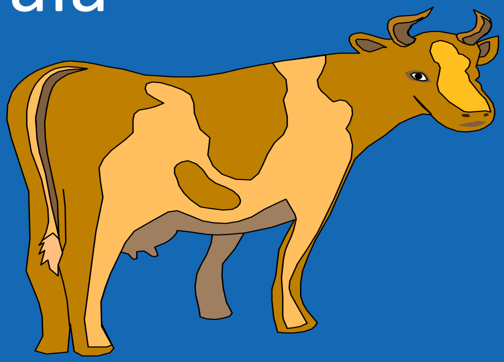
Forbes Marshall

Trusted Partners.
Innovative Solutions.

# Making Inroads in Energy Conservation

## The Dairy Industry - Kerala



Energy Conservation | Environment | Process Efficiency

# The Market

Forbes Marshall

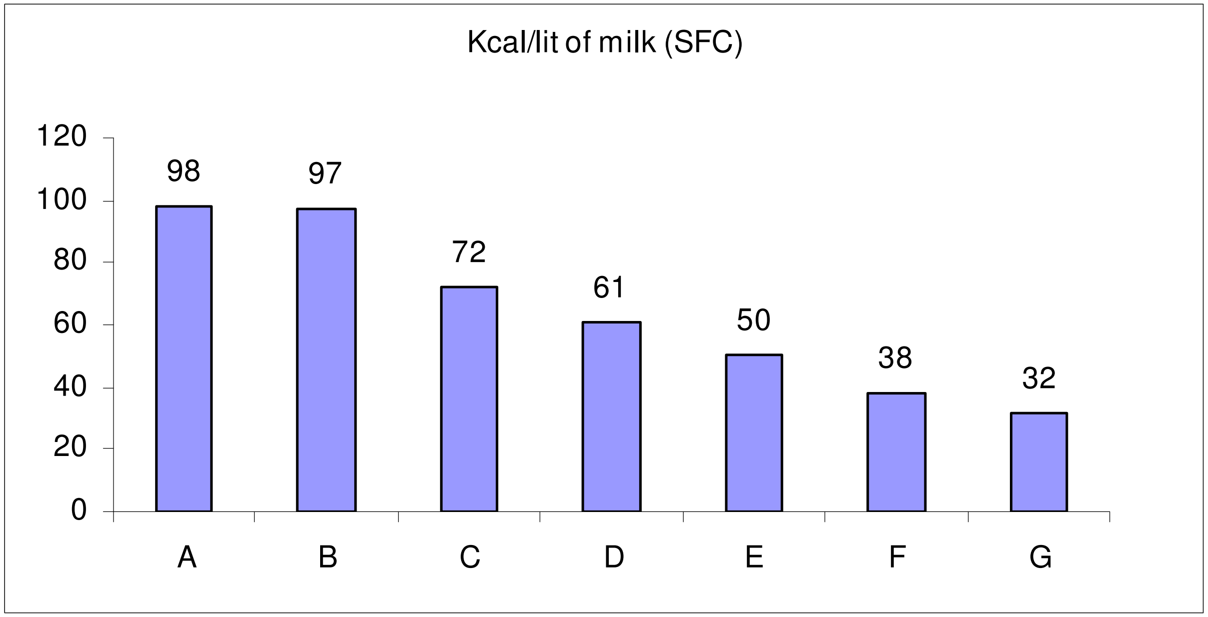
Trusted Partners.
Innovative Solutions.

- Competitiveness made adverse by –
  - **Raw material intensive** – for dairy it is as high as 78% of total cost (raw milk)
    - Not entirely in your control
  - **Rising Energy Costs**
    - In the last 3 yrs with the drastic increase in fuel costs your fuel bill will have soared for the same consumption.
    - In the last year alone fuel prices have almost doubled
  - **Quality an important element**
    - An audit can help sort out issues like steam starvation, improper temperature / pressure for your process
  - **Capacity utilization & Productivity**
    - An audit can help you optimize your system to improve both
  - **Environmental norms**
    - Better efficiency, reduced consumption, reduced emissions

# Specific Fuel Consumption

Forbes Marshall
Trusted Partners. Innovative Solutions.

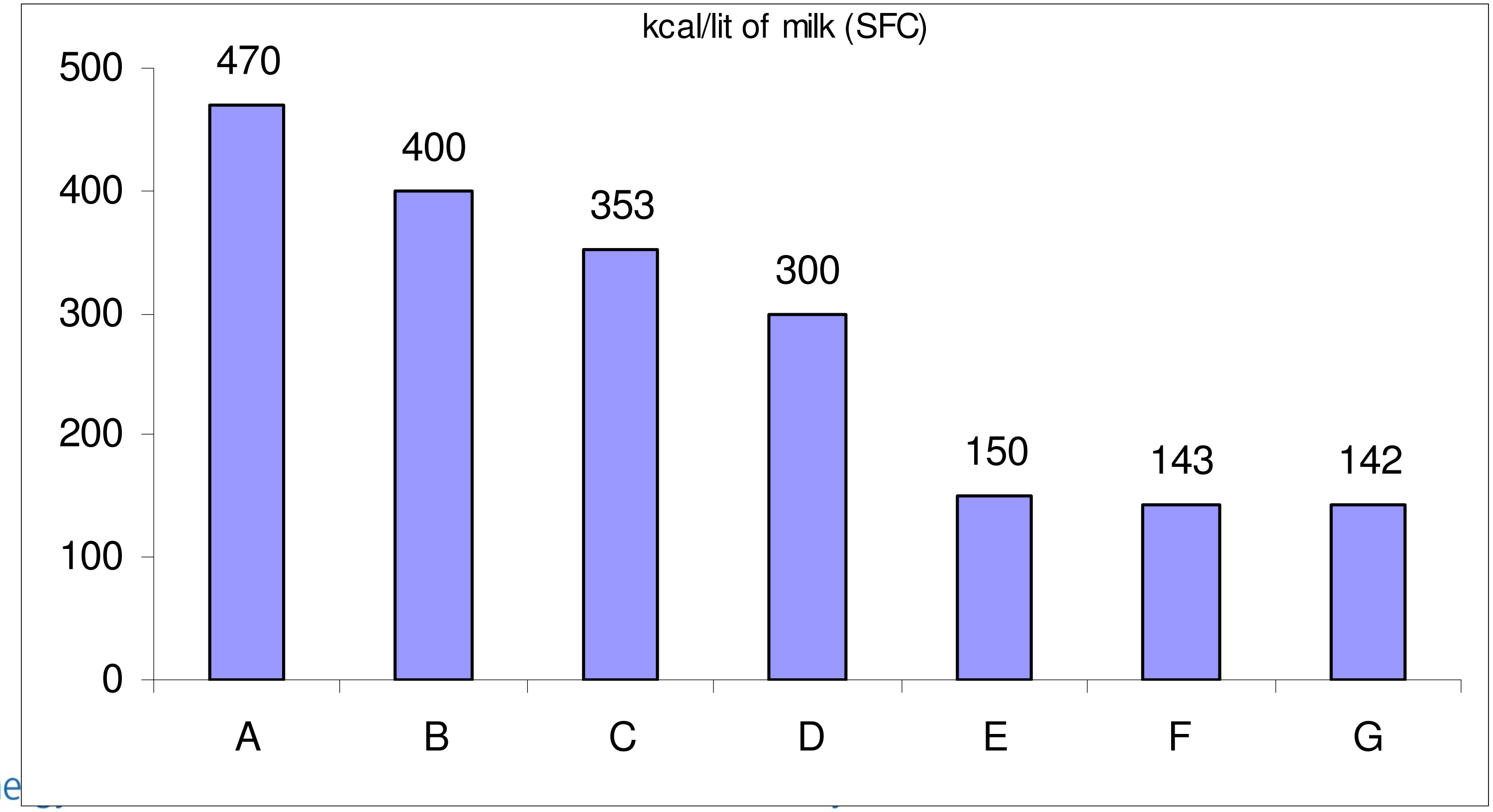
- SFC for 7 Non-powder plant dairies
- The worst plant requires almost three times more energy to process one litre of milk



# Specific Fuel Consumption

- SFC for 7 Powder plant dairies

- Again, the worst plant requires almost three times more energy to process one litre of milk



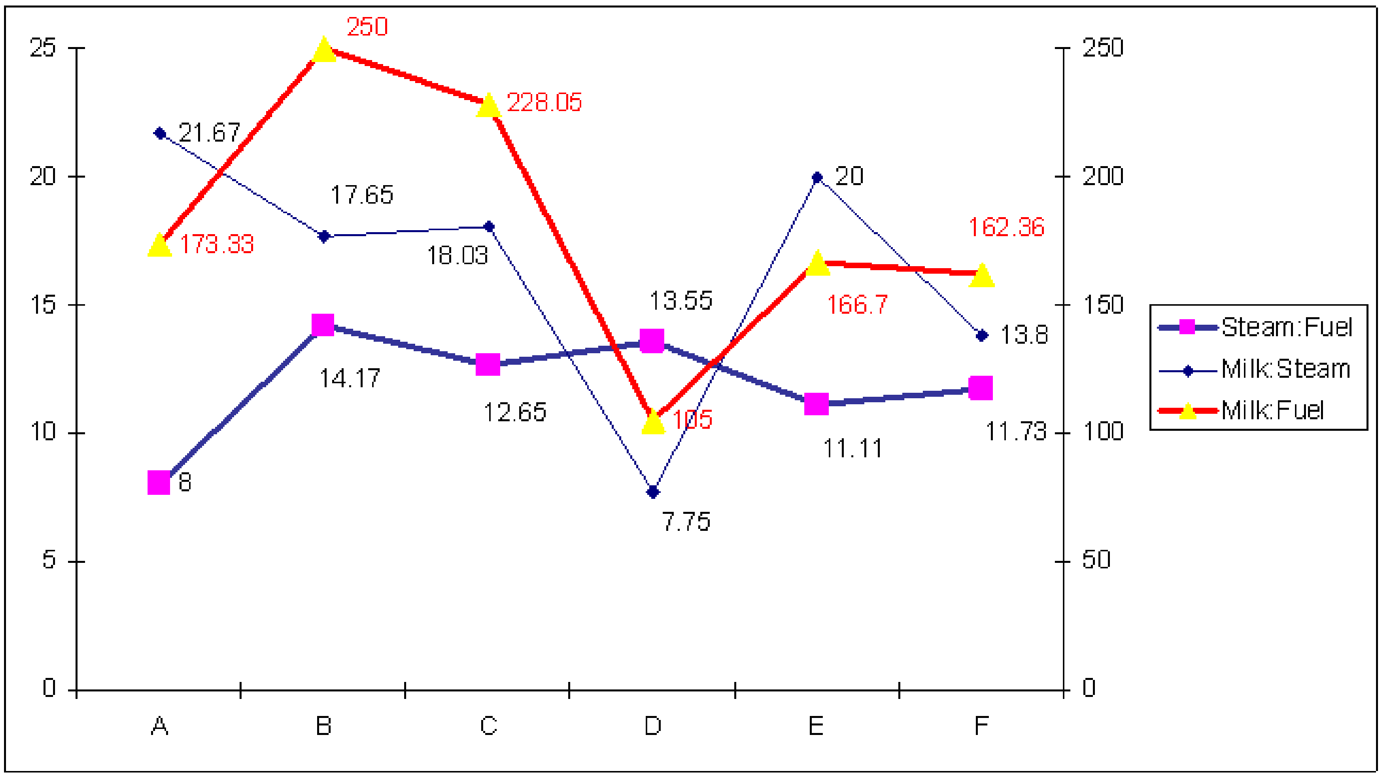

Ene

# Values for SFC

| Plant | Fuel | Classification | Plant Capacity in Lacs / day | Milk /unit of fuel |
|---|---|---|---|---|
| | | | | |
| **A** | **FO** | **Milk + Products** | **2.3** | **167** |
| **B** | **FO** | **Milk + Products** | **2.7** | **162.3** |
| **C** | **FO** | **Milk + Product** | **1.5** | **162.3** |
| **D** | **FO** | **Milk + Product** | **1.4** | **160.7** |
| **E** | **FO + Natural gas** | **Powder** | **12** | **Combined Fuel** |
| **F** | **FO** | **Powder** | **1.65** | **71** |
| **G** | **FO** | **Powder** | **3.5** | **67** |

