Forbes Marshall

Trusted Partners.
Innovative Solutions.

SteamHUB

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ANDROID APP ON Google play

The smart app for steam users

Best Practises in Steam System

1st Nov 2014

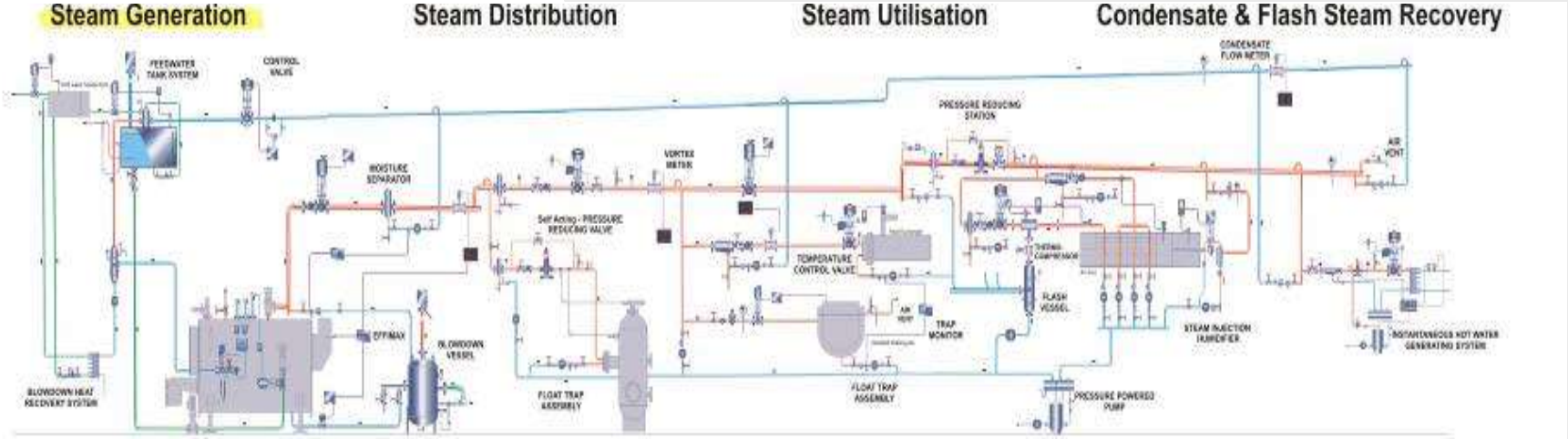
Hyderabad

Forbes Marshall

We Are Steam

Knowledge, Services and Products for the efficient use of steam

- **Steam Distribution and Metering**
- **Steam Trapping Solutions**
- **Condensate and Flash Steam Recovery**
- **Automatic Blowdown Controls**
- **Pressure and Temp Steam Distribution & Metering**



Knowledge Partners

- **Detailed knowledge of steam systems and process covering all industry segments.**
- **Thousands of detailed plant surveys conducted over 60 years.**
- **Industry wise Specific Fuel consumption norms from detailed studies of hundreds of plants.**
- **Three rounds of benchmark studies with CII.**
- **Hundreds of crores of savings achieved through our focused energy conservation efforts**

New initiatives

- **Spreading awareness throughout industry through initiatives like Energy Conservation Tip of the week program and online forums like SteamNet.in**

- **Growing beyond energy efficiency by focusing on safety, ease of operation & maintenance, conformance to environment and pollution norms and reliable life cycle.**

Our Services

- **Over 130 engineers who visit plants daily for sales, customer support and plant studies.**
- **Comprehensive coverage in the Indian sub-continent (27 Indian offices alone) pro-actively to identify energy saving potential at plant specific level.**
- **Dedicated helpline for prompt solutions on *Everything in steam***
- **No hidden cost of ownership**
- **Monthly customer training programs for operations, maintenance and design of steam systems**
- **State of the art, fully equipped Steam Engineering Centre where separate training programs are conducted for working engineers, fresh engineering graduates and teachers as a part of industry – academia interaction.**

New initiatives

- Pro-active installed base health check MOMs with plants.
- Hand-holding programs for sustaining savings achieved by implementation of product proposals (efficient product does not guarantee efficiency!).

Our Products

- **A to Z in steam**
- **A 60 year partnership with Spirax Sarco, the world leaders in steam engineering**
- **All the building blocks of an efficient steam system**
- **A World leader in –**
  - **Steam traps (> 3 m; more than everyone else put together)**
  - **Steam operated Condensate Pumps (over 6000 installations)**
  - **Steam Pressure Reducing Stations**
  - **Instantaneous Hot Water Systems**
- **Constant innovation; a strong R&D team evolving solutions for higher savings and easy day-to-day management of steam systems.**
- **State of the art manufacturing facilities**

Forbes Marshall

- **Partnership in Energy conservation**
- **One stop shop for all knowledge , services and products**

- **The plant with best SPFC for Solvent Extraction, Brewery & Beverage, Rubber, Dairy etc have all been designed by Forbes Marshall.**

- **Refinery and Fertilizer plants with minimum steam loss through steam traps and valves—FM has partnered them with Steam Trap Management Programme.**

- **---and Many More .**

Energy Conservation Redefined

- **Need for Energy Conservation well established**

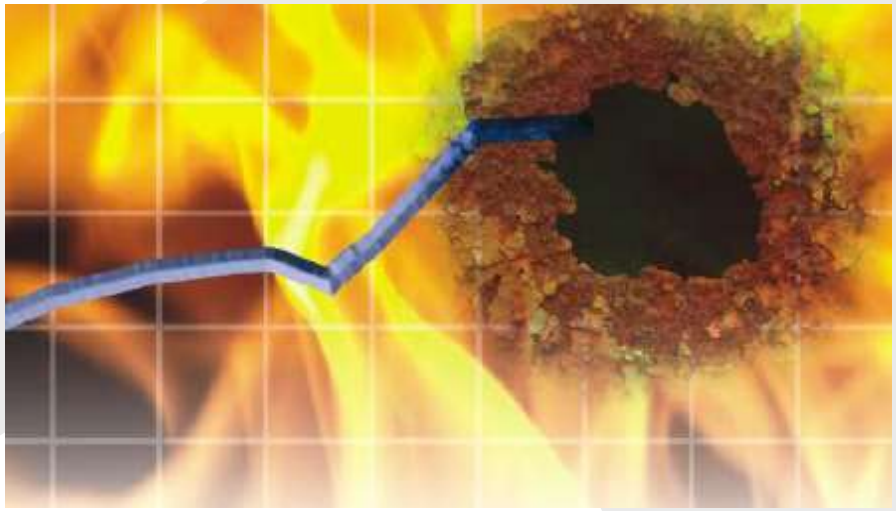
- **Some obvious areas already taken care of**
  - **Cost of generating steam – some major investments done , but still large scope exists**
  - **Efficient process technology, Condensate recovery etc**

- **Shift to "Time to get Specific"**

- **Specific Fuel Consumption**
  - **Directly relates to your product cost**
  - **Enables benchmarking!!**

- **FM Study on Time to get Specific**

Taming your Running Costs…



Is your Energy Consumption burning a hole in your profits

While cos would differ in their strategic approach towards Energy Efficiency all approaches have following elements in common..

- **Monitoring Energy Usage (Indexed to Production - SPFC)**
- **Recognizing that Management is as important as technology**
- **Identifying potential routes to save through an audit**

Benchmarking in Process Industry & our role

- Undertook a study across industry segments to establish “Best” & Average for Specific Fuel Consumption & utilities. Published the study in association with CII in 2003-04.

- Identified the opportunities for savings in each of the Industry Sectors factually.

% REDUCTION IN FUEL BILL

FM ENCON STUDY

Industry	Steam Generation	Distribution & utilization	Condensate & Flash Recovery	Capacity Utilisation	Total
Tyre	9%	7%	7%	0%	23%
Solvent	7.5%	3.5%	3%	12%	26%
Brewery	7%	1.5%	2.5%	13.5%	24.5%
Beverage	9%	9.5%	2.5%	11%	32%
Textile	12%	7%	7%	NA	26%
Average	9%	6%	4%	9%	26%

Boiler Efficiency & Cost of Steam

Fuel	Avg S:F	Avg Cost of Steam (Rs./Kg)
Furnace Oil	12	4
HSD	13	4.5
Natural Gas	12	3.0
Coal	4.5	1.45
Petcoke	7	1.2
Rice Husk	3.2	1.2
Briquette	3	1.8

Specific Fuel consumption trends

Industry	2003 Best/Average	2011 Best/Average	Units
Brewery	44/58	30/42	Ltrs of FO/ KL of Brew
Tyre	162/210	140/190	Kg FO/ Ton of Rubber
SEP (Rice Bran)	100/130	90/110	Kg Rice husk/ Ton of seed crushed
Paper (Kraft)	330/400	270/330	Kg Coal/ Ton of Paper
Textile	170/390	170/330	Kg Coal/ 1000Mtrs of cloth
Hospitality	5.7 (Coil Boilers)	3.8 (shell Boilers)	KgHSD/room/day

SFC, Cost of Processing

Industry	Cost in 2003	Cost in 2013
Brewery	Rs 1200/KL Brew	Rs 400/KL Brew
Tyre	Rs 3500/ T of Rubber	Rs 1700/ T of Rubber
SEP	Rs 180/ T of seeds	Rs 315/ T of seeds
Paper	Rs 1100/ T of Paper	Rs 2000/T of Paper
Textile	Rs 600/ 1000 mtrs	Rs 1100/ 1000mtrs
Hospitality	Rs 180/ room/day	Rs 170/ room/ day

SPFC Varies basis

- **Technology**
- **Installed Capacity**
- **Capacity Utilisation**
- **Product Mix**
- **Quality of Raw Material**
- **Steam & Condensate Loop**

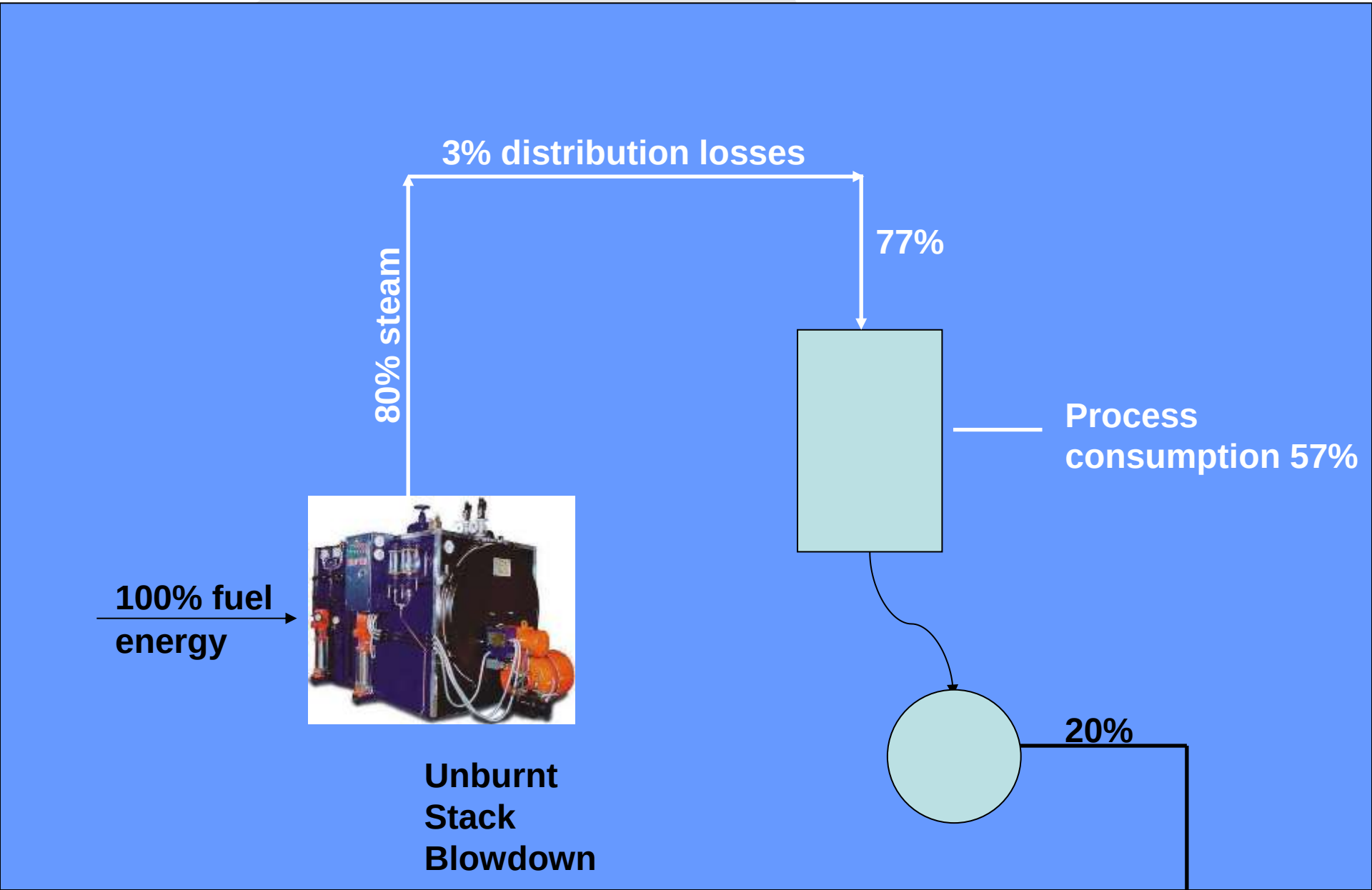
Optimal Steam System

Meeting the process demands in a manner which is:

