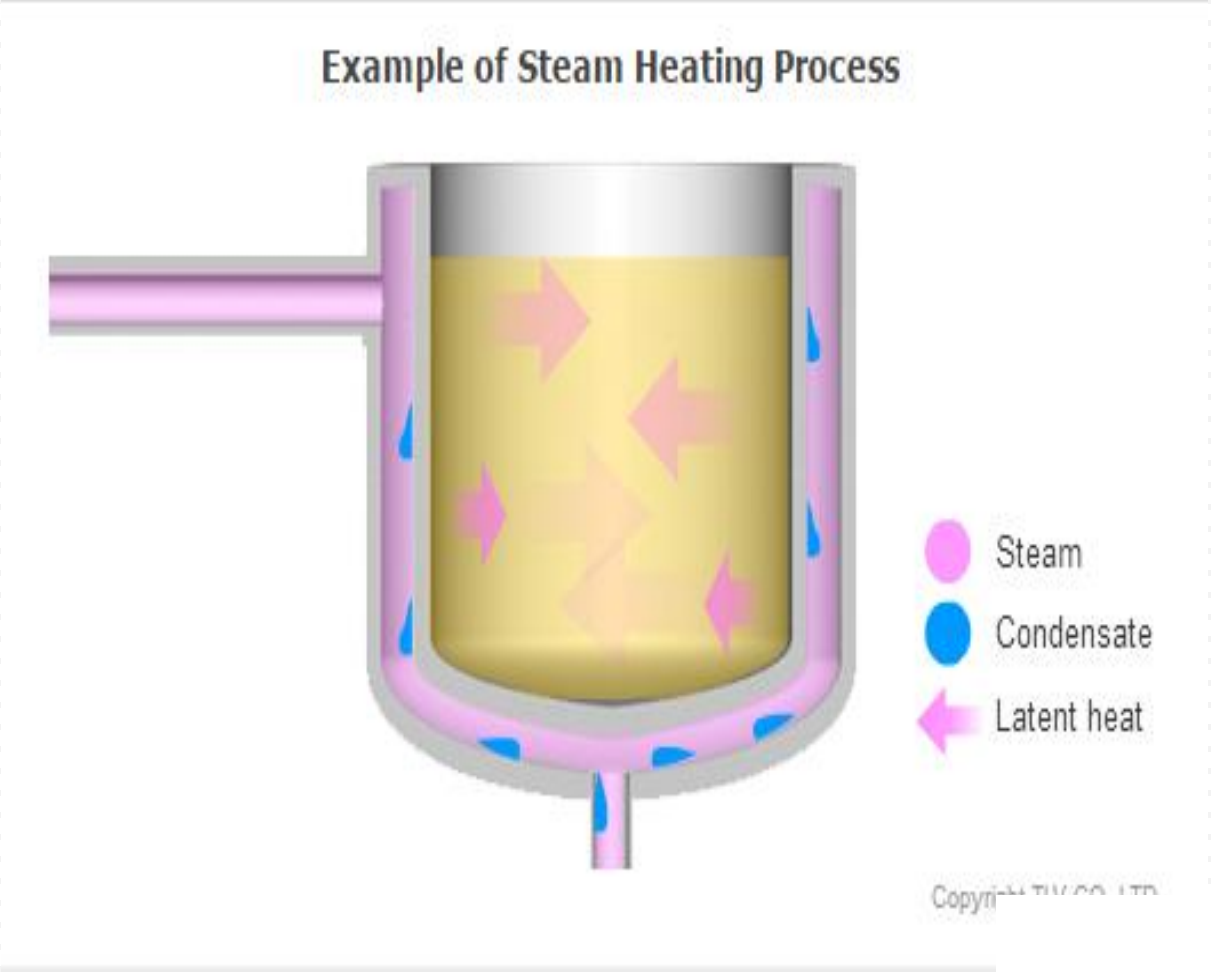
Through Faulty Traps

Through Valve Glands

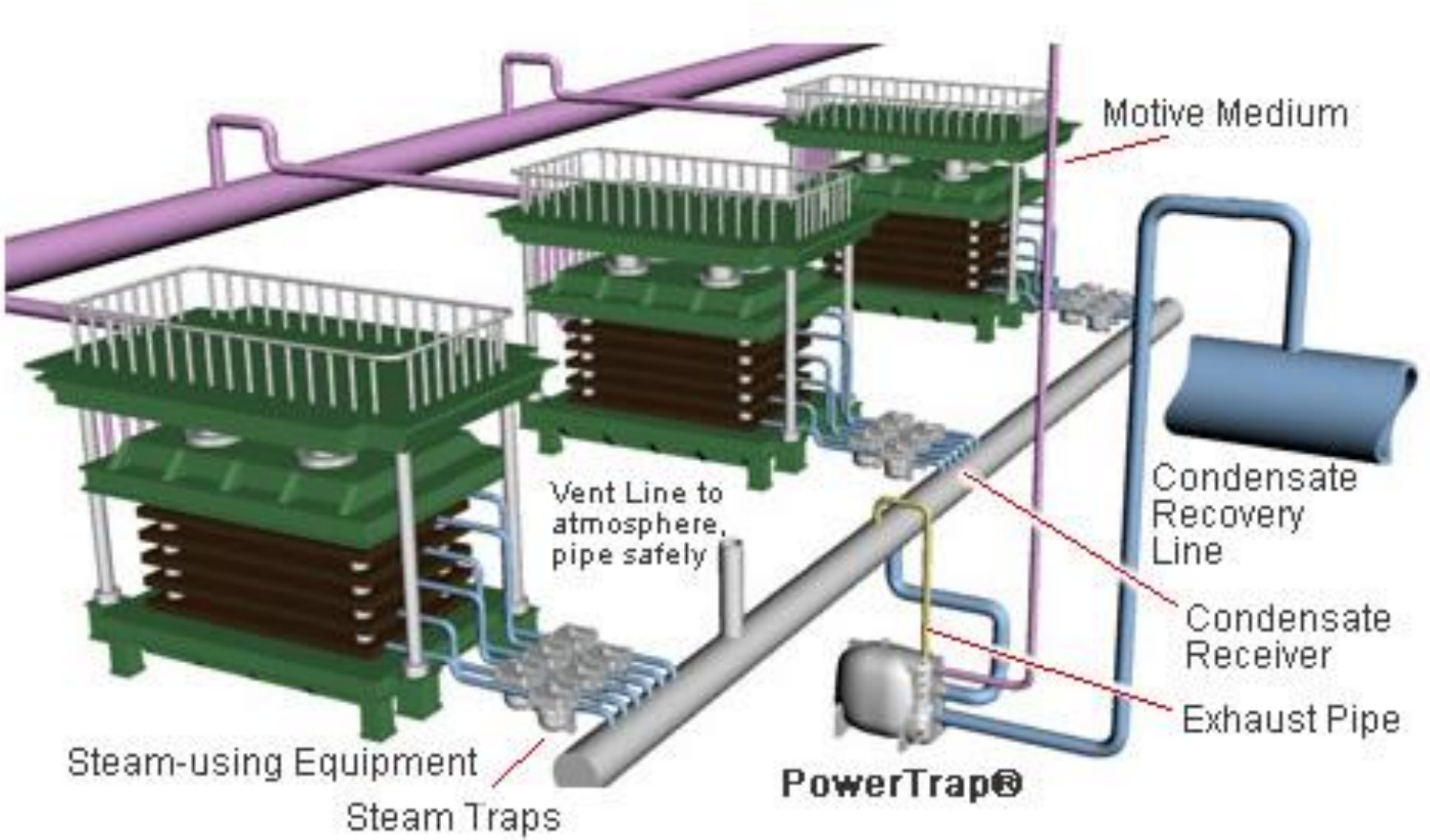
Through material deterioration

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)

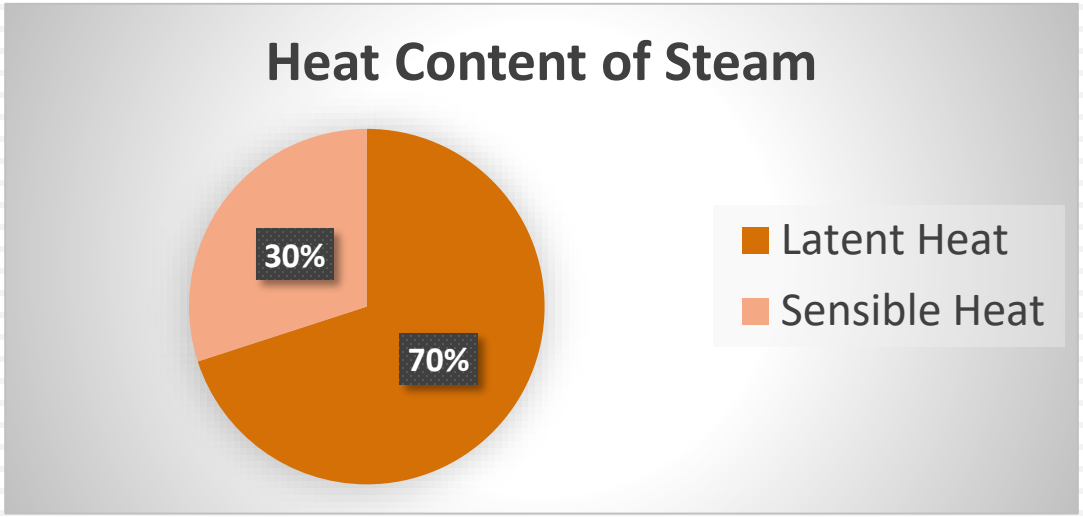


Typical Condensate Recovery System



Advantages of Condensate Recovery

- Reduced fuel cost - Sensible heat accounts for 30% of heat content of steam
- Reduced water consumption
- Reduced Effluent Discharge
- Improves Boiler output
- Boiler Feed water quality



Tips for maintaining EE in Boilers

- Keep records of water consumption and fuel consumption
  - Calculation Fuel Consumption/kg of Steam
- Frequently conduct insulation and leakage survey
  - Temperature
  - Leakage
- Check of O_2% at Stack and flue gas temperature
- Foremost importance to safety

THANK YOU….