# What impacts SFC

- S:F, Milk to Steam and SFC for Above 7 Non Powder plant dairies



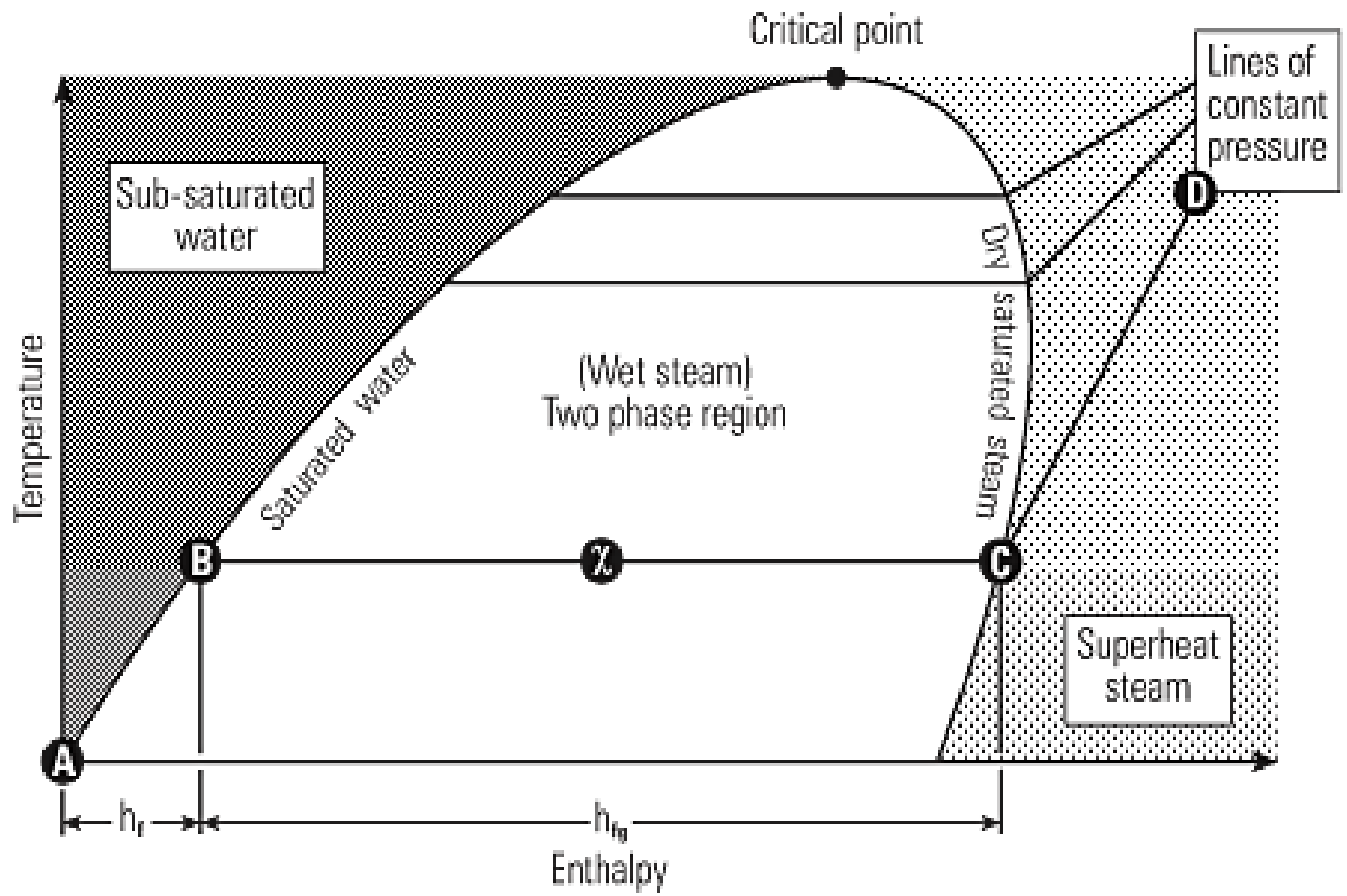
# What impacts SFC

- Differences in SFC due to differences in the Steam and Condensate loop i.e.
  - Steam to Fuel Ratio ie Efficient steam generation
    - Boiler Efficiency
    - Optimum Feed water temperature
    - Reduced blow down losses
  - Milk to Steam Ratio
    - Optimized steam distribution
    - Optimized steam utilization

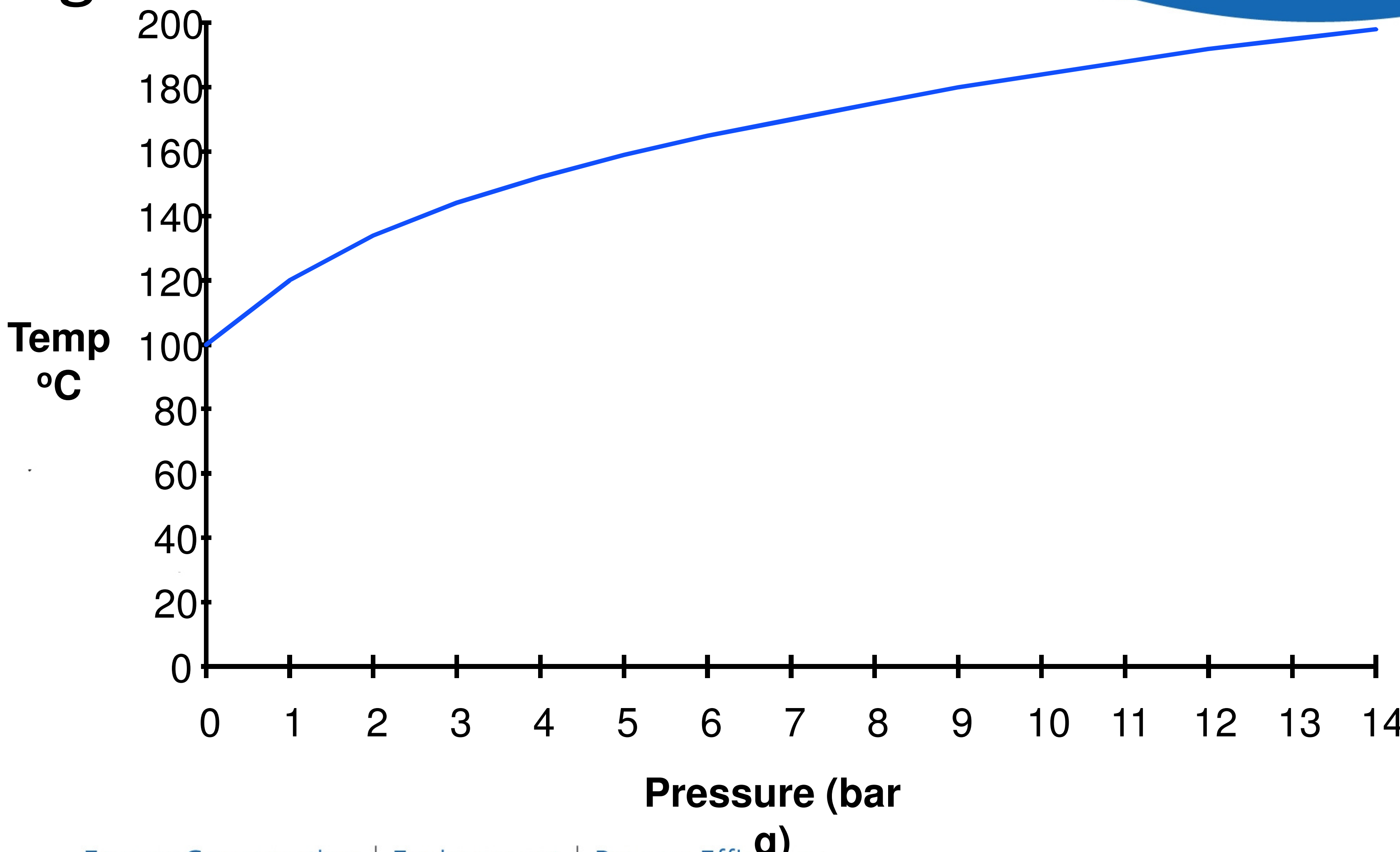
# What is Steam?

| Gauge pressure bar | Temp. ºC | ENTHALPY IN kj/kg Water ($h_f$) | Specific Enthalpy of evap'tion ($h_{fg}$) | Steam ($h_g$) | Volume Dry Sat. $m^3/kg$ |
|---|---|---|---|---|---|
| 0 | 100 | 419 | 2257 | 2676 | 1.673 |
| 1 | 120 | 506 | 2201 | 2707 | 0.881 |
| 2 | 134 | 562 | 2163 | 2725 | 0.603 |
| 3 | 144 | 605 | 2133 | 2738 | 0.461 |
| 4 | 152 | 671 | 2108 | 2749 | 0.374 |
| 5 | 159 | 641 | 2086 | 2757 | 0.315 |
| 6 | 165 | 697 | 2066 | 2763 | 0.272 |
| 7 | 170 | 721 | 2048 | 2769 | 0.24 |

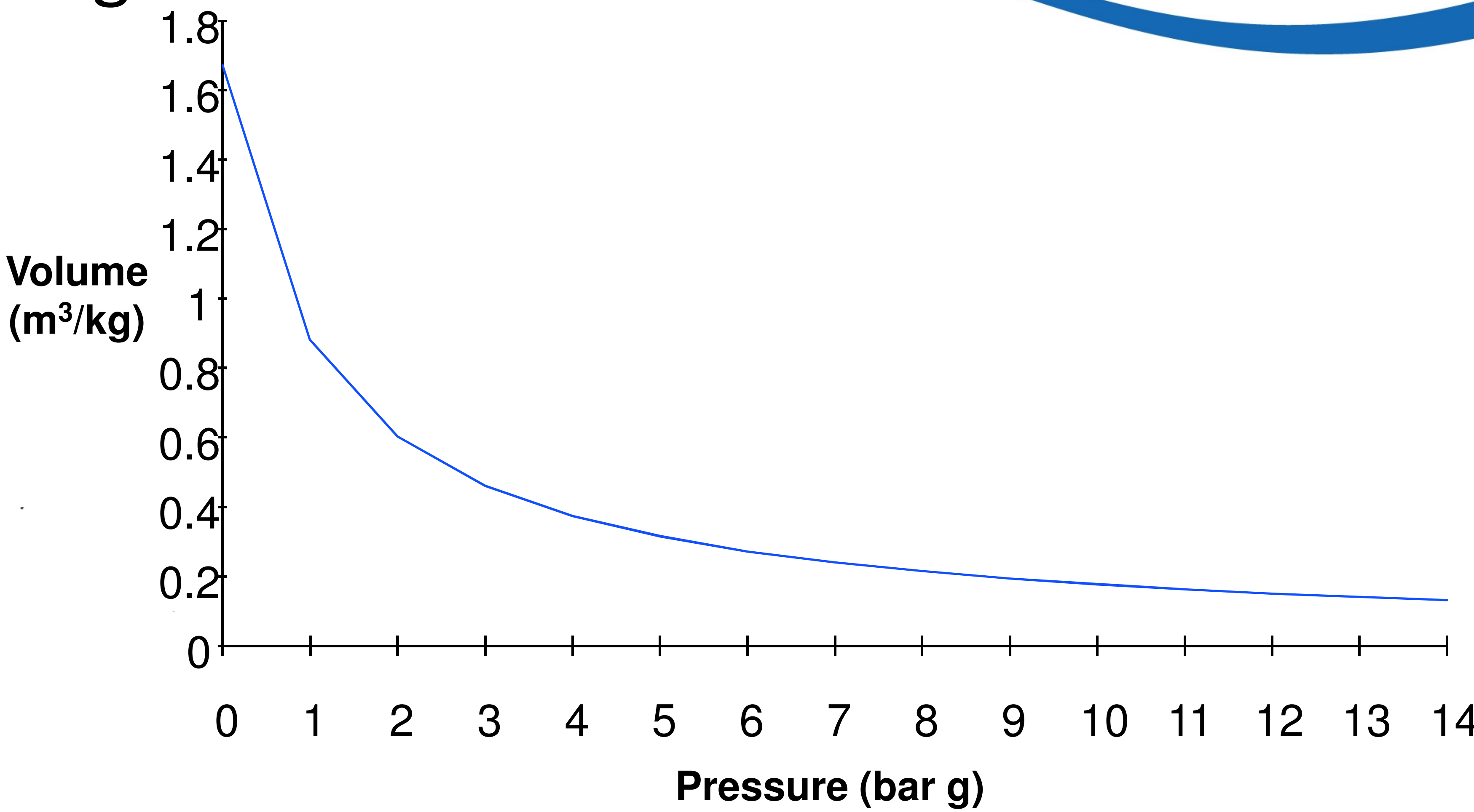
# Graphical Representation of Steam Tables