Important areas for SSE Improvement

- STEAM GENERATION : STEAM BOILER HOUSE
- STEAM DISTRIBUTION
- STEAM UTILIZATION
- HEAT RECOVERY SYSTEM

Steam & Condensate Loop



Steam Generation-Boiler House

- **Criteria for Selection of Boiler**

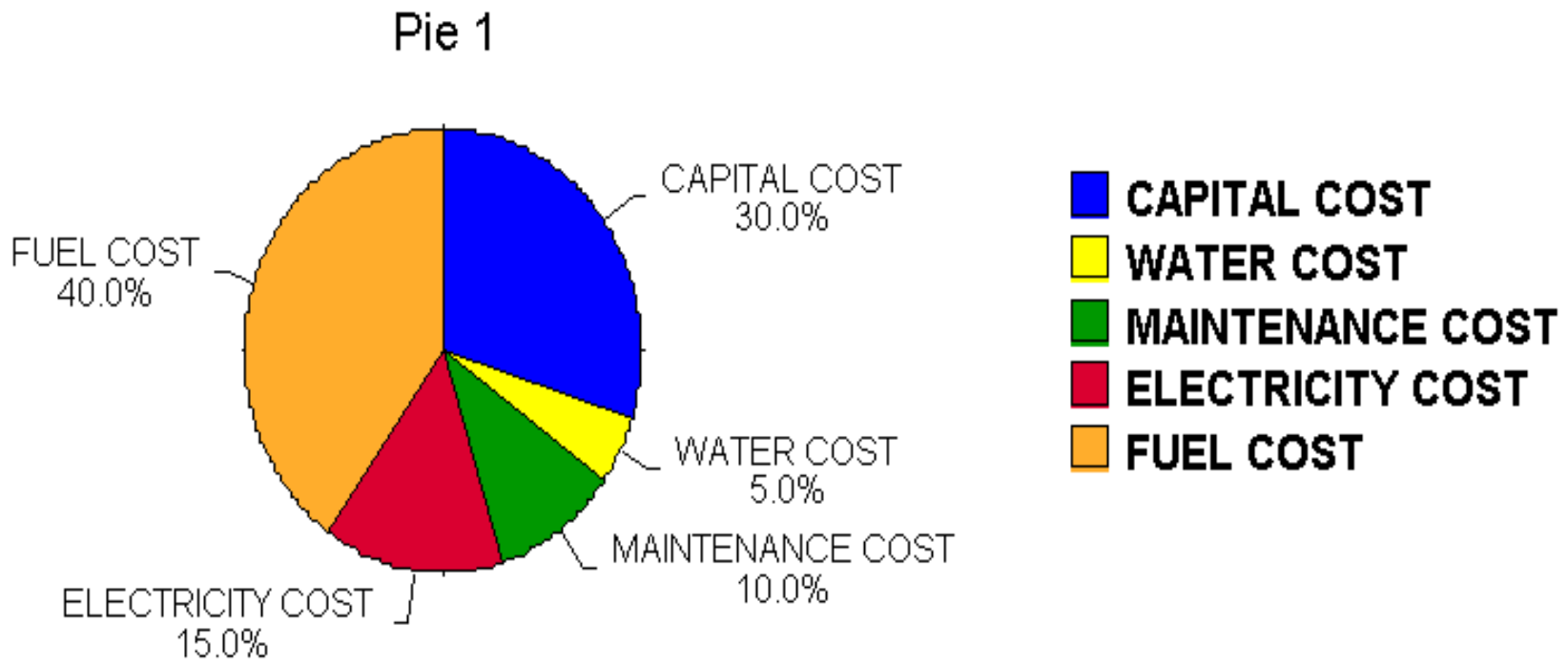
  - Steam Demand : Peak /Average load

  - Steam Consumption pattern

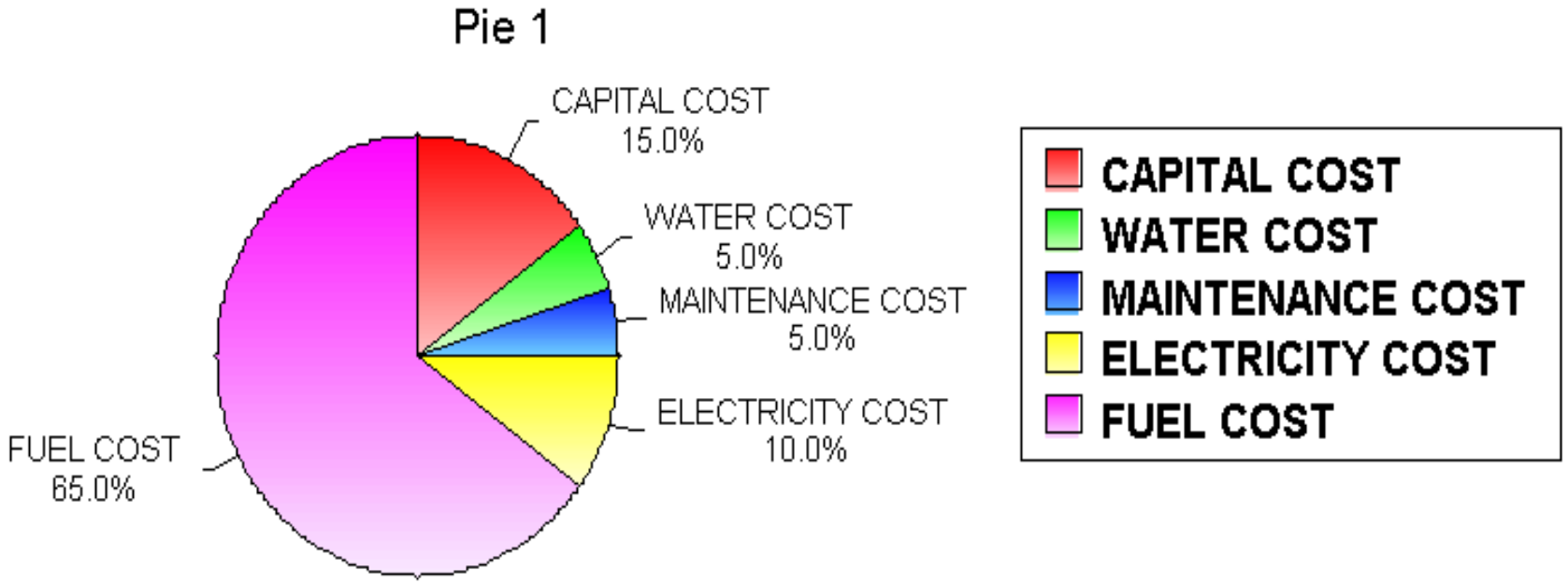
  - Fuel selection w. r. t. availability, cost

  - Feasibility of COGEN

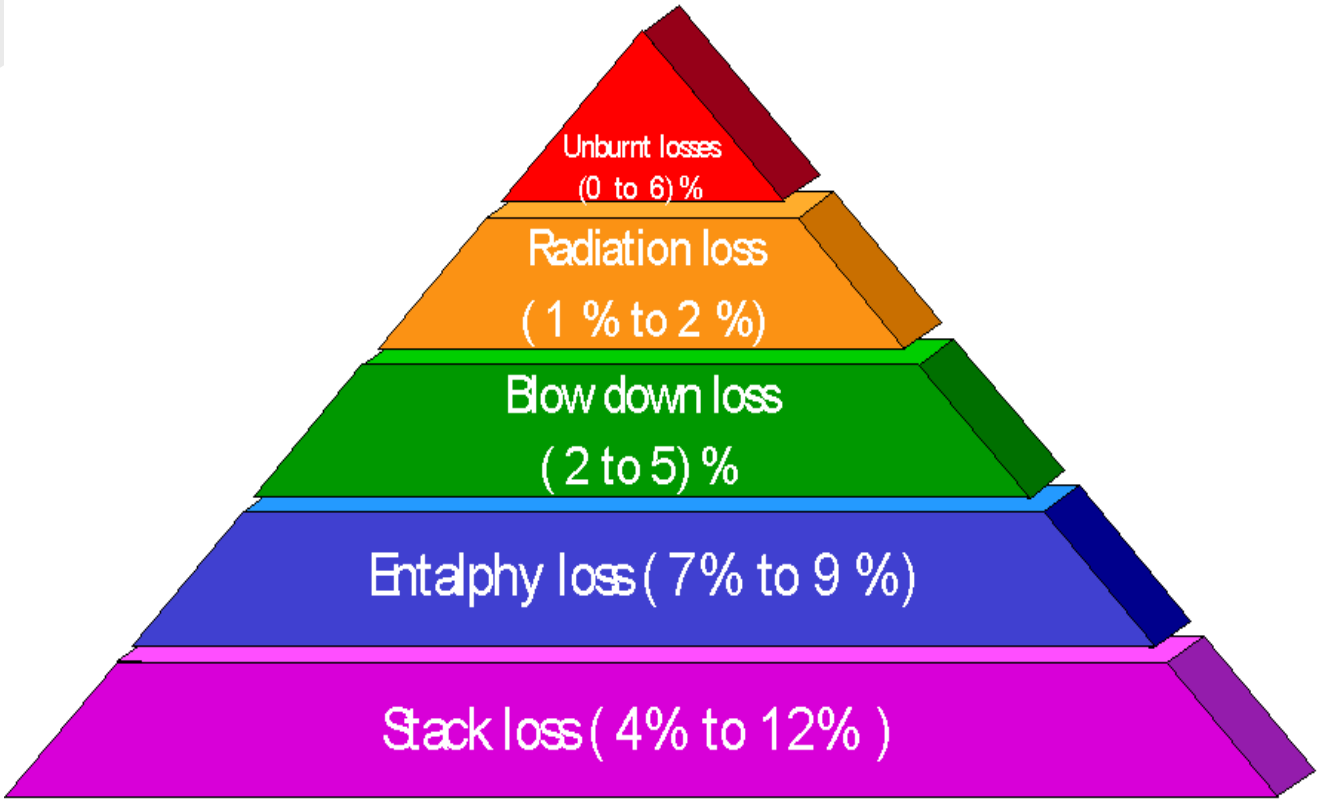
Cost of operation-Solid fuel



Cost of operation–Oil\Gas fuels



Measured Losses



Factors affecting boiler efficiency

1. Excess Air percentage.
2. Stack temperature
3. Combustion air inlet temperature
4. Feed water temperature
5. Feed water TDS
6. Blow down frequency
7. Un-burnt losses
8. Loading pattern of boiler
9. Boiler insulation
10. Burner on/off frequency
11. Fuel quality
12. Burner nozzle condition
13. Flame profile
14. Fuel temperature
15. Fuel pressure
16. Burner vibration
17. Scaling on water side
18. Scaling on smoke side of boiler
19. Corrosion effect

An increase of 2% efficiency in a 5 TPH boiler results in a saving of 53,200 liters of oil per year !

Comparison of Efficiency Methods

- **Direct Efficiency**

- **Useful Heat output / total heat input**
- **Covers all losses**
- **Simple to implement**
- **Instrument accuracy has a significant affect on final efficiency**

- **In Direct Efficiency**

- **Efficiency = 100 – Losses**
- **Considers Stack, Enthalpy, Radiation, Blowdown and unburnt losses**
- **Gives detailed break up of losses**
- **Not affected too much by instrument accuracy**

Real life scenario

- **The measured efficiency of Process boilers varies a lot**

	Min.	Avg.	Max.
Direct Efficiency	**61 %**	**72 %**	**82 %**
Indirect Efficiency	**63 %**	**78 %**	**84 %**

- **Efficiency is dynamic – It WILL keep on changing.**

What leads to variations

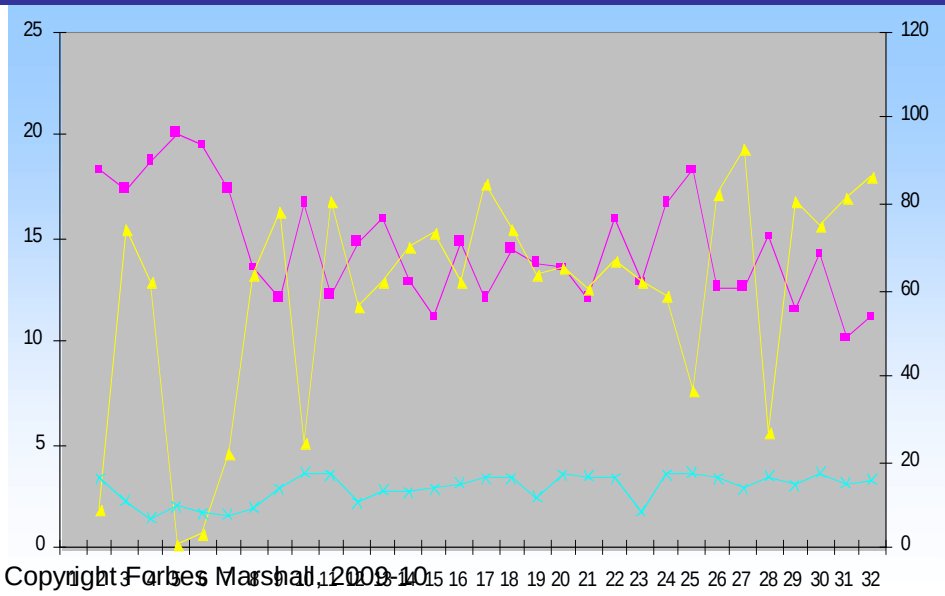
- **Air temperature**
- **Fuel temperature**
- **Fuel pressure**
- **Moisture in fuel**
- **Loading pattern**
- **Changing calorific value of fuel**
- **Use of multiple fuels**