# Temperature - Pressure Diagram

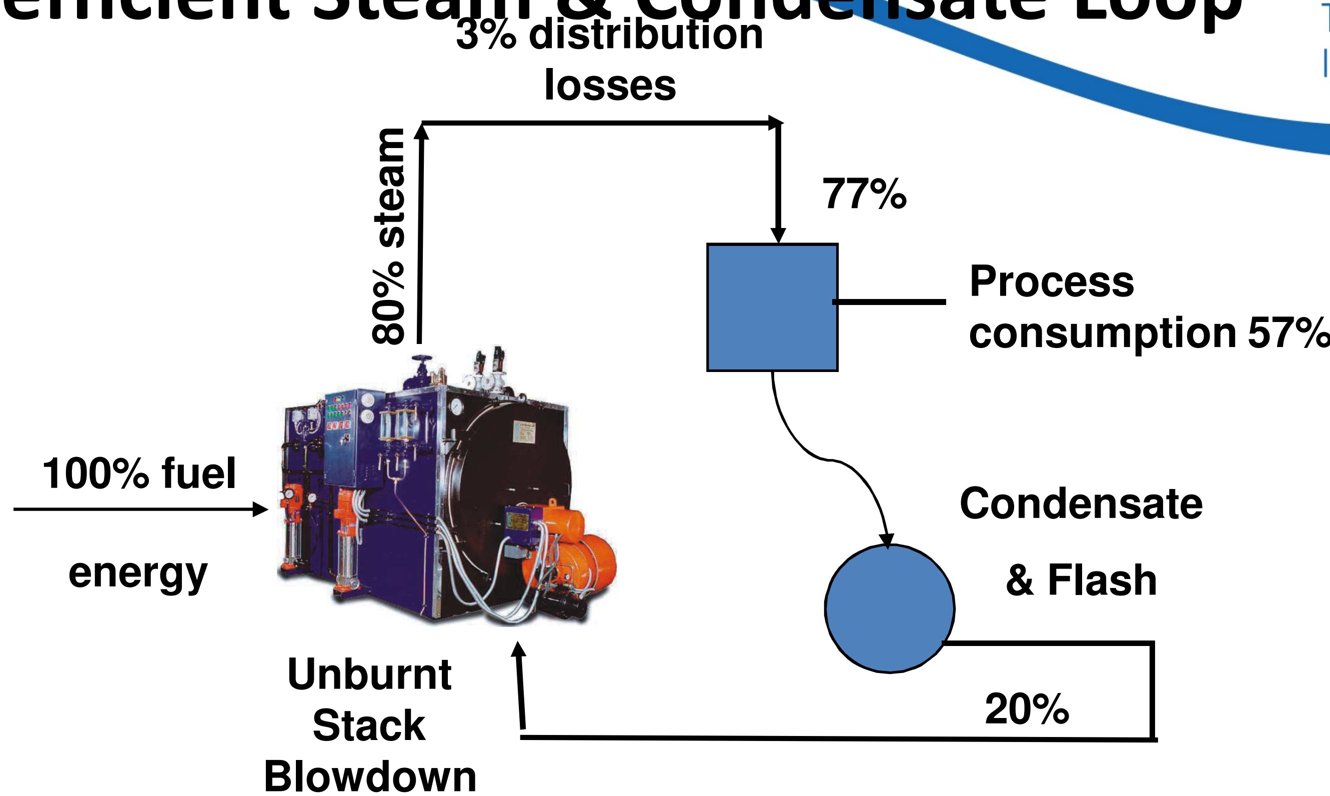


# Volume-Pressure Diagram



# An efficient Steam & Condensate Loop

Forbes Marshall
Trusted Partners.
Innovative Solutions.




- In an ideal S& C Loop of the total energy supplied to boiler
  - About 80% is utilized for conversion to steam
  - 3% of this energy is lost due to distribution losses
  - Only 57% of the energy supplied to the boiler is utilized by the process
  - The balance 20% exists as condensate and flash steam.

# S&C Loop in a dairy - SFC

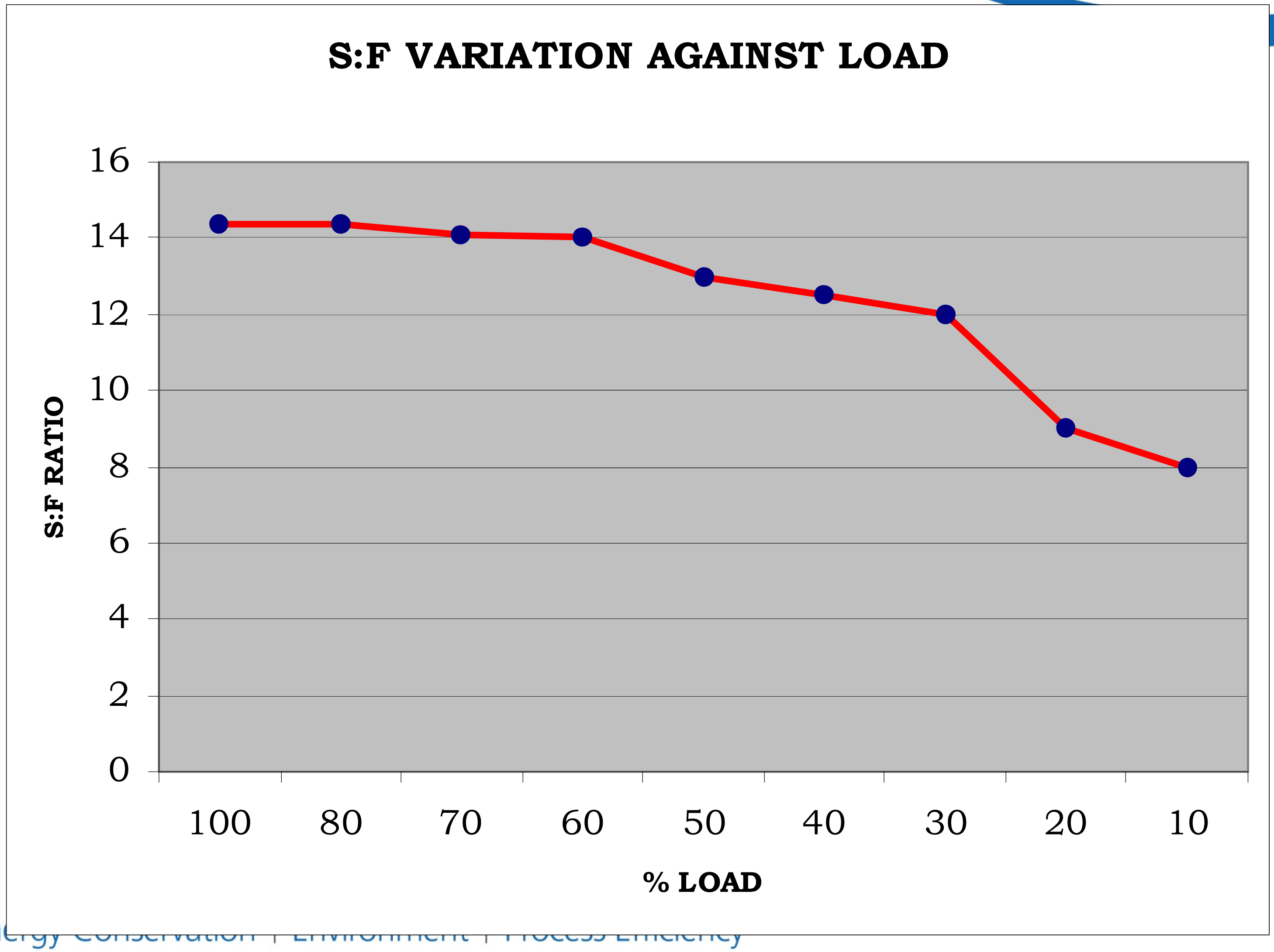
Forbes Marshall

Trusted Partners.
Innovative Solutions.

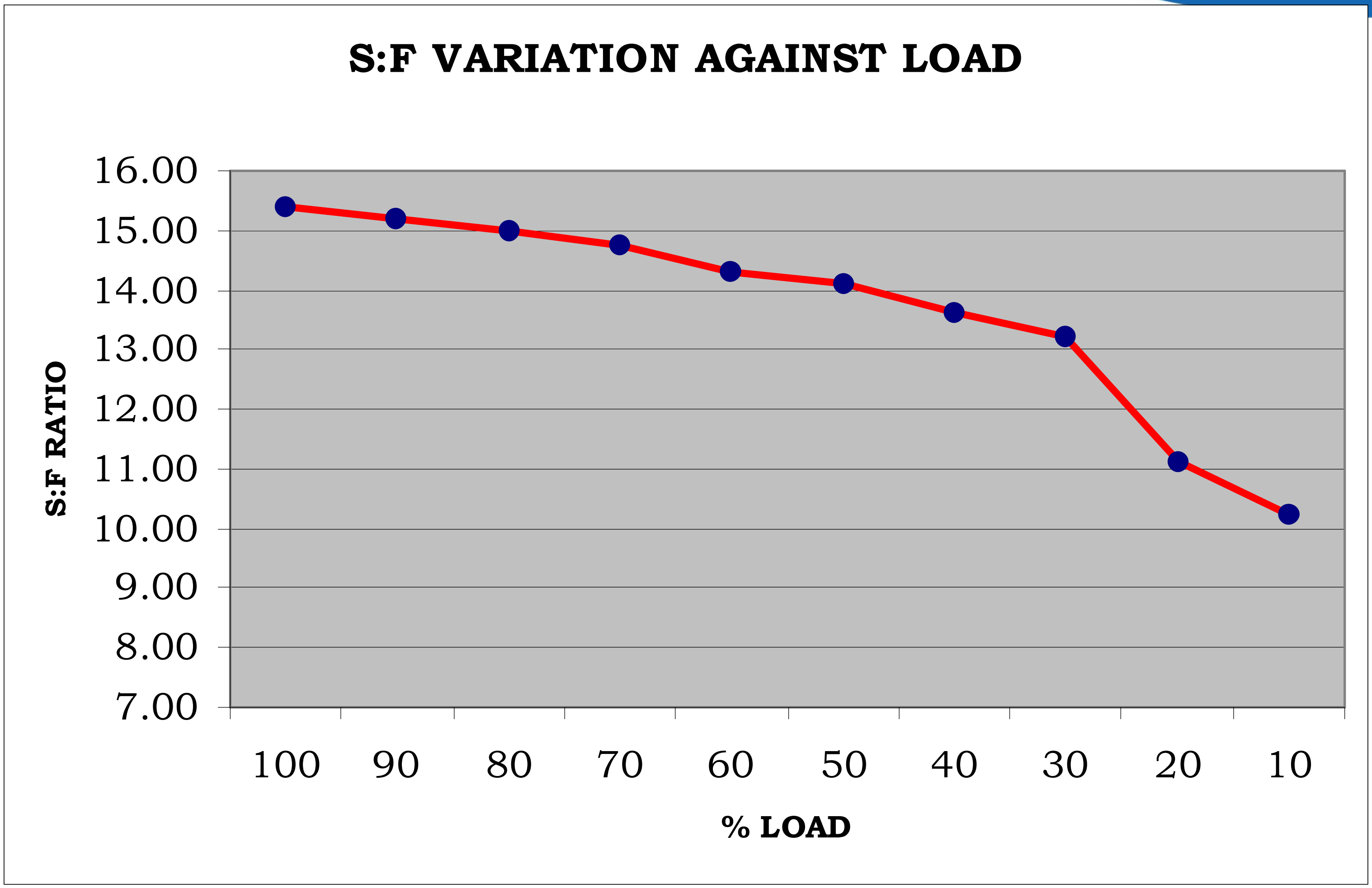
- S:F – Efficient Generation
  - Boiler efficiency
    - Highly oversized boilers operating at part loads
    - Frequent variations in load prevalent
    - Low loading & variations in load pattern results in frequent start-stops and thus poor efficiency
    - Steam is not generated at rated pressure affecting steam quality
    - No Diagnostics

8-10% saving is there on account of improving Boiler Efficiency

# Boiler Load & Steam to Fuel Ratio



# Boiler Load & Steam to Fuel Ratio



# S&C Loop in a dairy - SFC



- S:F – Efficient Generation
  - Optimizing Feed water temperature – Six degree rise in FWT results in a 1% improvement in efficiency
    - Feed water tank management
      - Oversized feed water tanks observed across dairies
      - No feed water management or control
      - A detailed mass balance calculation required to put in place feed water management strategy

# S&C Loop in a dairy - SFC

- S:F – Efficient Generation

  – Optimizing Feed water temperature – Six degree rise in FWT results in a 1% improvement in efficiency

  - Maximizing Condensate & Flash recovery
    – CRF very poor across dairies
    – Where condensate is being recovered it is done by electrical pumps with multiple handling of condensate and hence heat loss
    – Across most plants flash steam is not recovered

  – Optimizing Blow down
  - Blow down is manual across dairies
  - No heat recovery

**Overall 6-8% saving potential there in Dairies on account of CR**

# S&C Loop in a dairy - SFC

- Milk to Steam Ratio
  - Causes of distribution losses
    - Pressure drop issues observed across plants
    - Lines over/undersized, redundant lines, routing issues
    - Improper insulation/ bare lines leading to higher radiation losses

# S&C Loop in a dairy - SFC

Forbes Marshall
Trusted Partners. Innovative Solutions.

- Milk to Steam Ratio – Steam Utilization
  - Higher Steam Consumption in the process due to
    - Temperature overshoot in processes prevalent during milk pasteurization, ghee preparation, etc
    - Incorrect traps on the process which impact condensate evacuation and lead to higher steam consumption and also poor productivity
    - Number of CIP cycles – Heat recovery from the CIP section
    - In dairies with milk powder – 70% of the steam is consumed in the powder plant
      - Poor steam economy observed on the evaporator with huge potential for savings

% reduction in steam utilization has been found to be 10-15%

# Average Saving Potential

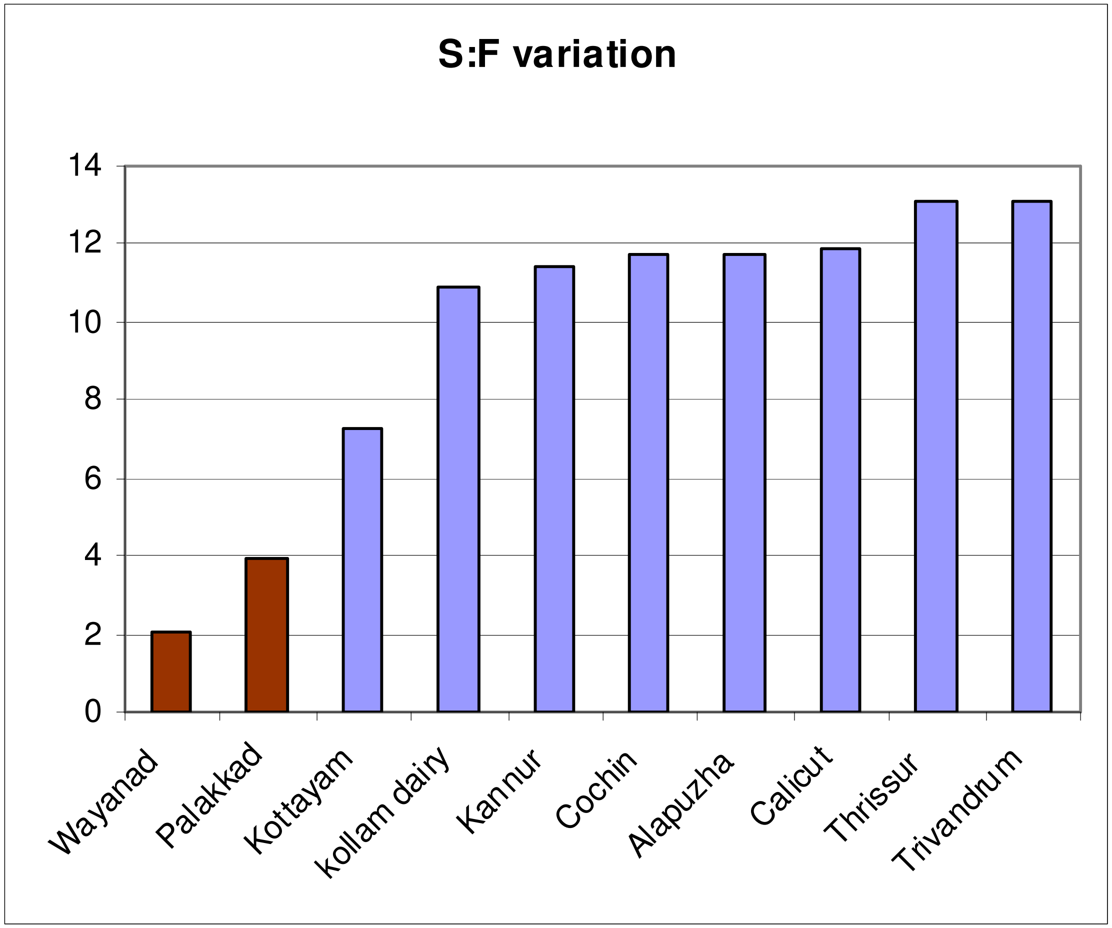
On an Average there is potential to save 24 – 33 % on fuel in Dairy Plants !!!

# SFC Variation

Forbes Marshall
Trusted Partners.
Innovative Solutions.

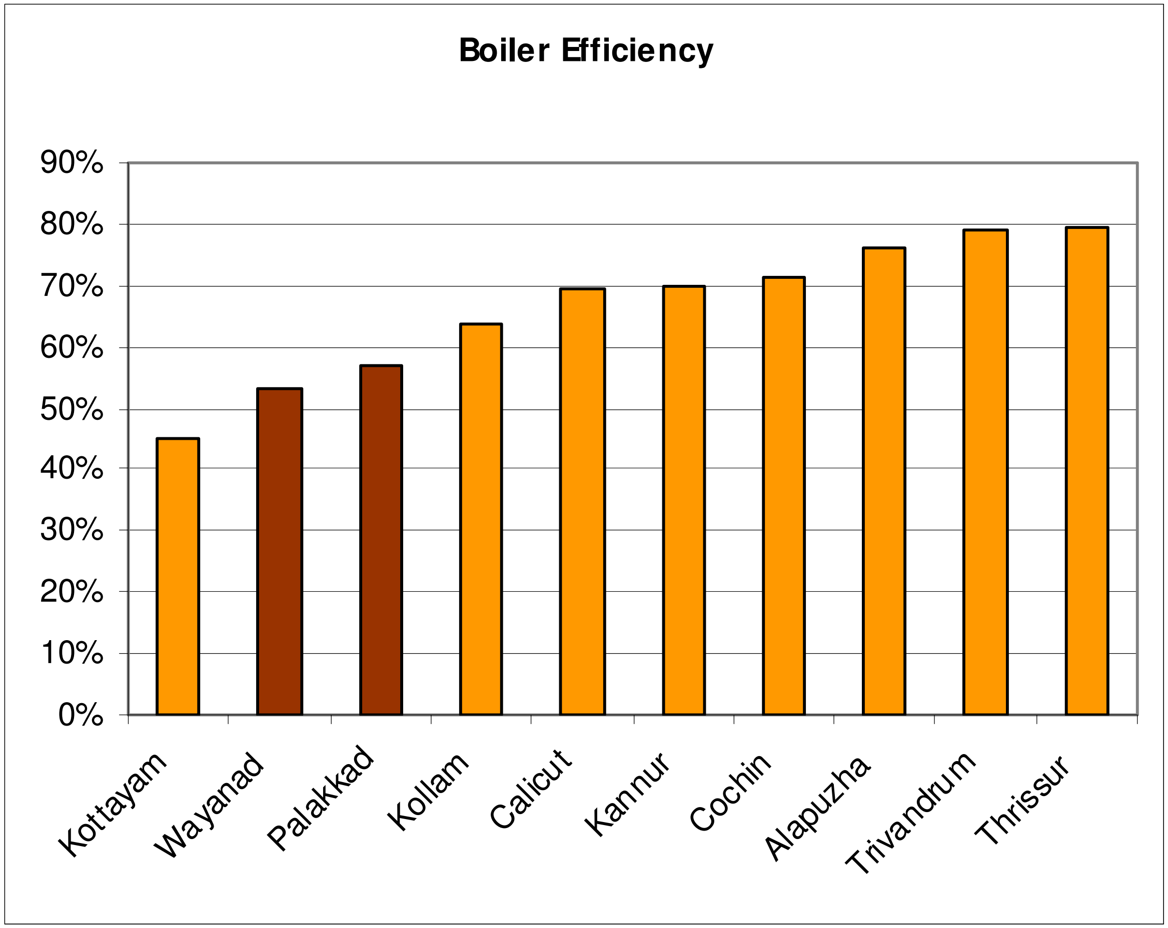
| Dairy | Thrissur | Kottayam | Alapuzha | Trivandrum | Cochin | Kollam | Kannur | Calicut | Palakkad | Wayanad |
|---|---|---|---|---|---|---|---|---|---|---|
| Steam/Fuel | 13.06 | 7.27 | 11.74 | 13.11 | 11.7 | 10.91 | 11.42 | 11.9 | 3.97 | 2.01 |
| Milk/Steam | 8.5 | 17.87 | 11.34 | 12.73 | 14.38 | 15.75 | 22.16 | 31.25 | 11.26 | 0 |
| Milk/Fuel | 111.82 | 130 | 133.26 | 166.97 | 168.38 | 172 | 253.2 | 372 | 44.74 | 0 |

# S:F Variation




- For FO fired Boilers ideal S:F is 14
- Palakkad & Wayanad have wood and coconut shell as fuel.

# Variation in Boiler efficiency




- Palakkad & Wayanad have wood and coconut shell as fuel

- All others have FO as fuel

# Condensate & Flash recovery

Forbes Marshall
Trusted Partners. Innovative Solutions.

- Poor Condensate recovery across the plants. Condensate contains almost 20% the energy in steam.
- Only 2 plants – Thrissur & Kochi Recover condensate.
- No plant recovers flash steam –Flash steam contains 50% of the energy in condensate.

# Objectives

Forbes Marshall
Trusted Partners.
Innovative Solutions.

**Bridge the variation across units and make the best plant better**.

- In-depth study of process & system
- Establishing the facts with actual measurements
- Comparison of existing performance with accepted norms
- Identify potential for savings and improvement

# The Audit Advantage

Forbes Marshall
Trusted Partners. Innovative Solutions.

- Quantify Energy Consumption & Utilization
- Comparing present operating conditions with norms
- Norms are continuously getting better due to improvements
- Energy saving measures identified in 3 stages- short, medium and long term
- Working out detailed payback period for Investment Decisions
- Conclude whether energy being spent is spent efficiently or not.