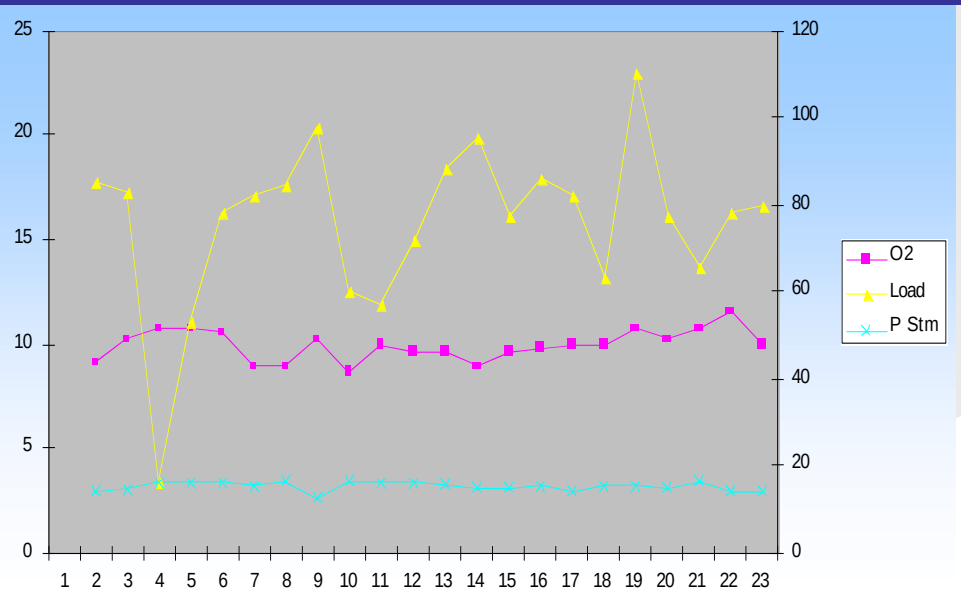
Perception and Reality

Diagnostics in the Boiler House

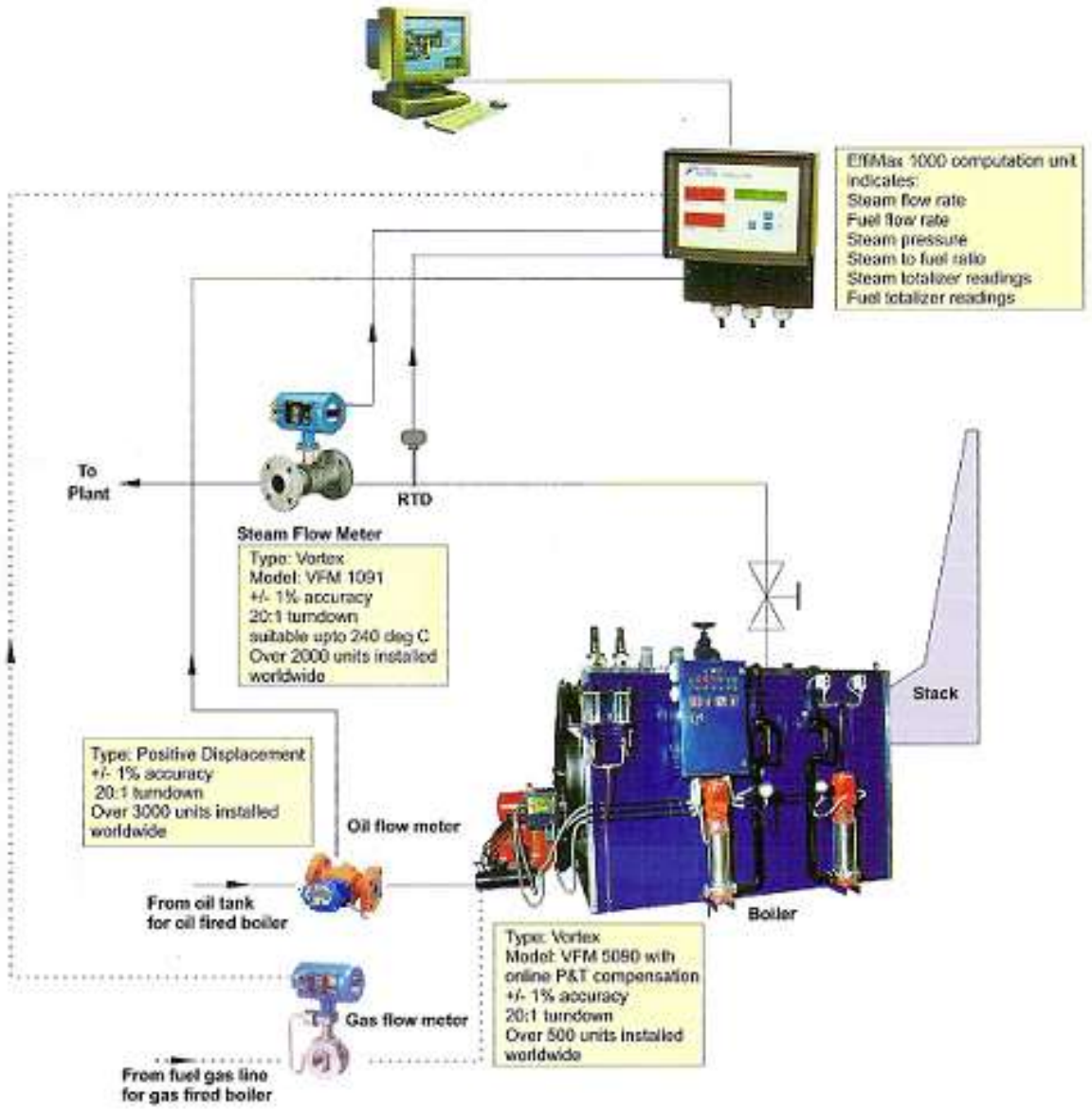
Parameter	General practice	Required
Fuel consumption	1 to 15% inaccuracy, daily--monthly	Online, Continuous, 1% accuracy
Feed water	1-15% inaccuracy	Online
Feed water tank temp	Hourly readings in log book	Online with graphical trends
Boiler Efficiency	Once in a month indirect, "direct"	Online for both with comparison

Before & After Online Efficiency Monitoring

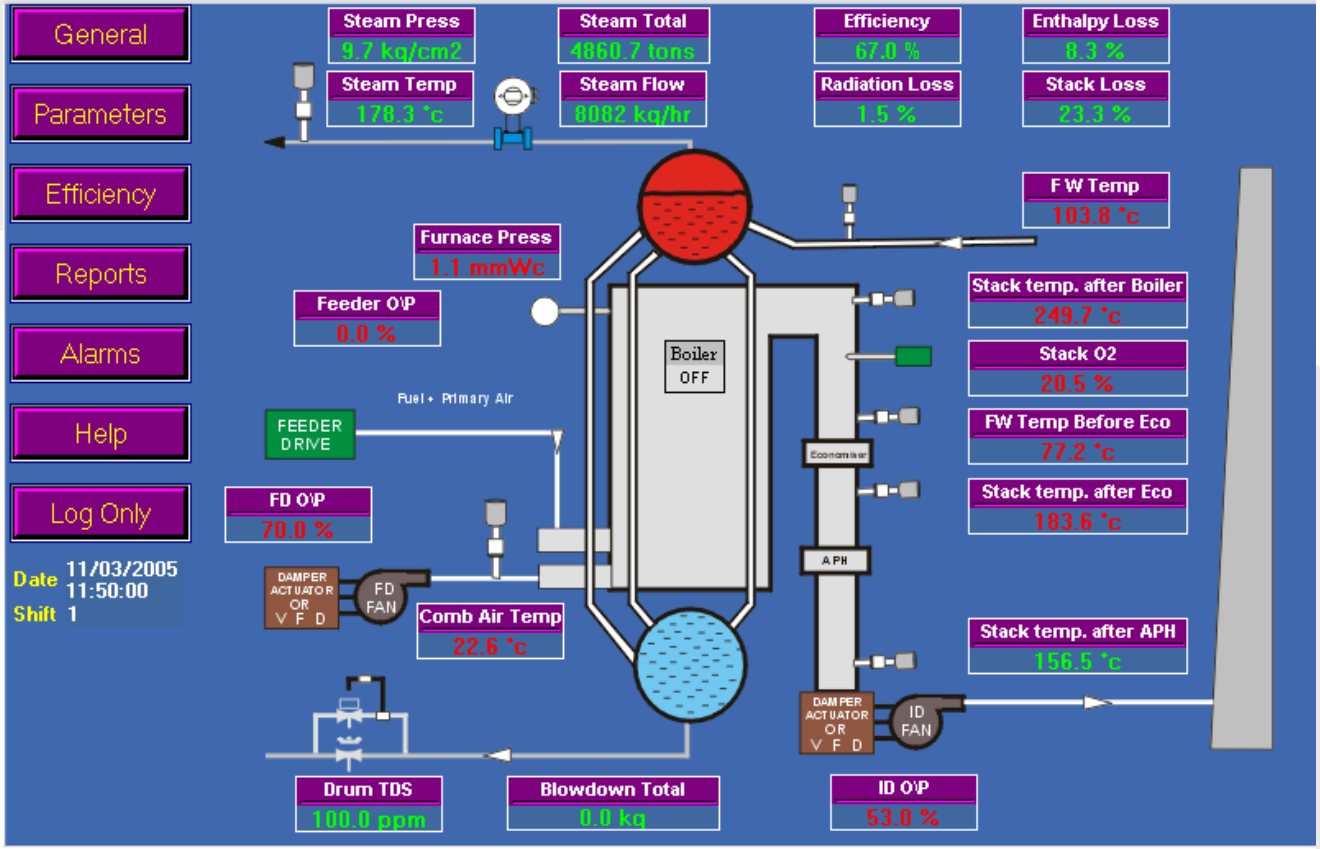


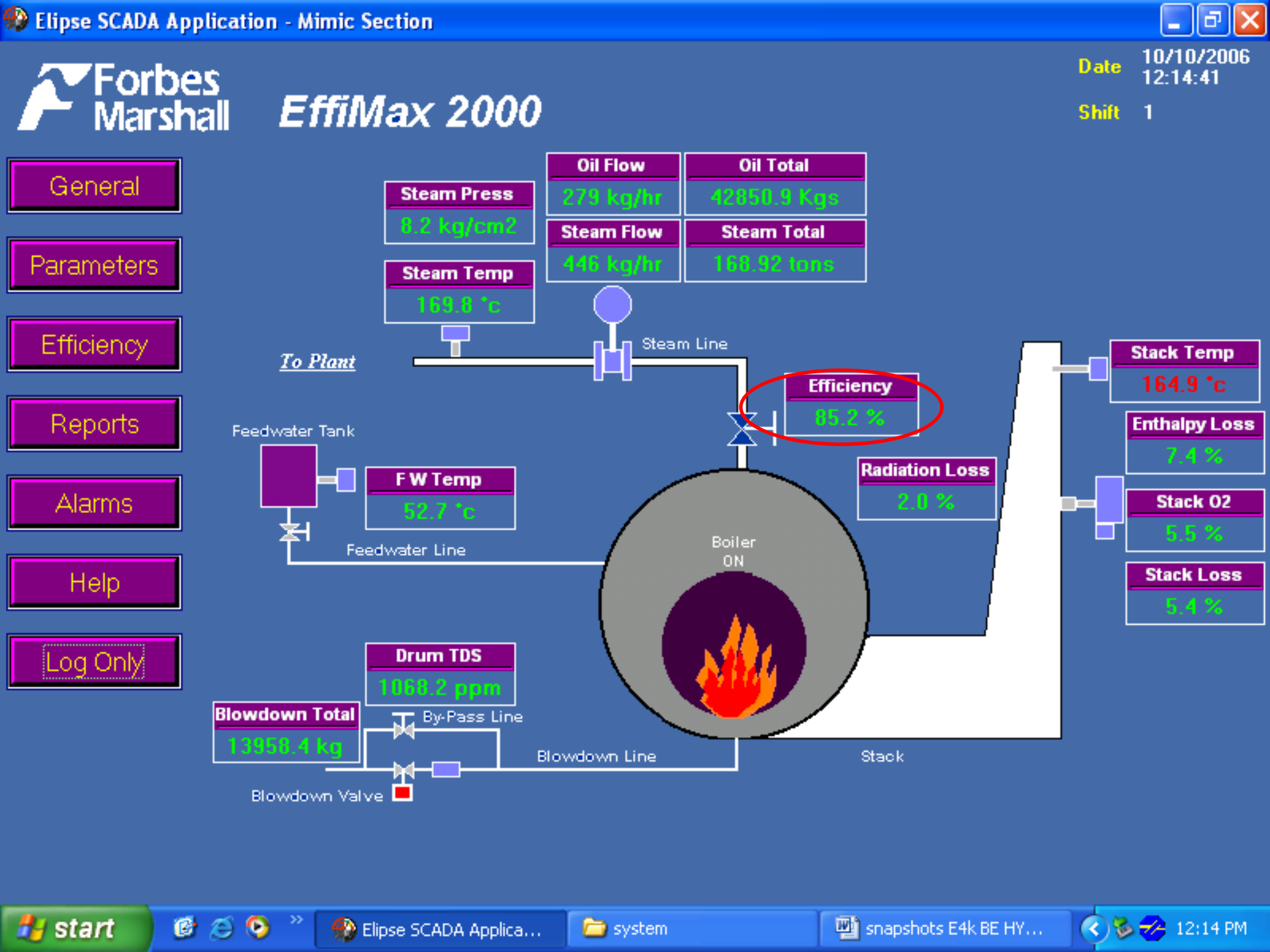


Online Efficiency Monitoring



Online Efficiency Monitoring




Elipse SCADA Application - Mimic Section
Forbes Marshall
EffiMax 2000
Date 10/10/2006 12:14:41
Shift 1
General
Parameters
Efficiency
Reports
Alarms
Help
Log Only
Steam Press 8.2 kg/cm2
Steam Temp 169.8 °c
Oil Flow 279 kg/hr
Oil Total 42850.9 Kgs
Steam Flow 446 kg/hr
Steam Total 168.92 tons
To Plant
Steam Line
Efficiency 85.2 %
Stack Temp 164.9 °c
Enthalpy Loss 7.4 %
Radiation Loss 2.0 %
Stack O2 5.5 %
Stack Loss 5.4 %
Feedwater Tank
F W Temp 52.7 °c
Feedwater Line
Boiler ON
Drum TDS 1068.2 ppm
Blowdown Total 13958.4 kg
By-Pass Line
Blowdown Line
Stack
Blowdown Valve
start
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system
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Latest Industrial Trends

Modular Boilers

Only utility connections to be provided.

Modular

- **-Feed water tank**
- **-Day Oil tank**
- **-FW tank accessories**
- **-Day oil tank accessories**
- **-Interconnecting piping**

Modular Boiler Contd

Advantages

20% more compact

15% price reduction on site jobs

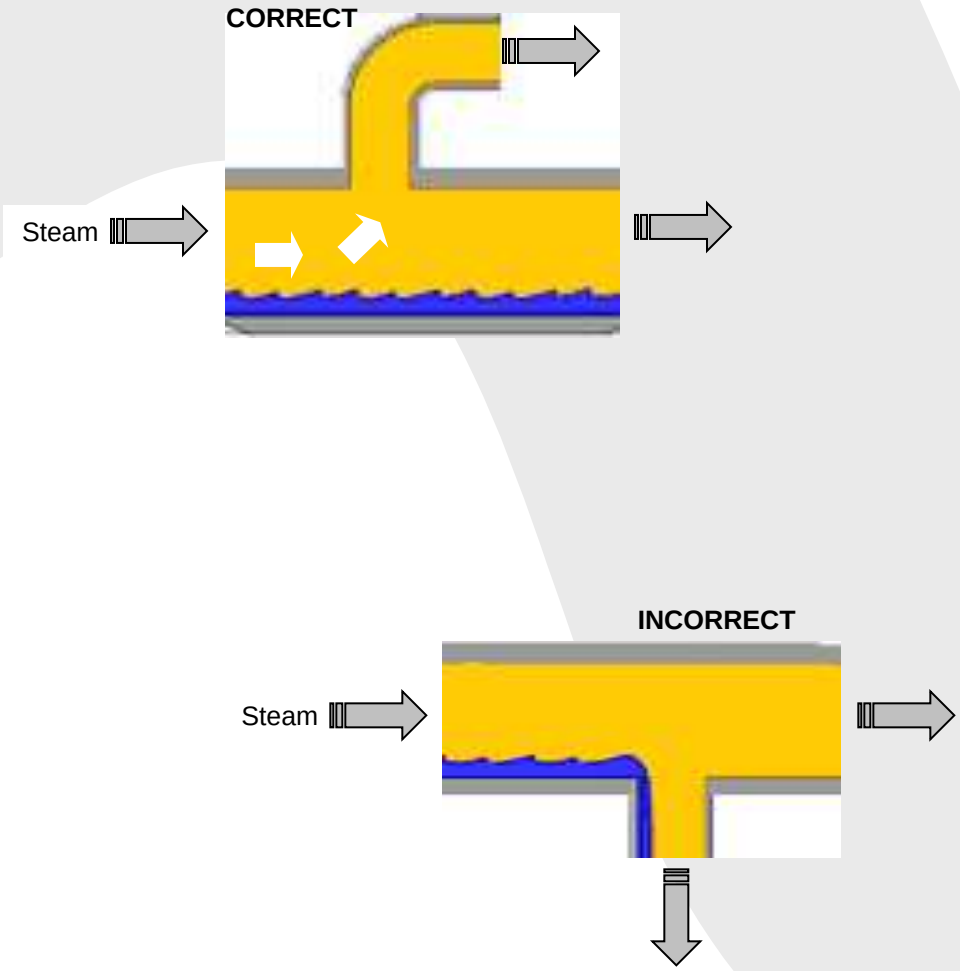
Complete control instrumentation available on unit