# Why FM?


✓ **Prioritizing**

Analysis of Pay back calculations and preparing the hierarchy chart.

✓ **Commitment of Savings**

Bridge the gap between the existing & industry best.

✓ **Quantification***

Quantification of achieved savings with respect to committed savings.

✓ **Sustaining the Savings**

- Identifying key parameters to be monitored & practical solutions for same with required accuracy & to identify gaps in sustaining savings over a period of time.
- Help establish operating practices to bridge the gaps
- Enhance overall awareness through trainings

# Why FM?

Forbes Marshall
Trusted Partners. Innovative Solutions.

– Rich experience & know-how of both Steam & Processes to arrive at the right solution for each industry and each plant

  - Energy Conservation Partner since 1946
  - Over 1000+ process audits including sectors like Tyre-Tube, Textiles, Food & Beverages, Rubber, Pharmaceuticals, Chemicals, SEP, Oil & Petrochemicals, Fertilisers, Breweries, Distilleries and many more!

– Team of qualified, professional industry specific auditors

– Each audit is discussed with a panel of experts in-house

– Part of Forbes Marshall Group of companies, leaders in Steam Engineering & Process Instrumentation

# Benchmarks Of Success

- Reduced SFC
- Increased process output
- Improved product quality
- Reduced down time
- Improved monitoring & control process
- Direct monetary savings

METRO DAIRY LIMITED

**TO WHOM IT MAY CONCERN**

This is to state that M/S. Forbes Marshall Pvt Limited has carried out the total Technical Audit for our complete Steam Management System in our Milk Processing and Ice Cream Manufacturing Unit at Kolkata.

As per the recommendation of Forbes Marshall we have implemented their suggestion and installed the following items;

- **Boiler House Efficiency monitoring Package Unit, Model; Effimax 2000**
- **Condensate Recovery Systems for individual equipment**

It is observed that by implementing Forbes Marshall suggestions, the Fuel consumption (Furnace Oil) is reduced by 13% and the specific fuel consumption for milk processing is reduced by 22%.

All equipment supplied by Forbes Marshall are working satisfactorily and performing well.

For METRO DAIRY LIMITED

13/01/07

NARESH CH. DAS
MANAGER-ENGINEERING

# Steam Utilization in Dairy

Forbes Marshall

Trusted Partners. Innovative Solutions.

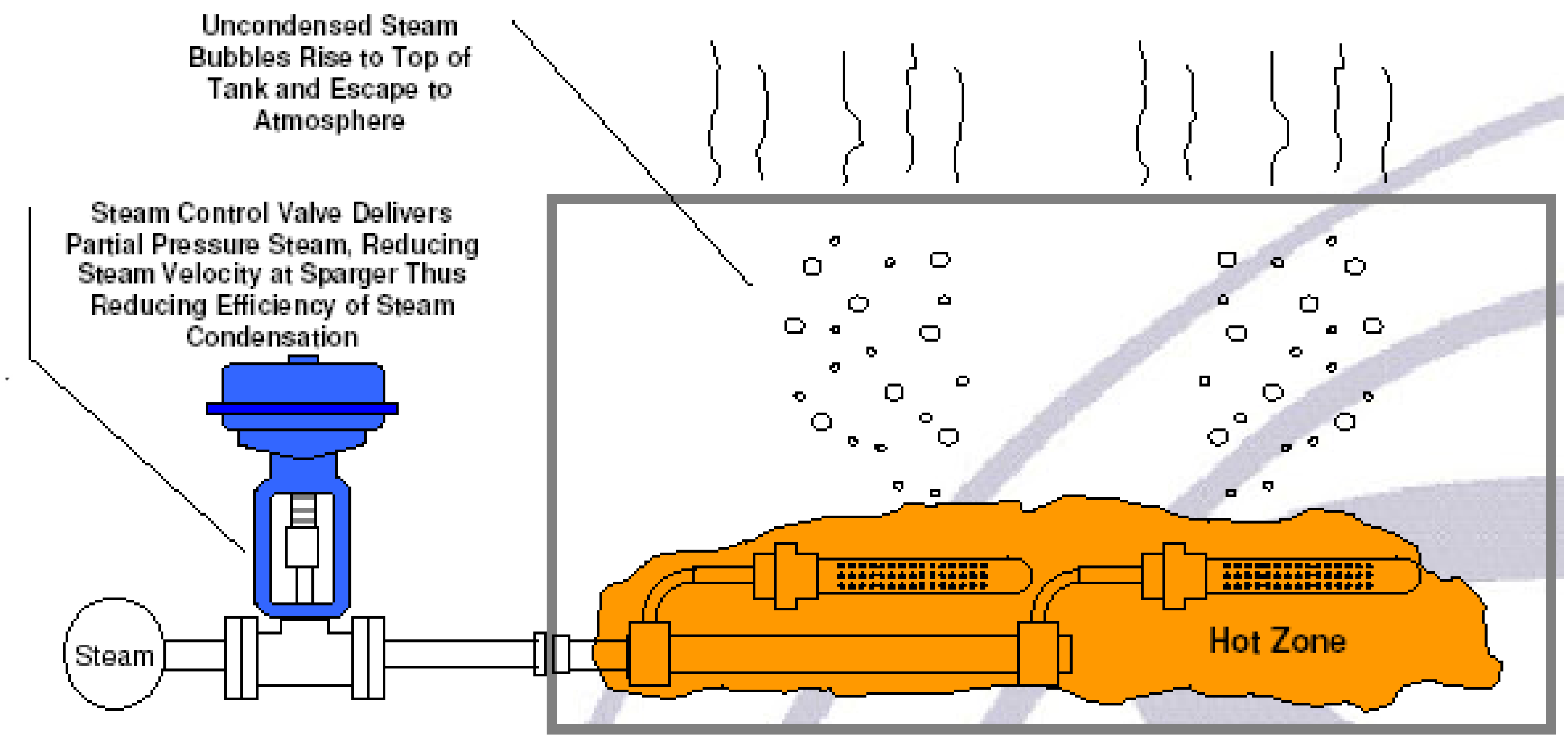
## Hot Water usage In Dairy

- **Pasturiser - Milk, Cream , Butter Milk , Curd, Ice-cream Mix, UHT,**
- **CIP System for Silos /tanks**
- **Can / Crate / Bottle washer**

# Hot Water generation System

- **1. Conventional system – Steam Mixing (Storage type TANK HEATING)**
- **2. New Generation – Packaged Plant Room system (Instantaneous)**

# Steam Mixing heating System-



Forbes Marshall
Trusted Partners.
Innovative Solutions.

# Problem Face  by Dairy In steam Mixing

- **Rough Operation – Steam hammer and vibration**
- **Poor Temperature Control**
- **Energy Loss – Uncondensed steam bubbles represent a direct loss of energy**
- **Limited turn down capability.**
- **No condensate recovery**
- **Steam ->Fuel –> Money gets wasted to maintain the temperature under no load conditions**

# Efficient System for HWG

Forbes Marshall

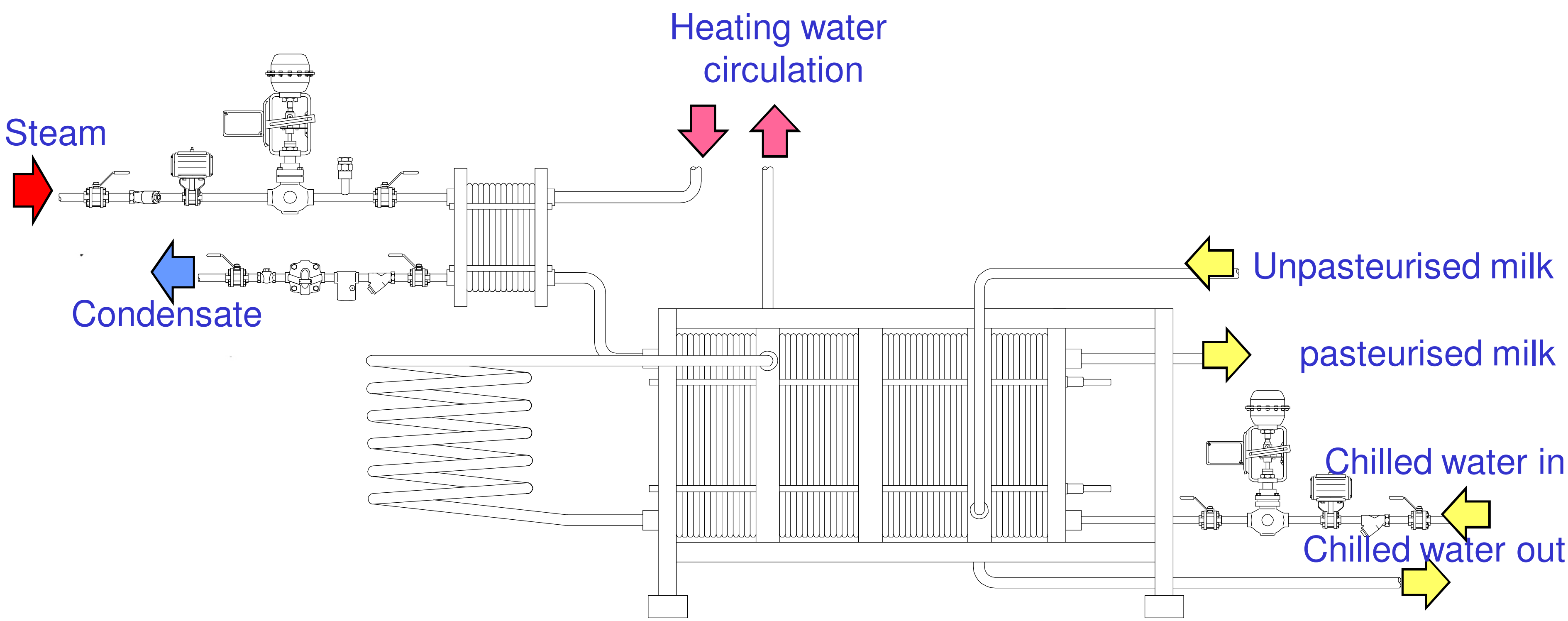
Trusted Partners.
Innovative Solutions.

## What is PPRS

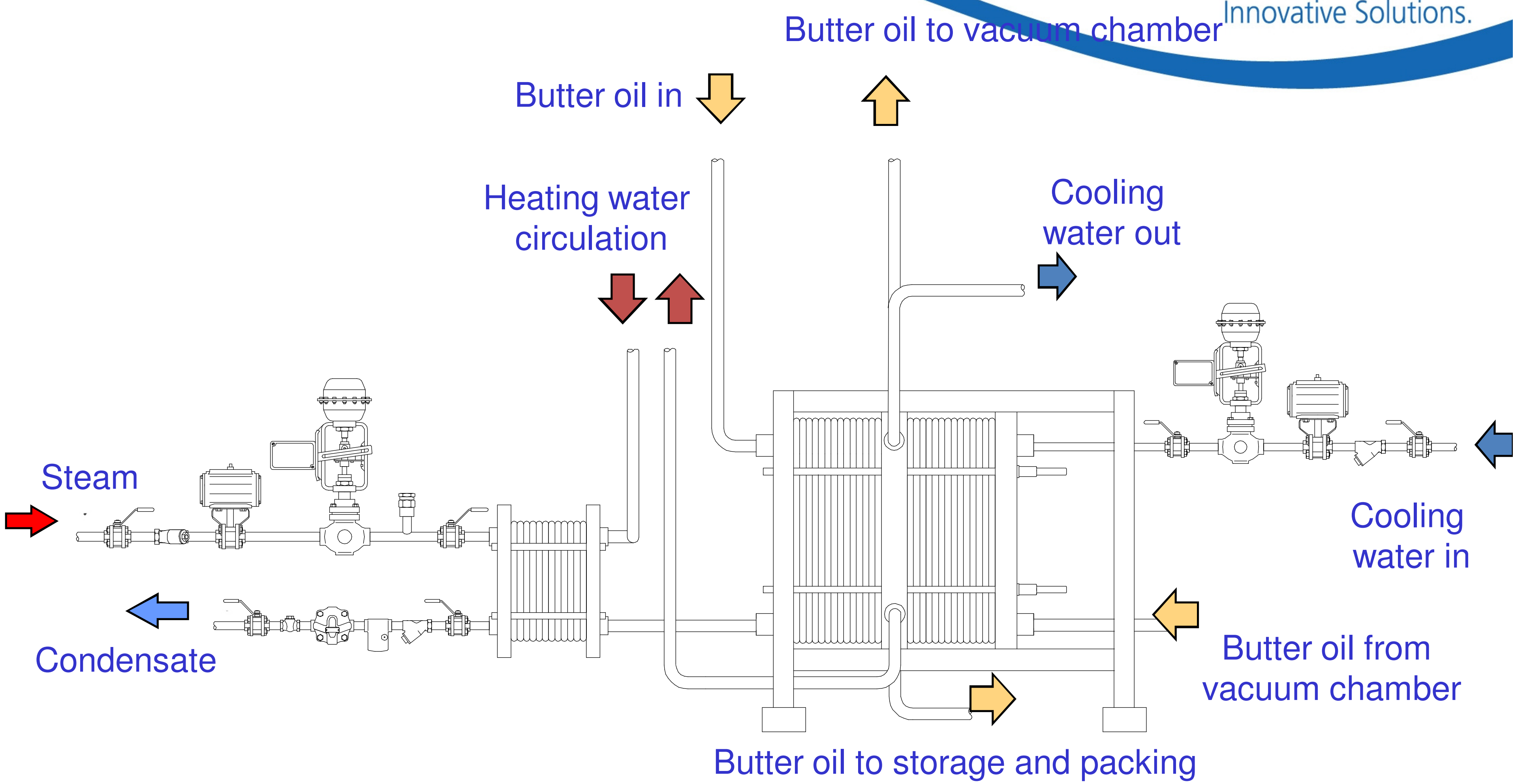
Simplest and the best way to generate hot water using Low  Pressure steam for

- Pasteurizer units
- CIP System
- Crate / Can / Bottle Washer

# Hot water for pasteurizer & UHT



# Butter Oil Production



Forbes Marshall

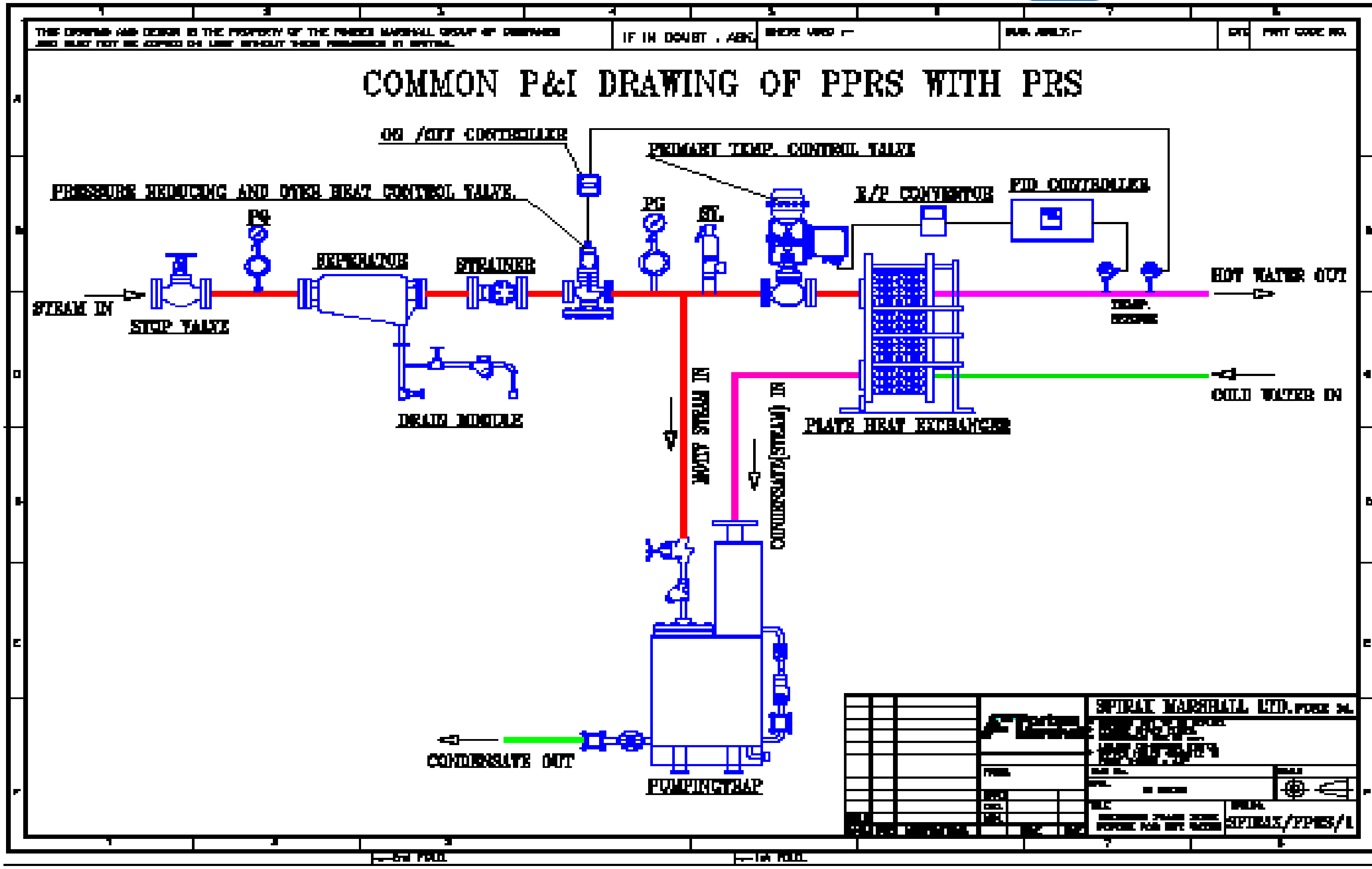
Trusted Partners. Innovative Solutions.

## Why PPRS System- for Dairy

- Instantaneous in nature as low hold up volume
- Effective temperature control
- No pressure drop in the boiler during peak loads
- No implosions, water hammer & noise problems
- Best for Continous operations
- Energy efficient, low carbon footprint, saves upto 10% fuel

# PACKAGED PLANT ROOM SYSTEM.

Energy Conservation | Environment | Process Efficiency


COMMON P&I DRAWING OF PPRS WITH PRS
IF IN DOUBT , ASK
ON /OFF CONTROLLER
PRIMARY TEMP. CONTROL VALVE
PRESSURE REDUCING AND OVER HEAT CONTROL VALVE.
PG
SL
E/P CONVERTOR
PID CONTROLLER
SEPERATOR
STRAINER
STEAM IN
STOP VALVE
HOT WATER OUT
TEMP. SENSOR
COLD WATER IN
DRAIN MODULE
MOTIV STEAM IN
CONDENSATE(STEAM) IN
PLATE HEAT EXCHANGER
CONDENSATE OUT
PUMPINGTRAP
SPIRAX MARSHALL LTD.
SPIRAX/PPRS/1

# Components of a Typical PPRS

Pressure reducing station

Plate heat exchanger

Primary temperature control loop

Over heat protection loop

Stall protection

Condensate recovery equipment

Forbes Marshall

Trusted Partners.
Innovative Solutions.

## PRESSURE REDUCING STATION

•To reduce excess pressure of steam as per the design to ensure constant pressure steam is provided to plate heat exchanger

•To provide dry saturated steam to have better heat transfer

•To safe guard PHE from damage by providing a safety valve

# TEMPERATURE CONTROL LOOP

- Temperature transmitter – senses the water temperature at the outlet of the PHE & gives 4 – 20 ma signal
- PID controller - accepts signal from the transmitter & gives output to the E/P converter
- E/P converter - based on the signal from controller, actuates the control valve
- Control valve - this accepts signal from E/P converter and controls the flow of steam to PHE

# OVER HEAT PROTECTION LOOP

- Temperature sensor - this senses the temperature of hot water at the outlet of PHE
- On/Off controller - this accepts signal from temp. sensor, and gives the output based on the set temp.
- Solenoid valve – this accepts signal from on/off controller and stops the steam supply

***NOTE :- This loop comes in to action only when primary loop fails***

Forbes Marshall

Trusted Partners.
Innovative Solutions.

## CONDENSATE RECOVERY EQUIPMENT

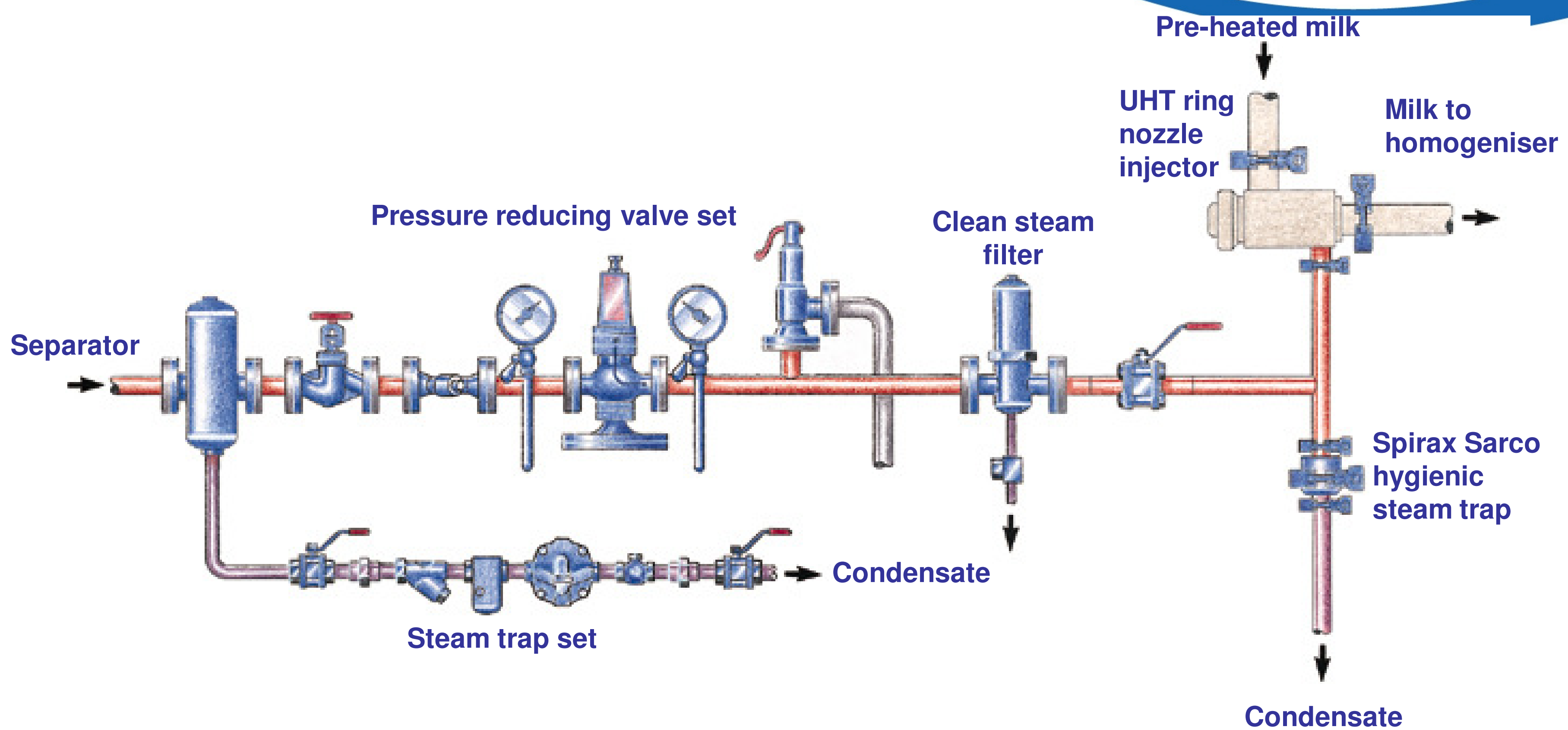
- Pumping trap combination - This is used to remove condensate from the PHE under all conditions, even under stall condition
- Condensate removal is essential, to keep the PHE heating area free from condensate.