Erection time reduced by 80%

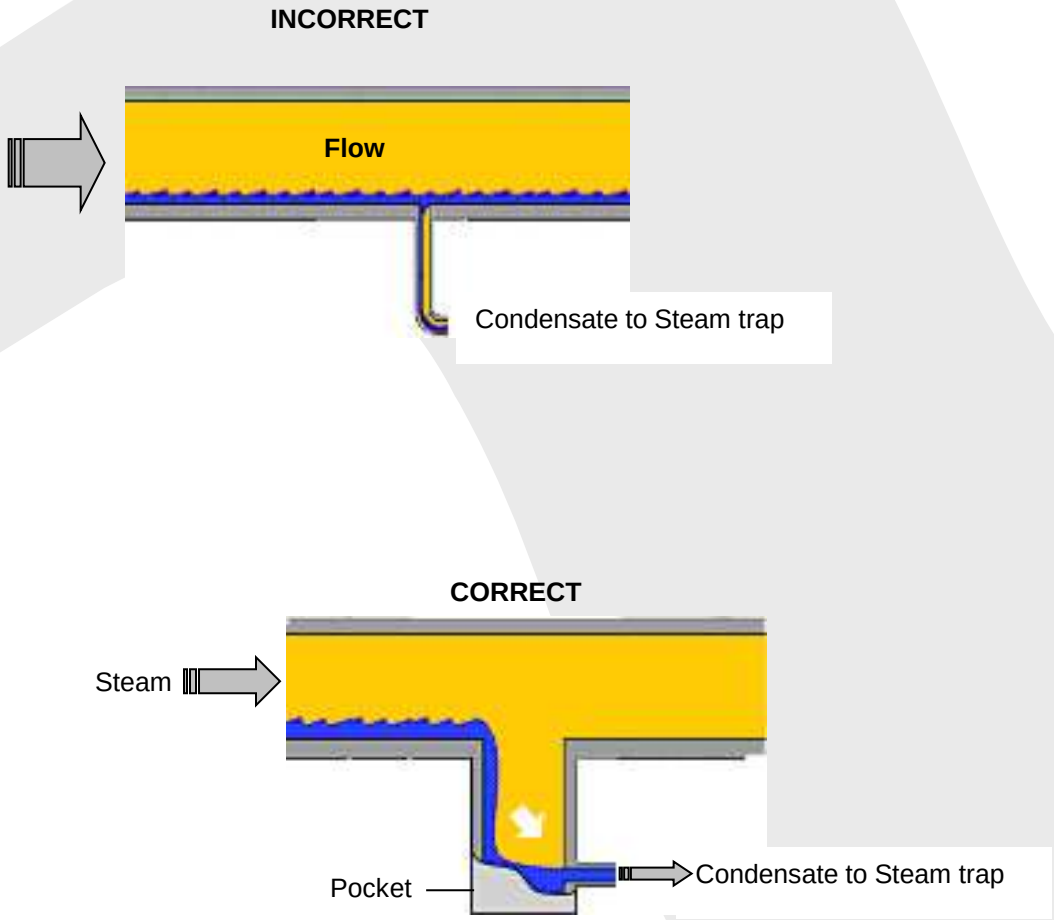
Steam Distribution

- **Pipe Sizing & Layout**
  - Check adequacy & recommend improvement
  - Identify redundant piping & optimise layout for reduced losses.
- **Insulation**
  - Check adequacy & estimate losses
  - Recommend improvements
- **Air Venting**
  - Identify locations
  - Recommend right type, size & quantity
- **Metering**
  - Identify locations
  - Recommend right type & size.
- **Trapping**
  - Trap survey & recommendations
  - Estimation of loss through leaks
  - Recommendations of trap monitoring

Steam pipe layout



Steam Mains –Condensate drain



Importance of Correct Pipe Sizing

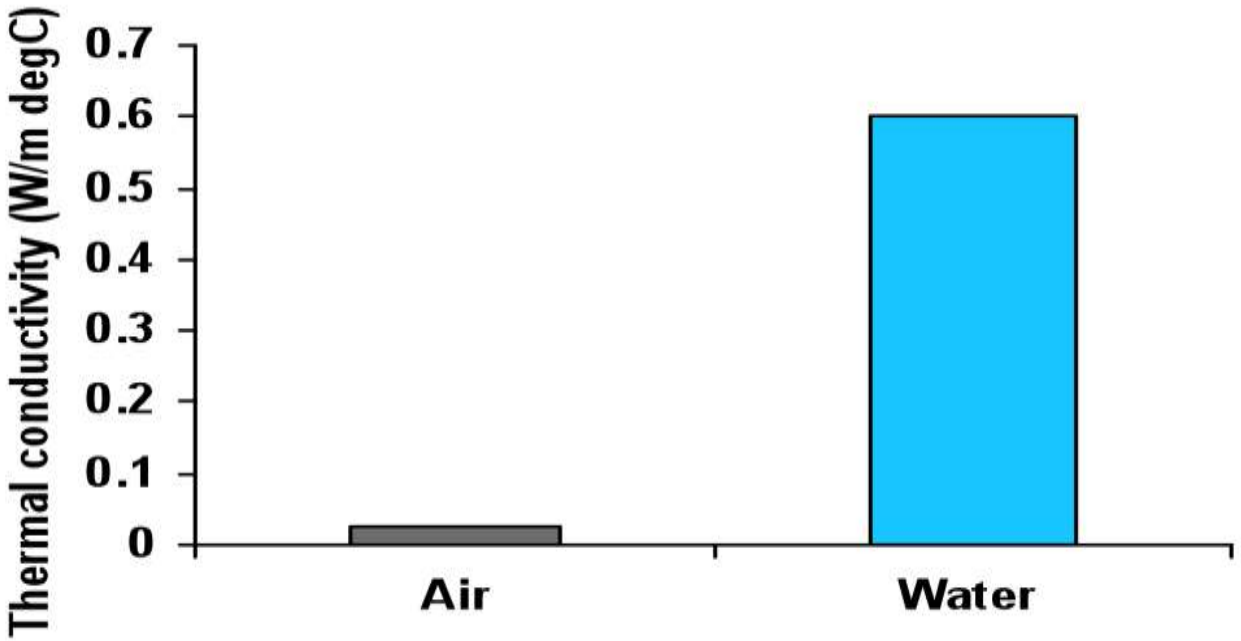
Illustration:

Parameter	Required	Actual	Impact
Line Size	80 NB	100 NB	• Material costs 20% • Heat losses 15% • Insulation Costs 25%
Line Size	100 NB	80 NB	• Velocities 60% • Pressure drop 300% • Steam Starvation - Process / Product get affected

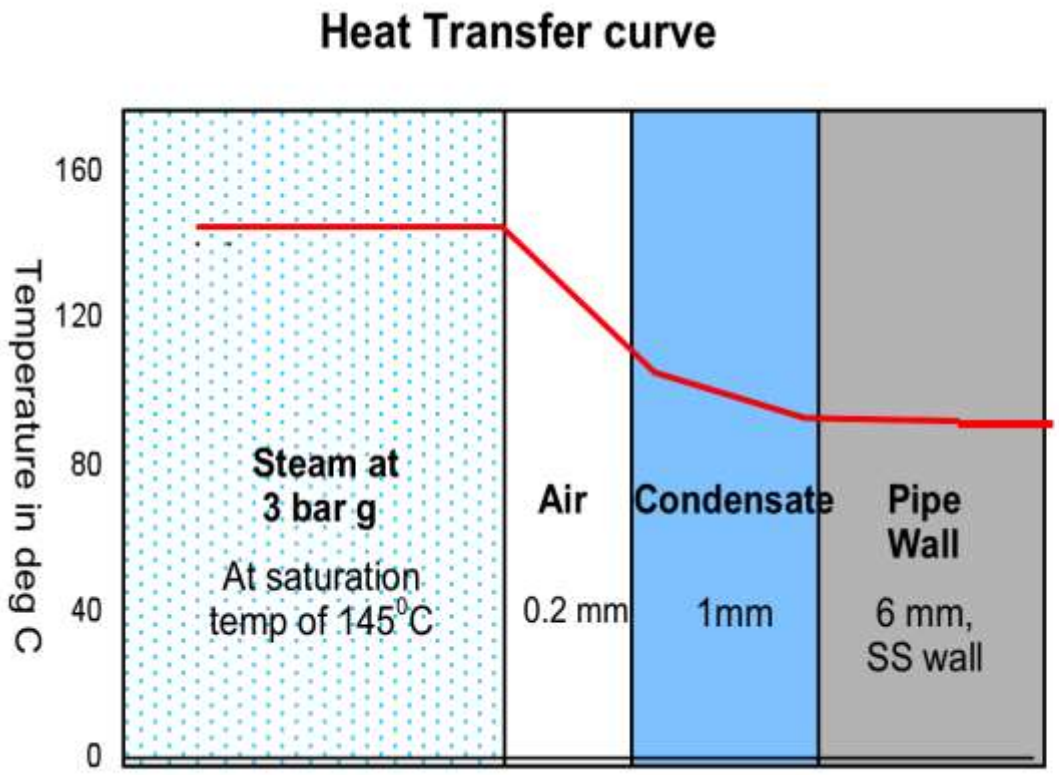
Insulation

Keeping the insulation dry reduces radiation loss and thus saves fuel. Heat loss by radiation from steam pipe to water or wet insulation can be 30 times greater than that to air due to higher thermal conductivity.

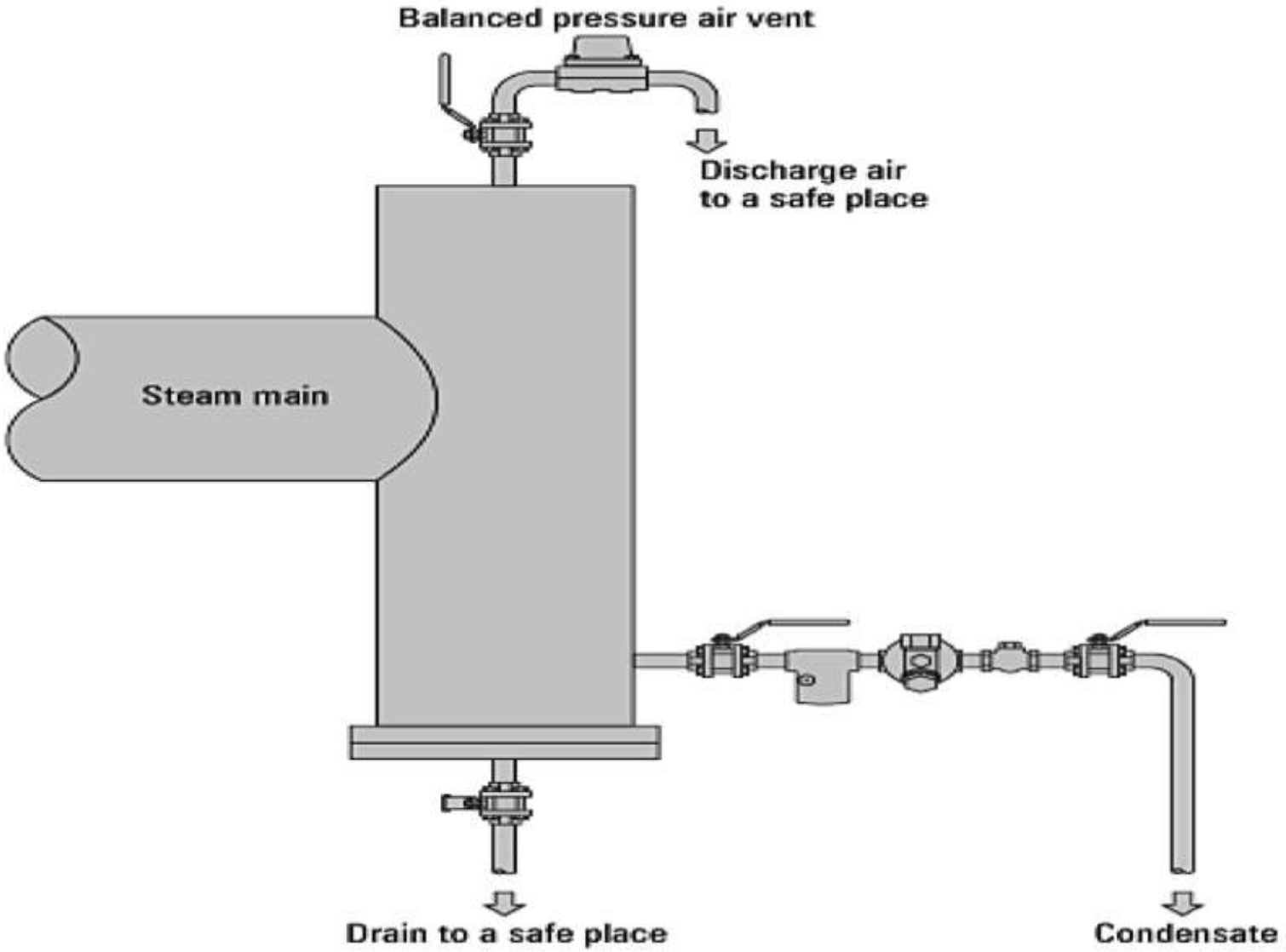
As see in the graph the thermal conductivity of water at ambient temperature is 0.6 and that of air is 0.025 W/m^{0}C.



Need for Air Venting



Air Venting….