Forbes Marshall
Trusted Partners. Innovative Solutions.

# FEATURES MAKING PPRS THE CLEAR WINNER

- Instantaneous nature allows Hot water at any time
- Easy to maintain and Install
- Less Steam Consumption and High thermal Efficiency
- Compact in volume, weight and liquid holdup & Provision for capacity expansion
- Accurate & constant temperature under various heat loads.
- Low water content reduces the risk of legionella breeding.

# Direct UHT Controls



Forbes Marshall
Trusted Partners. Innovative Solutions.

# Stall and condensate removal

## What is stall?

- No movement of condensate

# Stall and condensate removal

What is stall?

No movement of condensate = back-up in heater

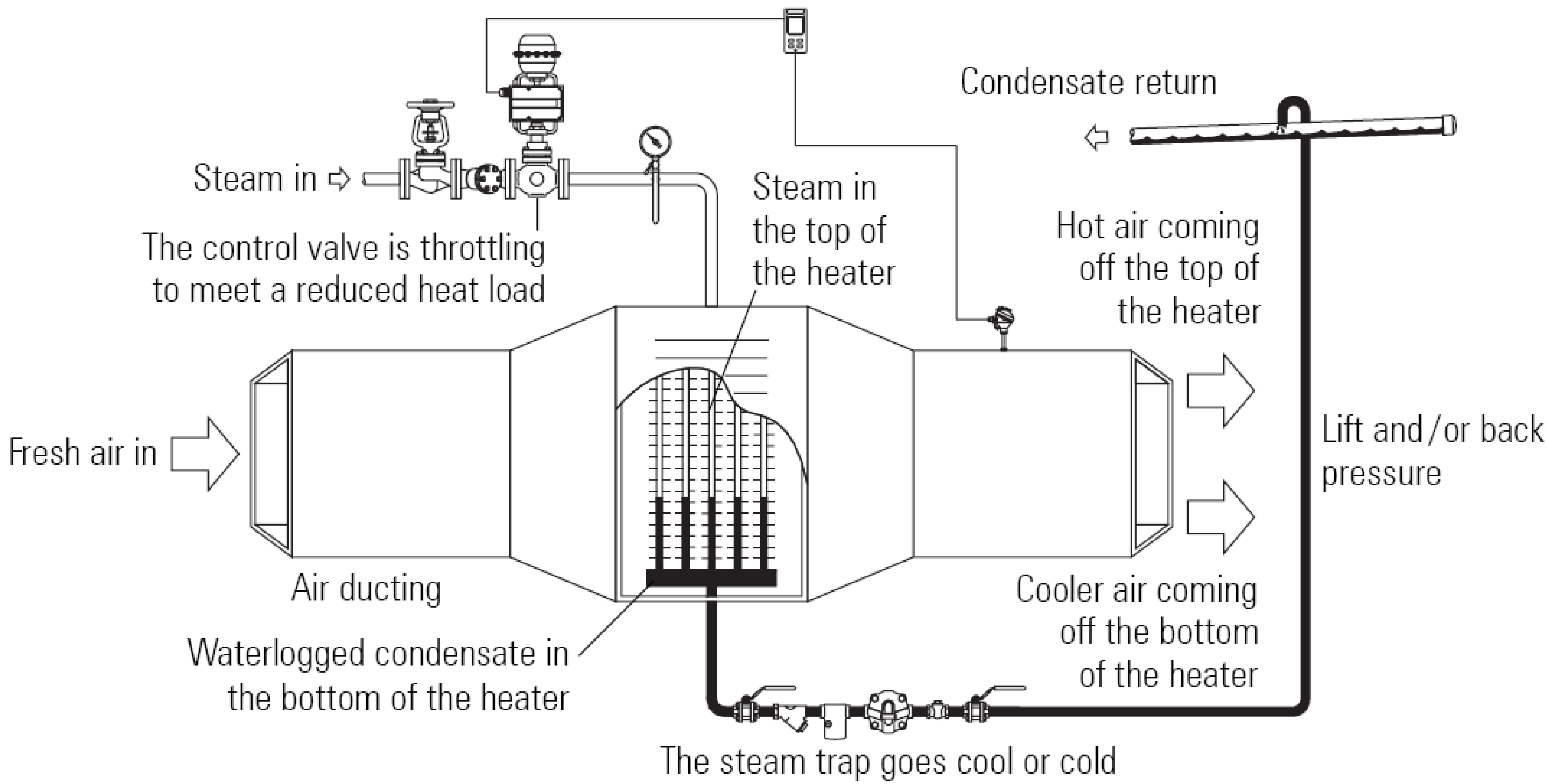
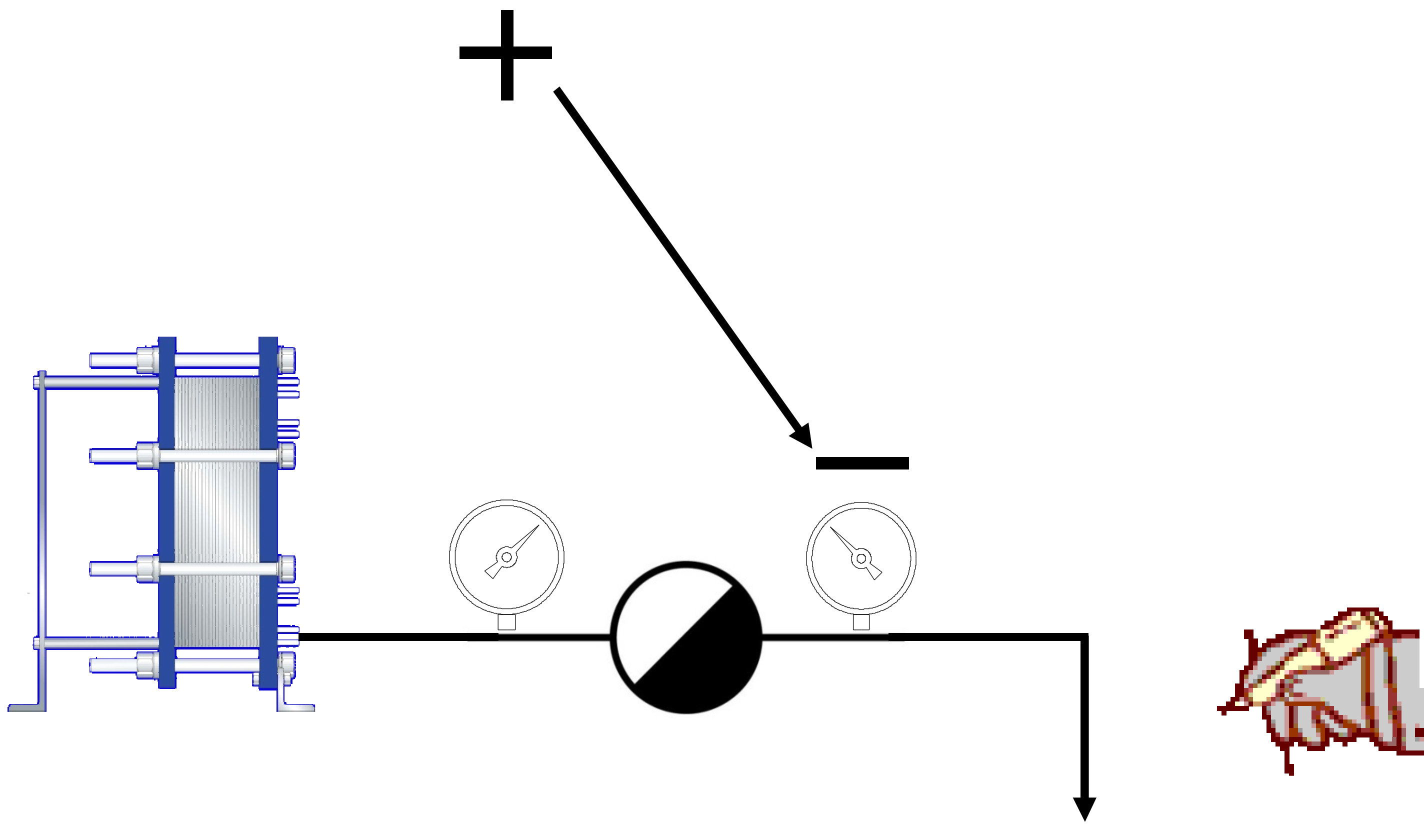



**Fig. 13.1.1 An air heater battery suffering the effects of stall**

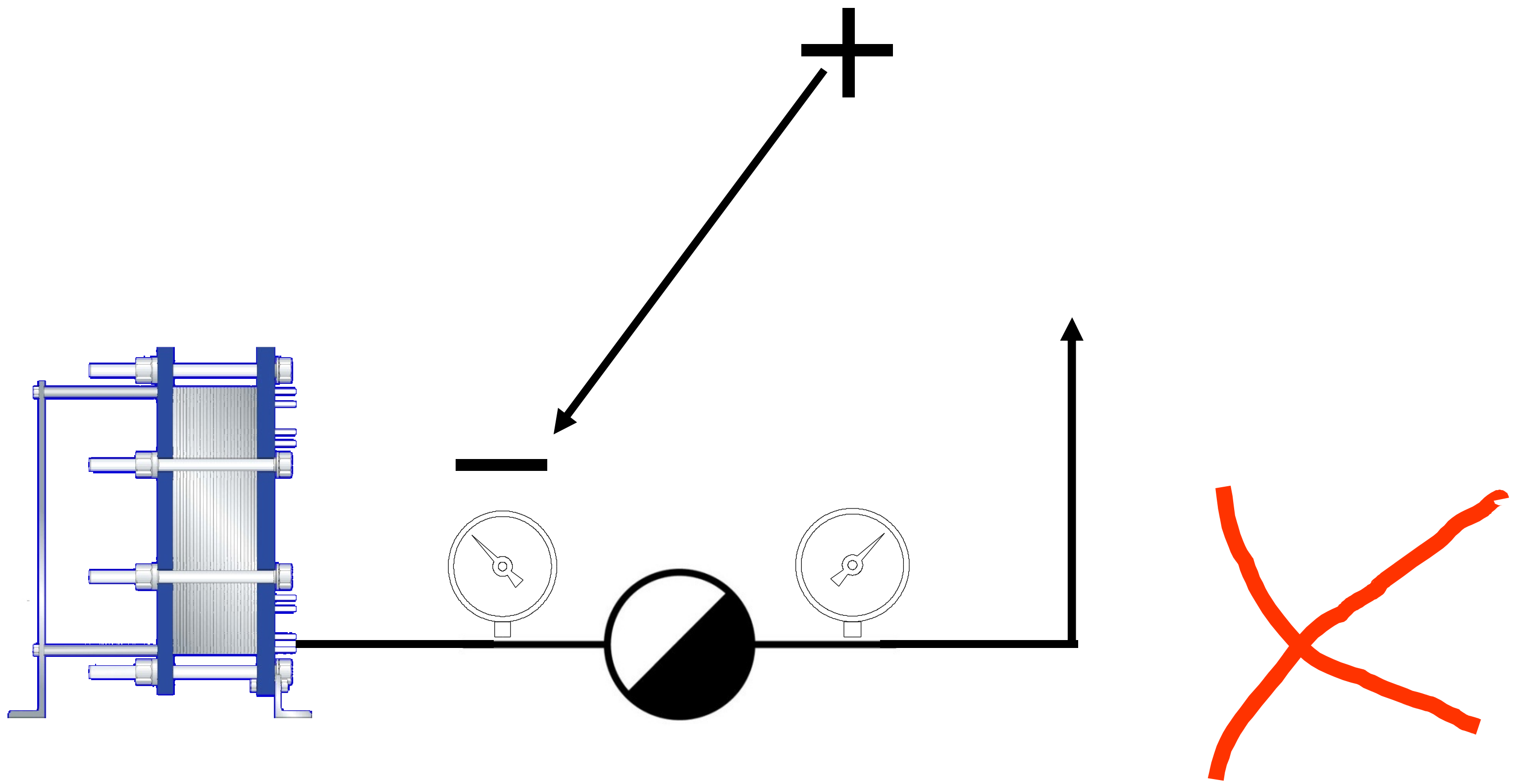
# Stall and condensate removal

Condensate flows out when heater pressure is higher than backpressure.