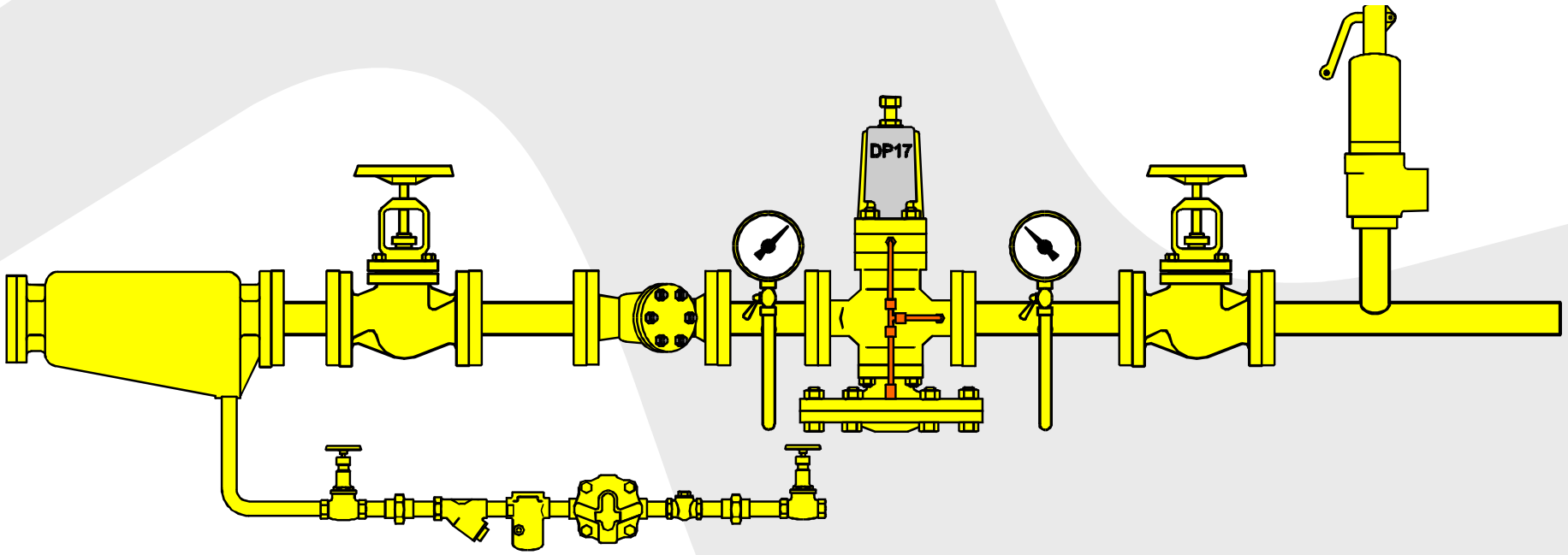


Distribute at High Pressure

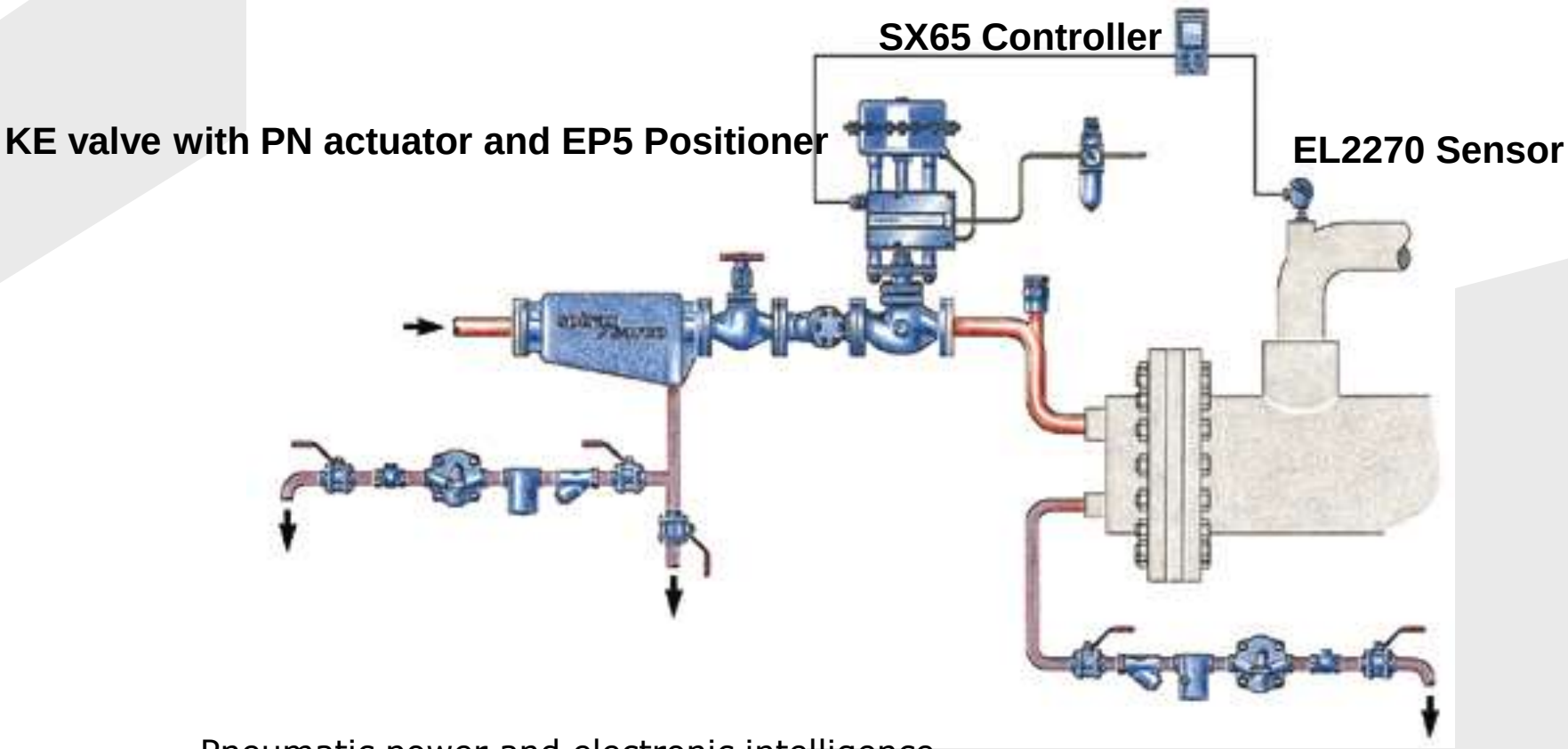
This will have the following advantages:

- **Smaller bore steam mains needed so less heat (energy) loss due to smaller surface area.**
- **Lower capital cost of steam mains, both materials such as pipes, flanges and support work and labour.**
- **Lower capital cost of insulation (lagging).**
- **Dryer steam at point of usage due to drying effect of pressure reduction taking place.**
- **Boiler can be operated at higher pressure corresponding to its optimum operating condition, thereby operating more efficiently.**
- **Thermal storage capacity of boiler increases, helping to cope more efficiently with fluctuating loads, & a reduced risk of priming & carryover**

Pressure Reducing Station



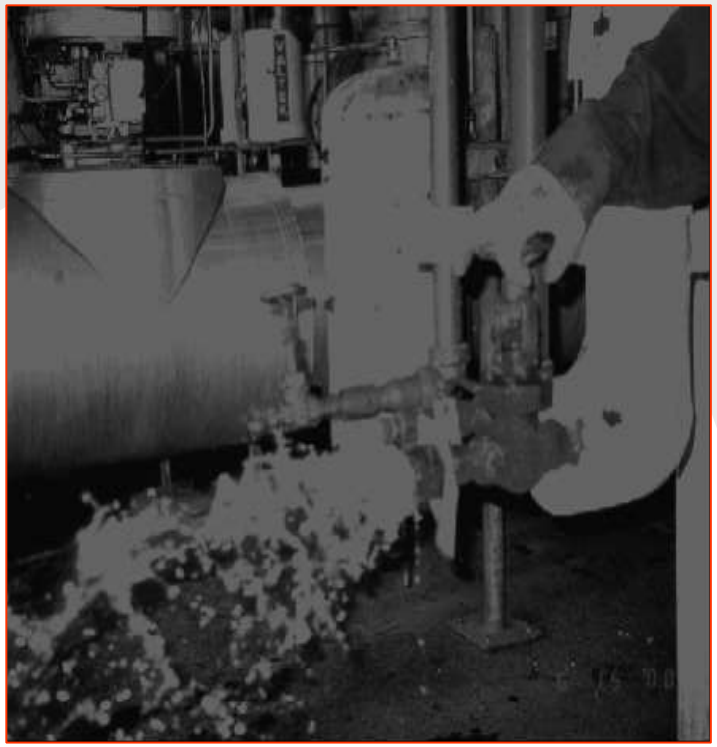
Electro-pneumatic Temp control



Pneumatic power and electronic intelligence
on a steam to liquid heat exchanger

Trapping Issues

Not Fit For Purpose



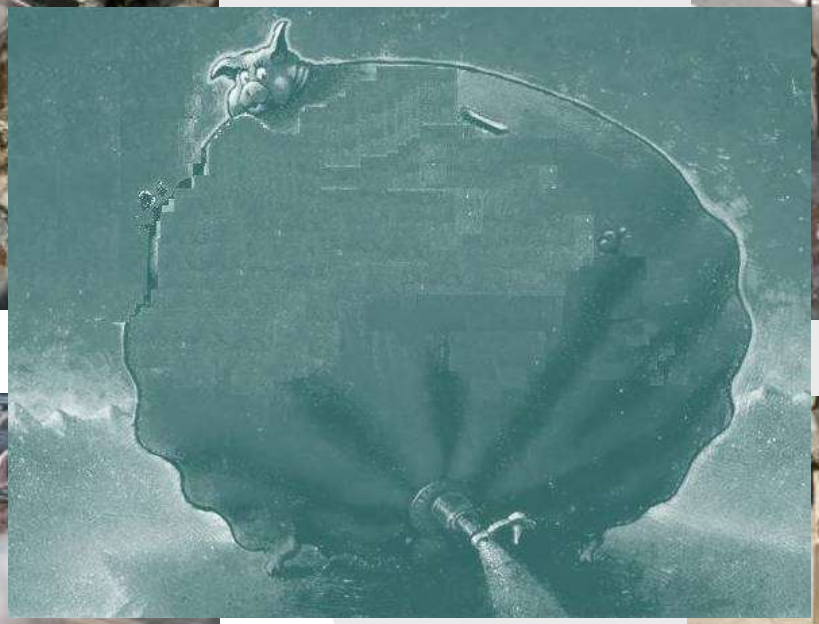
Plant Start Up

Not in service

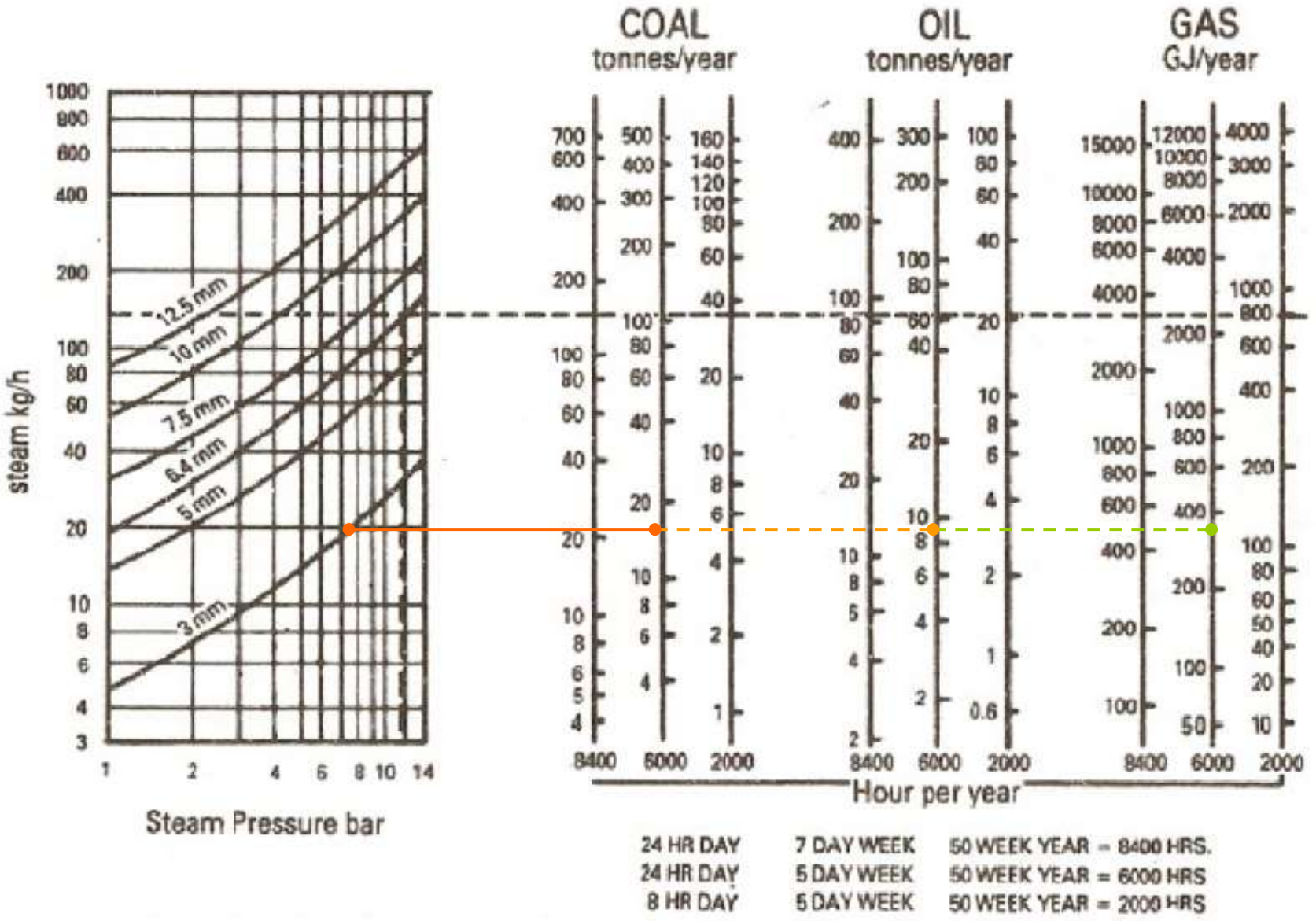
Commonly Prevailing

- **Failed Closed**
- **Failed open**
- **Not in service**
- **Not fit for purpose**
- **Installation**

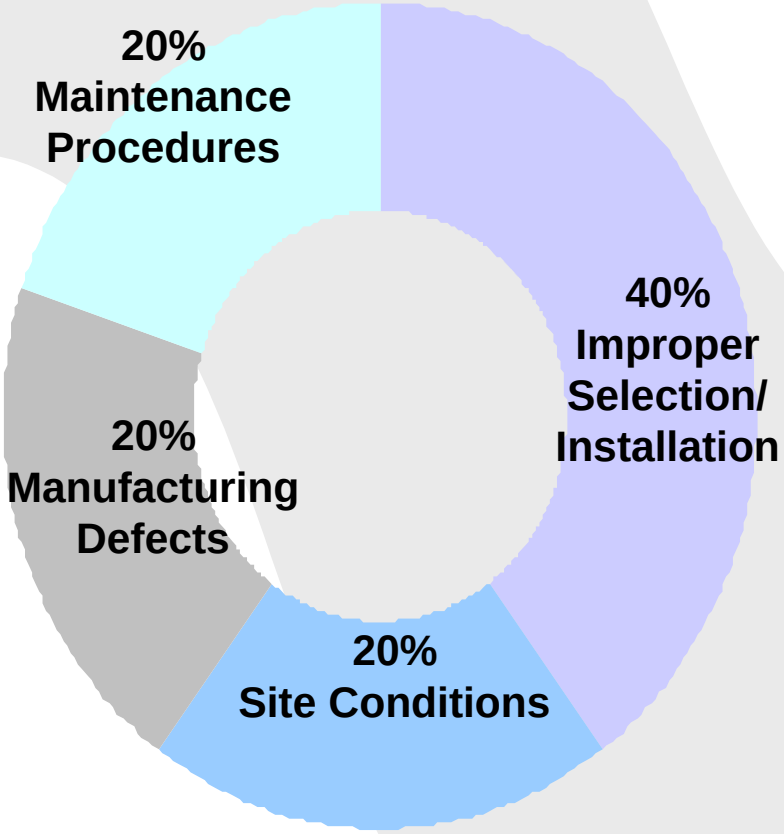
The cost of Leaks??



Cost of Steam Leaks….



Maintenance addresses only 20%!



Steam Trap Selection Criteria

Steam Application	Present type of Trap	Benchmark	Key Selection Factor
Steam Main Line Drain	**Thermodynamic (TD)**	**Thermodynamic (TD)**	**Quick condensate removal**
Steam Tracing for product line	**Thermodynamic (TD)**	**Balance Pressure Thermostatic (BPT)**	**Energy Conservation**
Copper Tracing for instrument tracing	**No Traps**	**Thermostatic (MST)**	**Energy Conservation**
Process Heating Equipments	**TD / IB / FT**	**Mechanical (Float Trap - FT)**	**Process Efficiency and time**
Pump Casing	**Thermodynamic (TD)**	**Thermodynamic (TD)**	**Quick condensate removal**

Steam trap selection….

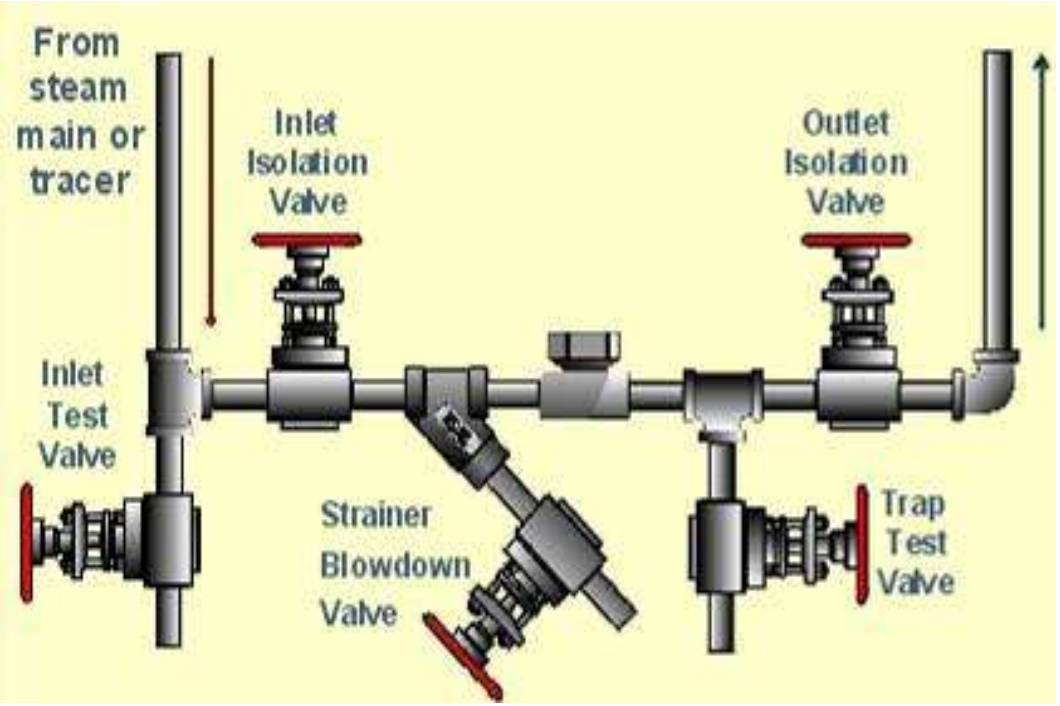
ication	Requirement from trap for the application	Suitable trap	Remarks
m Mains Drain	1. Should be Economical 2. Discharge pattern: Not of significance 3. Ability to handle low condensate loads 4. Robustness	**Thermodynamic trap**	Ensures effective condensate discharge, with compact & robust design.
ess Equipments	1. Discharge pattern: Continuous 2. Ability to handle high condensate loads	**Ball float trap**	Continuous discharge of condensate at steam temperature ensures rapid warm up in process & saves energy.
eting and Tracing	1. Should be economical 2. Discharge pattern: Not of significance 3. Sub cooling advantageous	**Balanced pressure traps**	Sub cools condensate before discharge, giving additional heat to application thus saving energy.
critical heating ications with existing of water hammer. anks with bottom coil ers with top entry & exit eam and condensate ectively.	1. Robustness	**Inverted bucket trap**	Effective, but inefficient from energy perspective and has problems with air venting.

Compact Steam Trapping Station

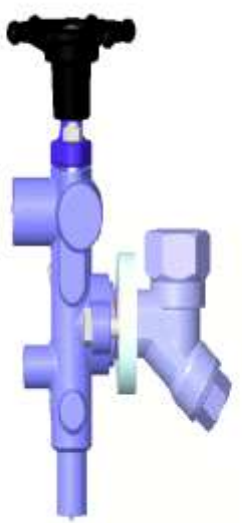
Assembly Parts & Labor

5 ea. 600# rated globe or gate valves
8 ea. Sch 80 nipples
2 ealine "tee"
1 ea. elbow
1 ea. Line strainer
16 ea 1/2'' welds
1 ea. Steam trap

720mm



160 mm



245mm

Estimated weight : **13 kg** **4.0 kg**

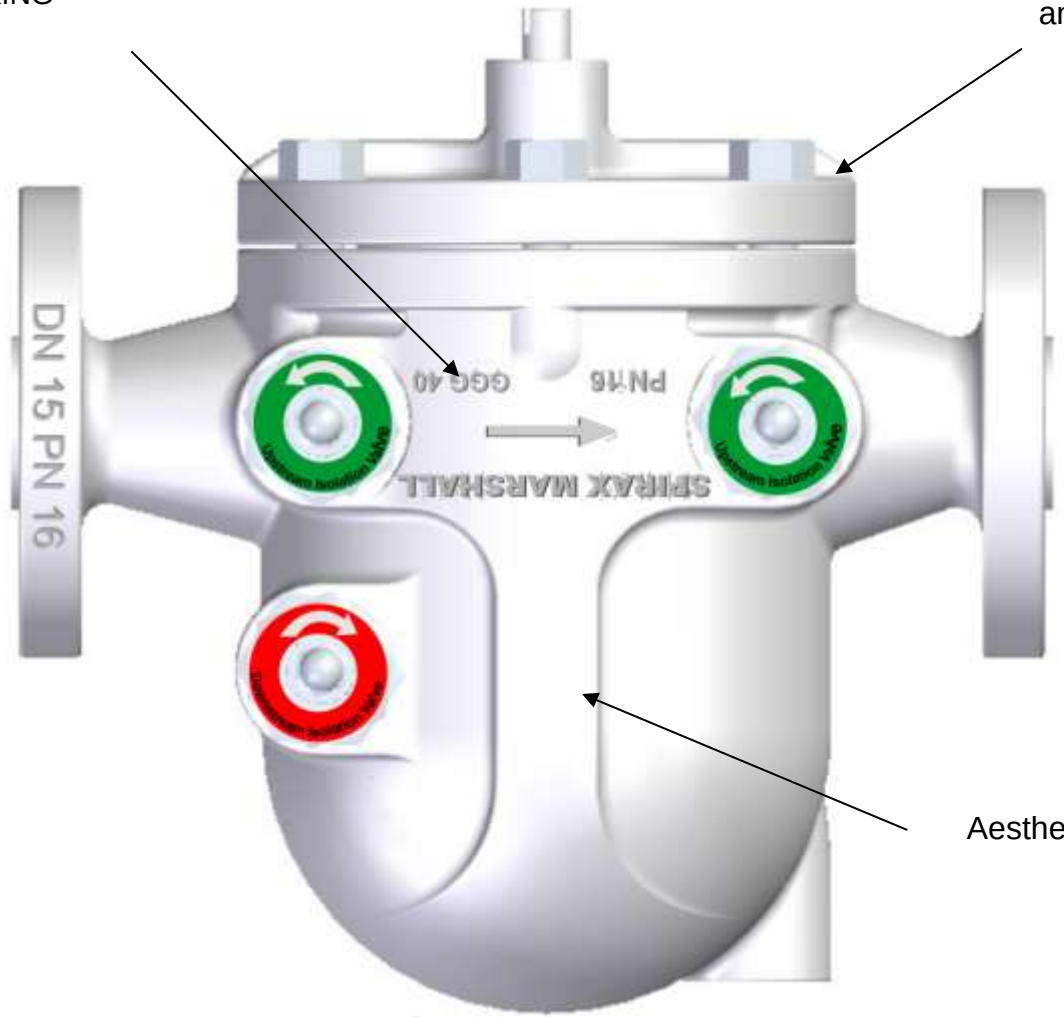
CONVENTIONAL

Modern Process Trap Assembly

TOFT

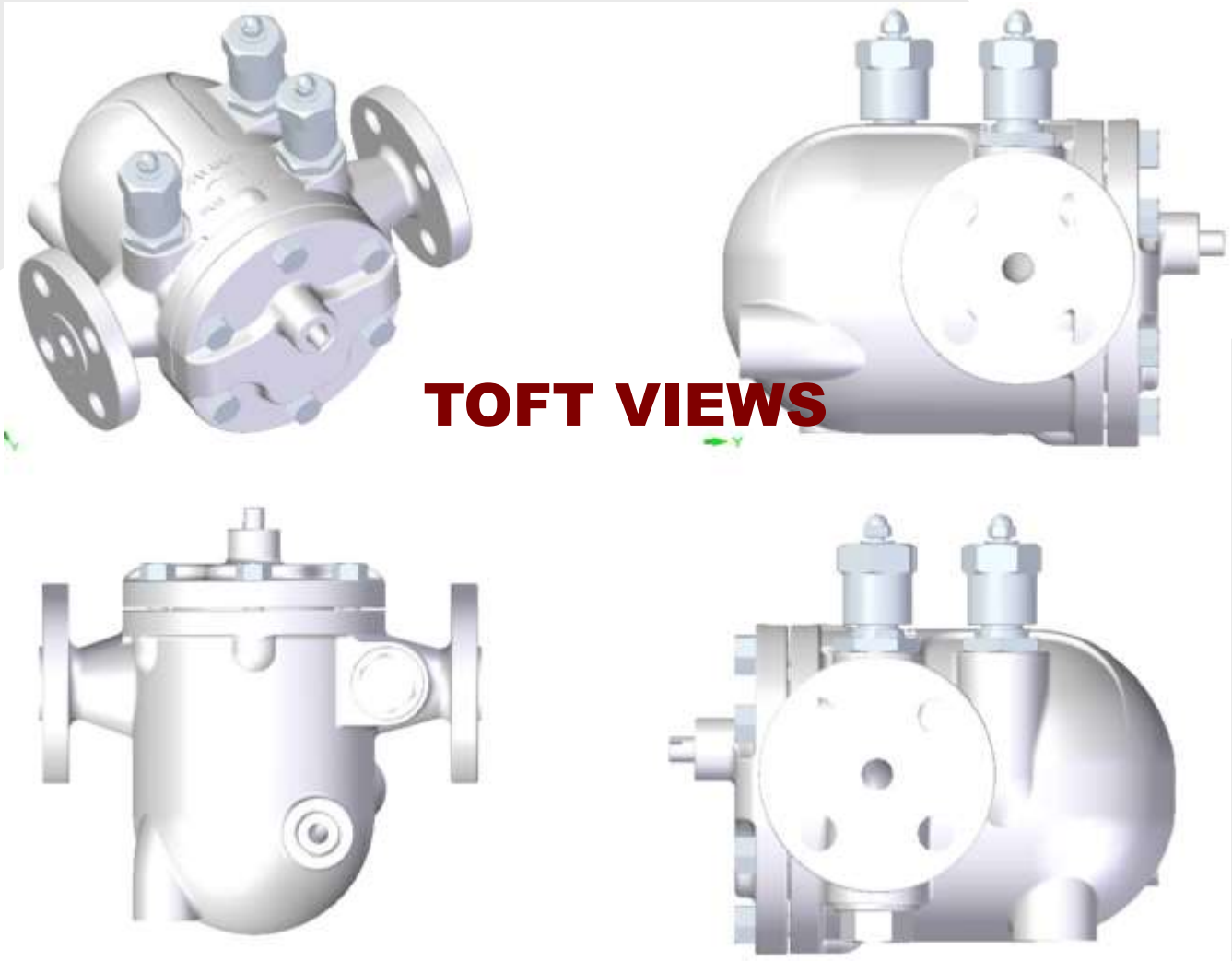
PRODUCT MARKING

Integrated design for base and Cover

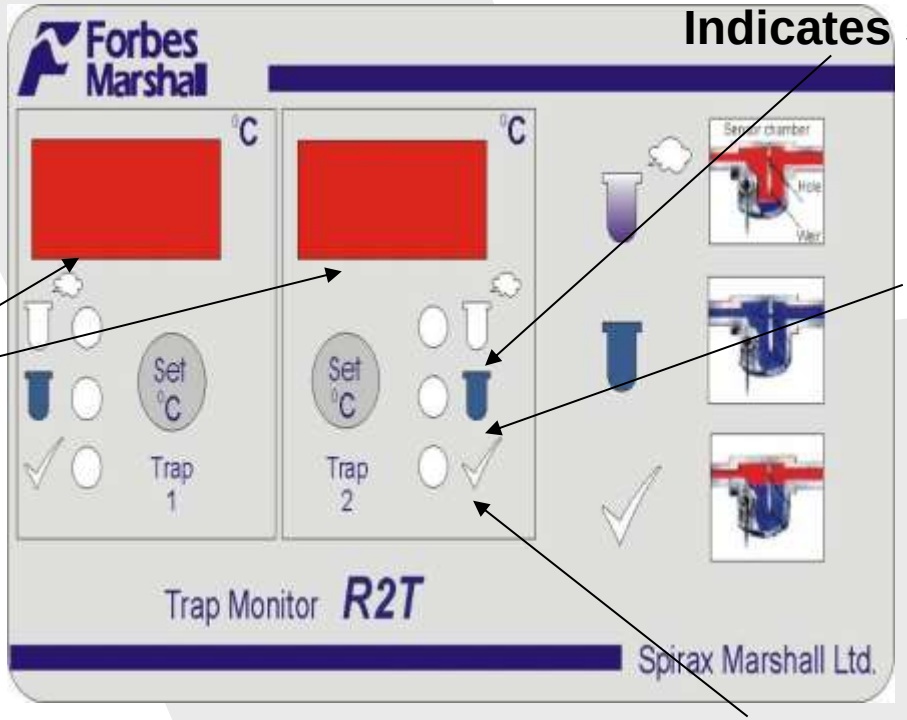


Aesthetic Features

n Float Trap Assembly



Steam Trap Monitoring System



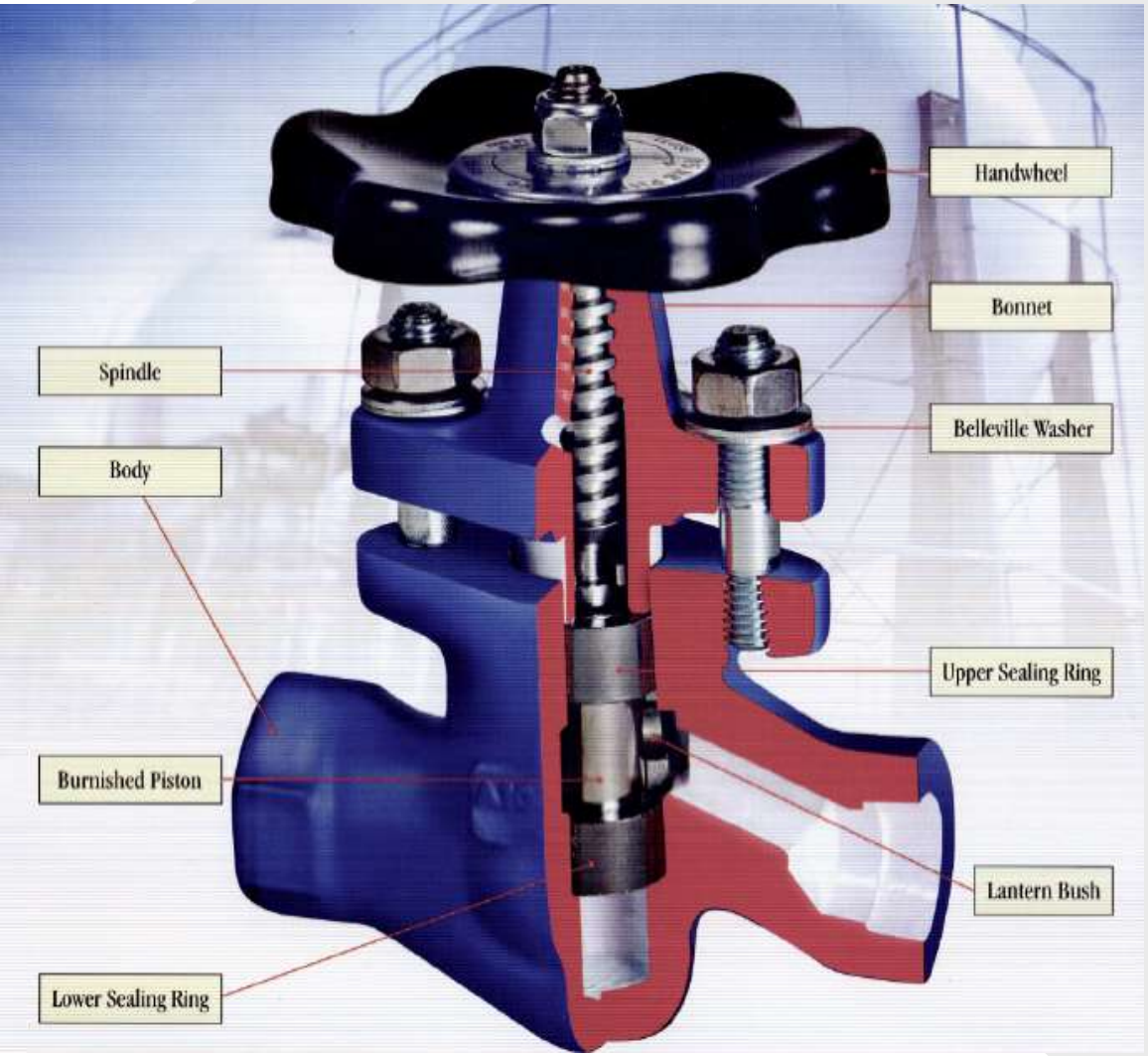
Indicates steam leak

Indicates water logging

Display of actual Condensate temperature

Trap working correctly

Glandless Piston Valves



FEATURES

- CLASS VI, BUBBLE TIGHT SHUT-OFF

  Ensures Positive Isolation

- SS REINFORCED GRAPHITE SEALING RINGS

  Asbestos free Sealing rings,

- FORGED CS BODY FOR SIZES UPTO 1 ½”

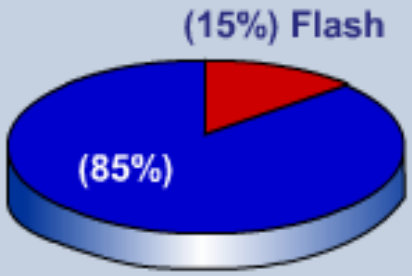
Max. Pressure : 78 Kg/cm2
Max. Temperature : 427 ° C

Condensate Recovery

Condensate contains 25% of Total Energy Supplied – Using this can make a difference

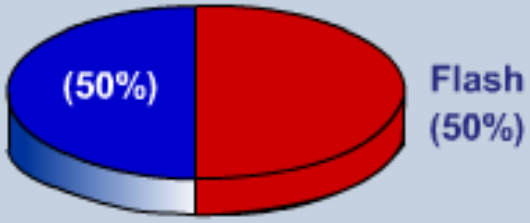
To Drain!

Approximate Amount of Flash Steam in Condensate



kg / kg of Steam

Approximate Amount of Energy in Flash Steam



KCal in flash steam/Total KCal in condensate & flash

Why Return Condensate?

- **Monetary Value**
- **Water Charges**
- **Effluent Restrictions**
- **No Boiler Derating**
- **Reduced water treatment costs**

Every 6 deg increase in feed water temp from return of hot condensate & recovery of flash steam cuts your fuel bill by 1 %

As per our audit findings Average CR factor in industry is 50-60%(energy recovered still less) & very few recover Flash steam

Monetary values for Condensate

Returning 1 ton/hr of condensate saves	- Rs.2, 30,000 in one's water treatment cost.
	- or Rs.4,70,000 in DM water costs
	- 600 water tankers annually!
	- 101 ton of coal or 35 KL of furnace oil per year!

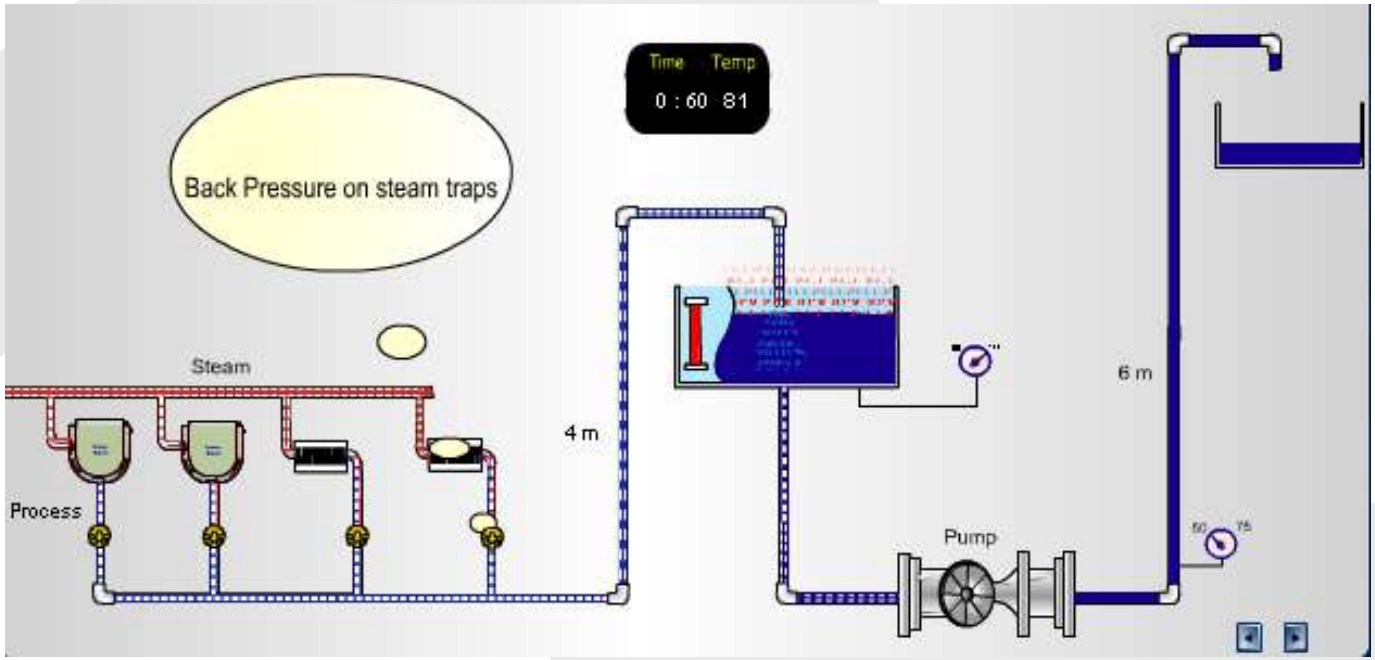
Higher FW Temp. leads to fuel savings

Consider 1kg of feed water to be converted to steam at 5 barg.

		Case 1	Case 2
A	Feedwater temp	40°C	46°C
B	Amount of energy in feed water	40Kcal	46Kcal
C	Steam at 5 barg contains	657.9 kcal	
D	GCV of fuel (Furnace Oil)	10200kcal/kg	
E	Amount of fuel required to produce steam (C - B) / D	0.060kg	0.059Kg

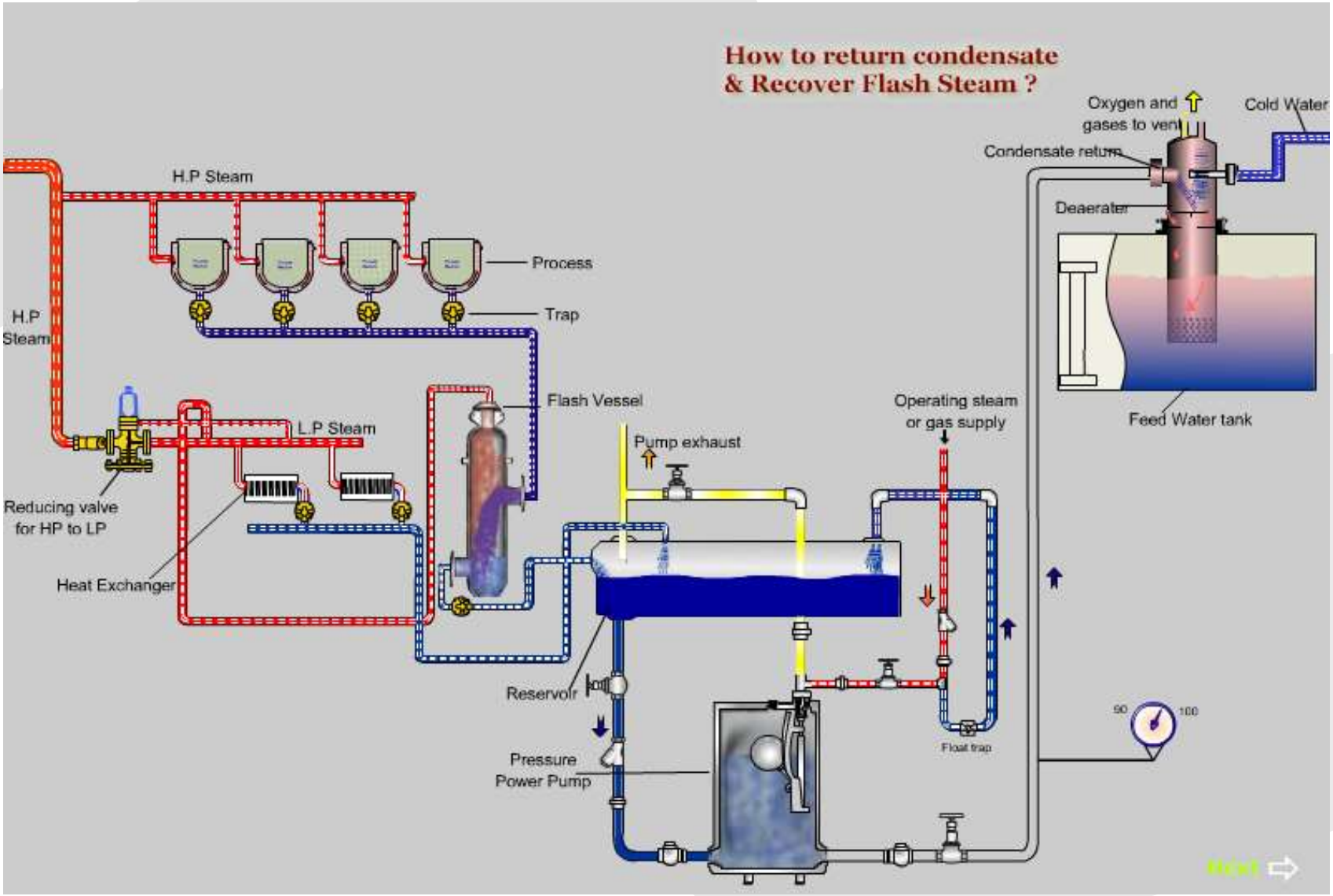
As seen, the fuel required has reduced by 1.6% over the previous requirement.

Conventional Method - CR



- **Back Pressure on Steam Traps**
- **Flash Steam vented**
- **Drop in Condensate Temp**
- **Electrical cost of pumping – besides pump problems**
- **Too many components to maintain**

Effective CR



FW Tank size matters….

Return condensate as soon as it is formed. Holding condensate in collection tanks reduces the condensate temperature via radiation losses.

Illustration:

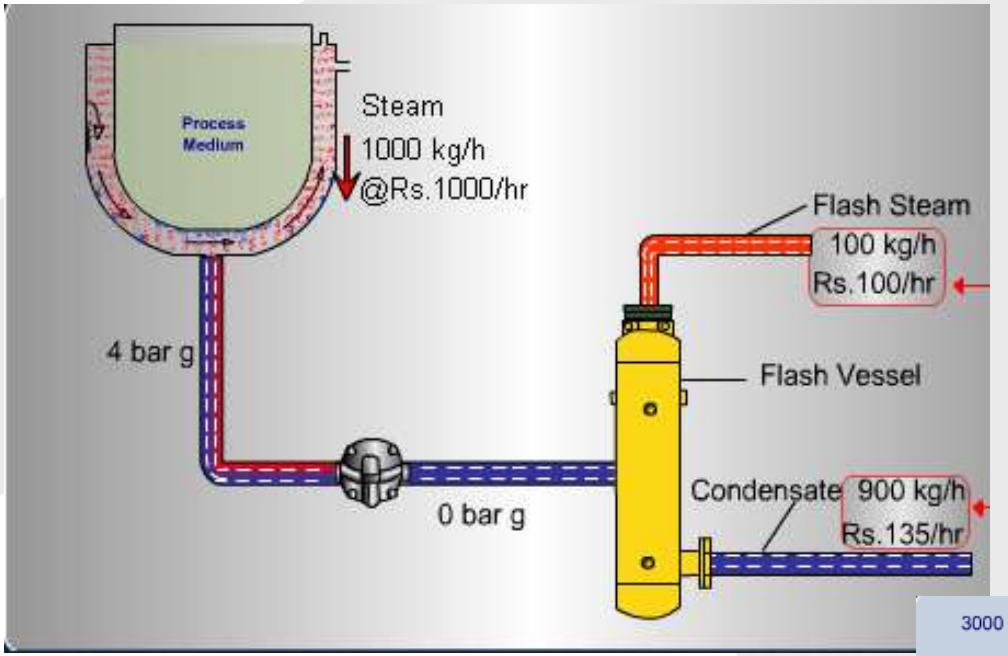
Consider 4KL of condensate at 90 deg C held up in a tank. Now even a 10 deg. C drop here means a loss of 32KL of FO or 91tons of coal annually!

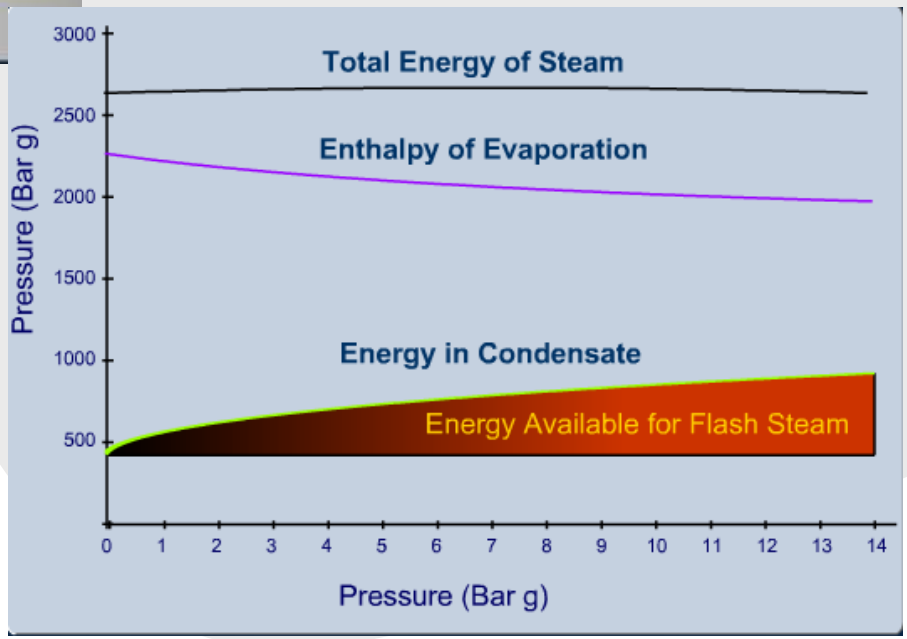
As a rule of thumb, feedwater tank should be sized to be 1.5 times the peak steam demand.

Illustration:

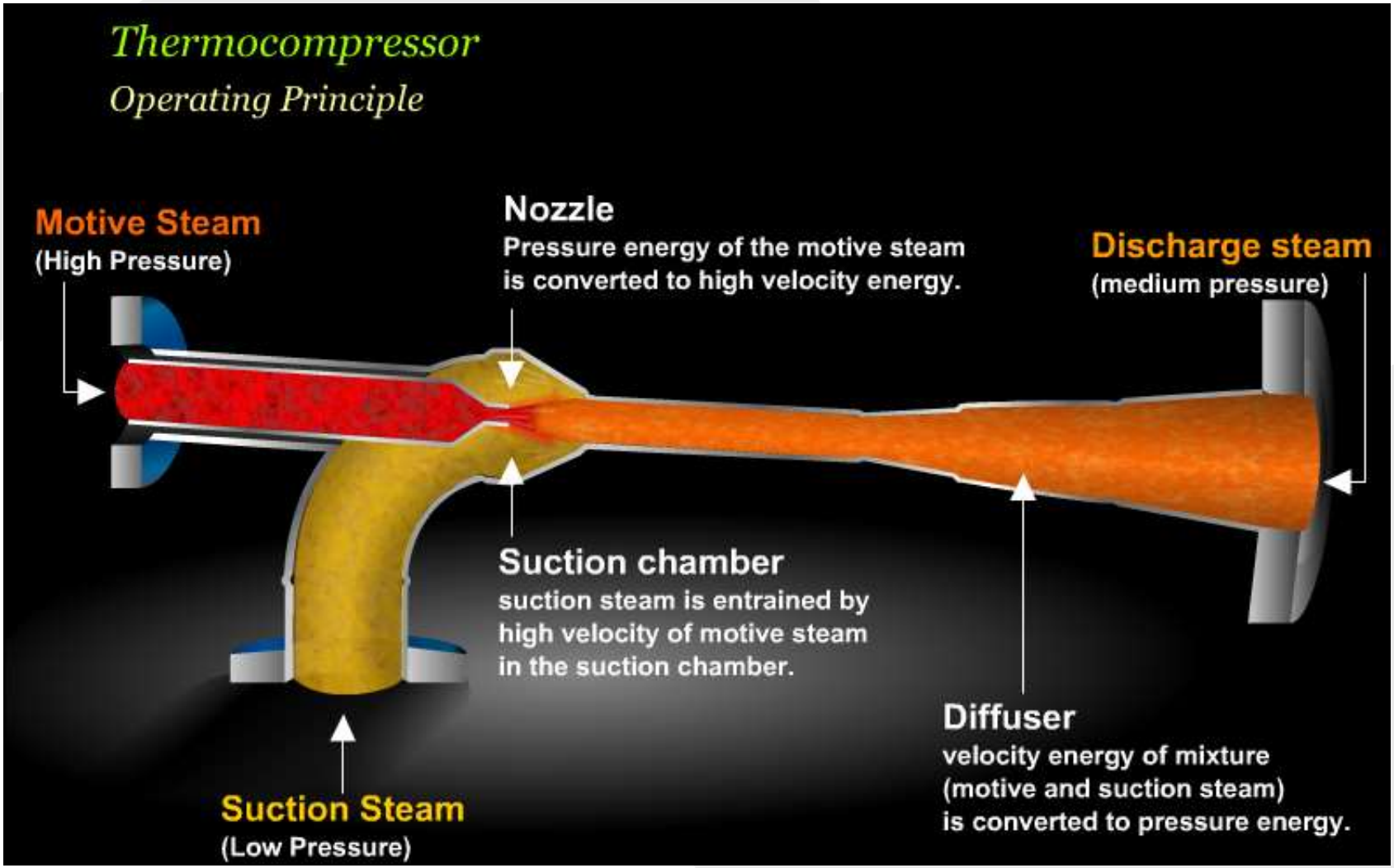
Peak Steam Demand	3 Tons Per Hour	
Condensate Returned at 90degC	2 Ton Per Hour	
	Case 1	**Case 2**
Feedwater tank size	10 KL	6 KL
Water at ambient (30degC)	10-2 = 8KL	6-2 = 4KL
So, Final feedwater temperature	**42degC**	**50degC**

Heat Content-Steam & Condensate

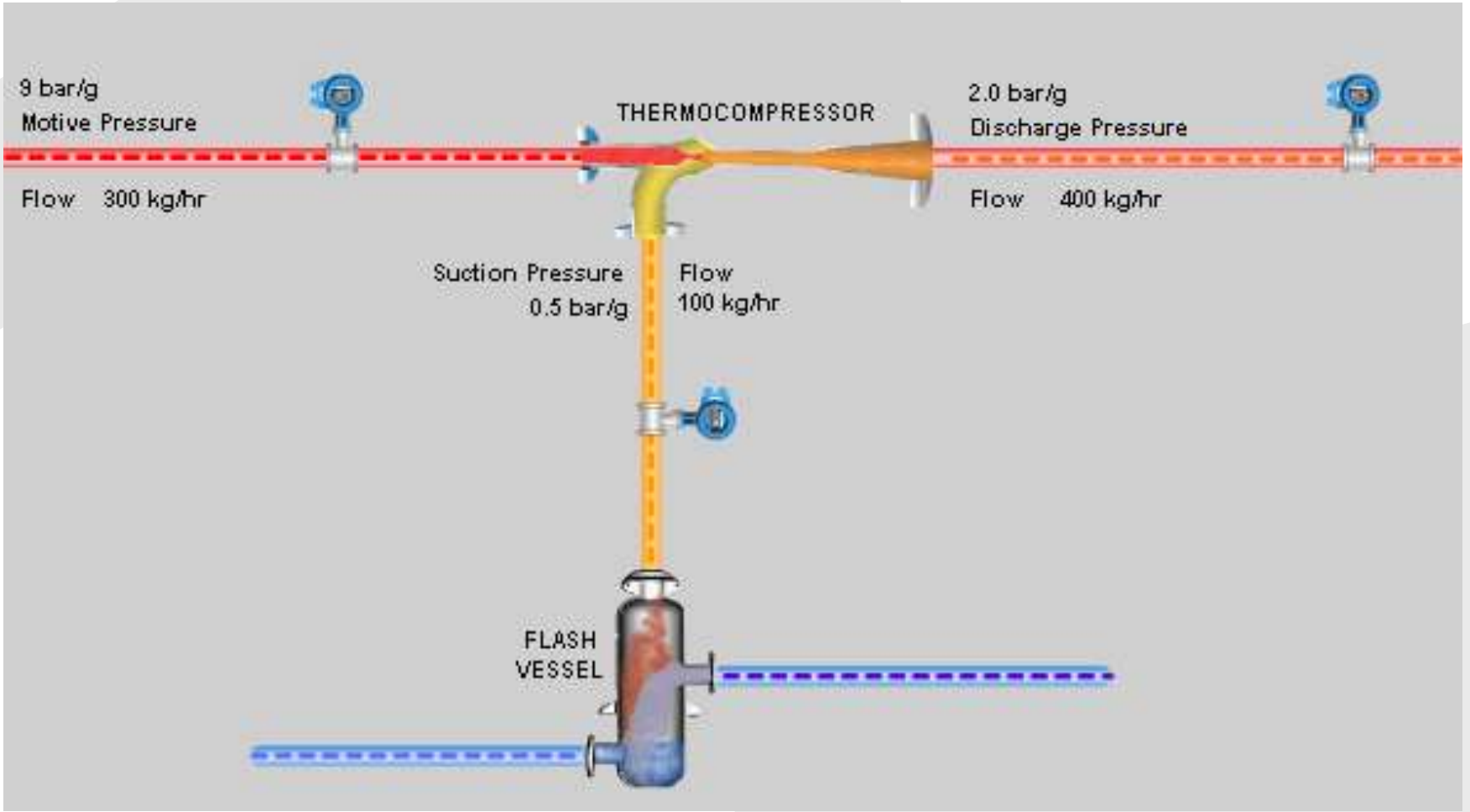




Thermocompressor

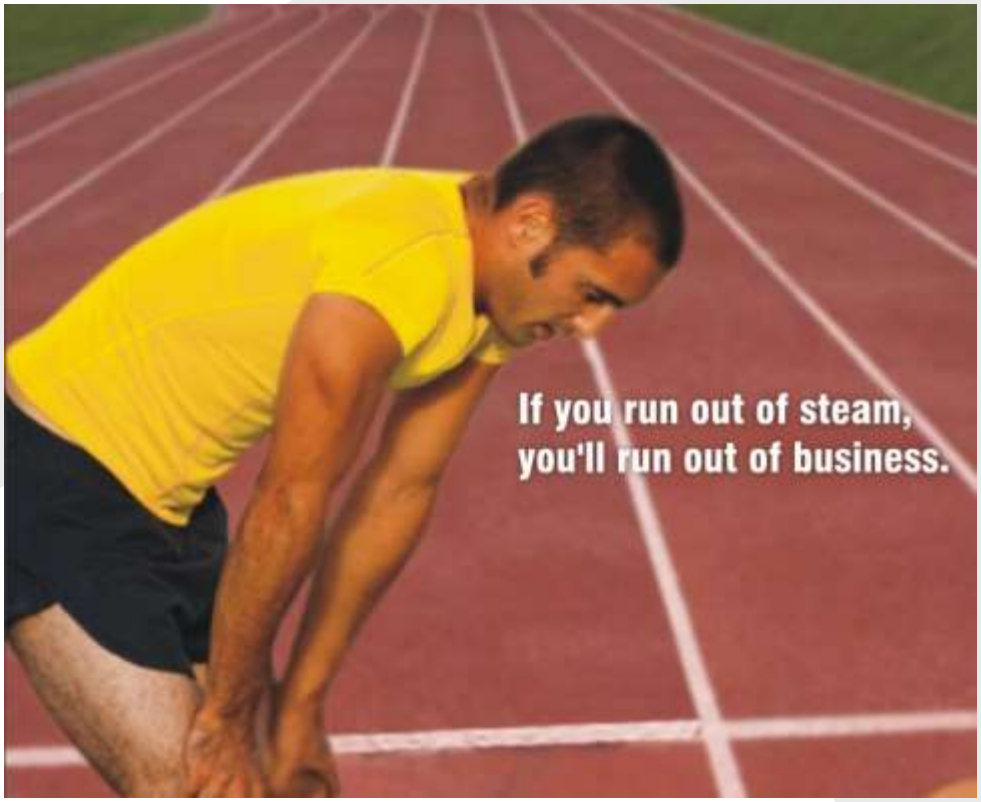


Thermocompressor



Benefits of optimum SSE

- **Reduced Specific Energy Conservation.**
- **Increased process output.**
- **Improved product quality.**
- **Reduced down time.**
- **Improved monitoring and control process.**
- **Direct monetary savings.**



Fuel prices would continue to spiral upwards……. & so would your losses!

Find out where you stand.

Act fast and grow your Profits!!!

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