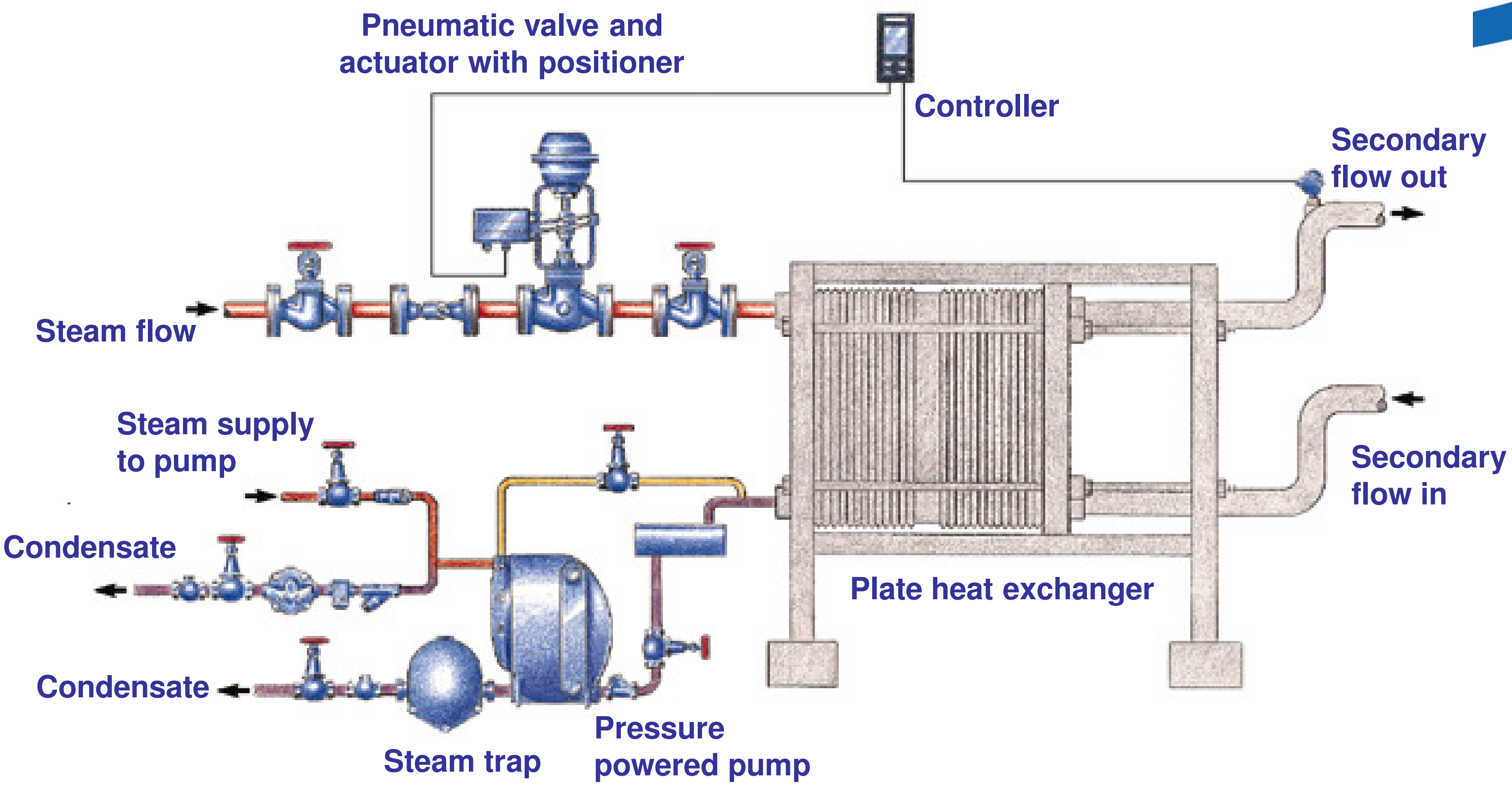


# Stall and condensate removal

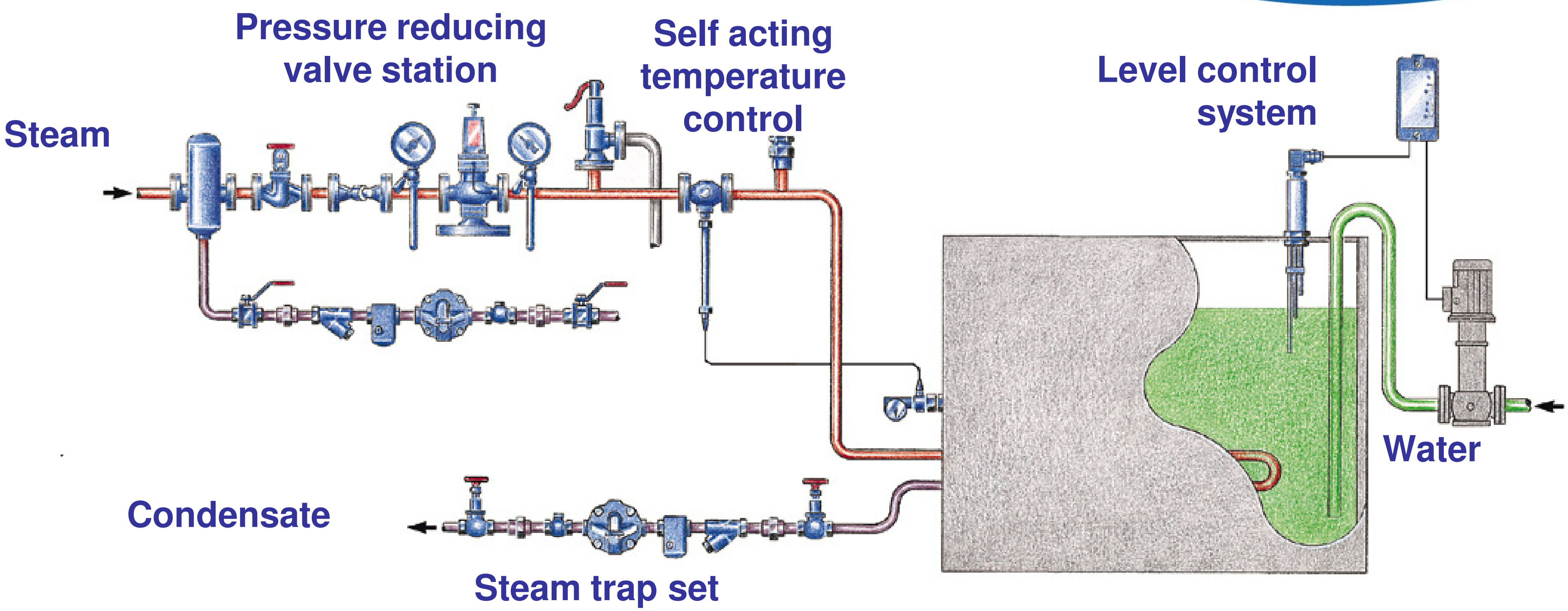
Stall occurs when the backpressure is higher than the pressure in the heat exchanger.



# Plate Heat Exchanger Temperature Control and Condensate Drainage



# Hot Liquor Tank Controls



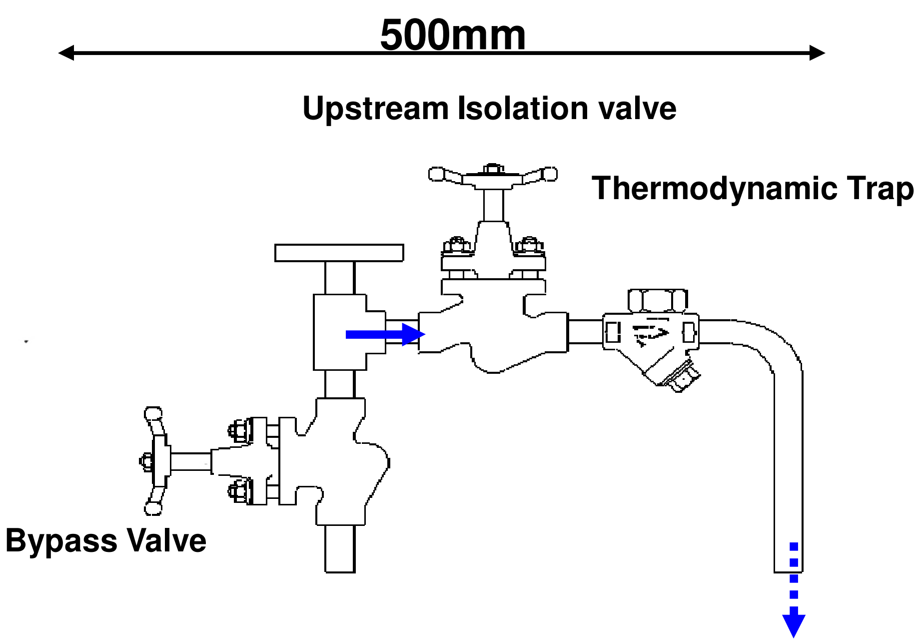
# Condensate and Flash Recovery

- Flash Vessel for flash steam recovery
- Steam Operated Pump

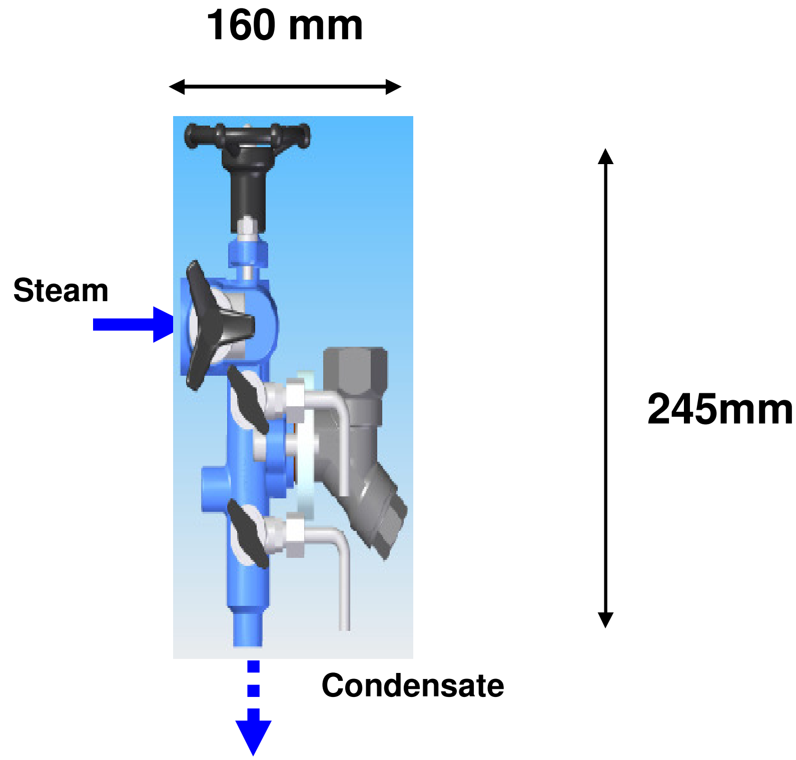
# COMPARISON:
# COMPACT / CONVENTIONAL

Forbes Marshall
Trusted Partners.
Innovative Solutions.

## CONVENTIONAL STEAM TRAP STATION




## COMPACT STEAM TRAPPING STATION

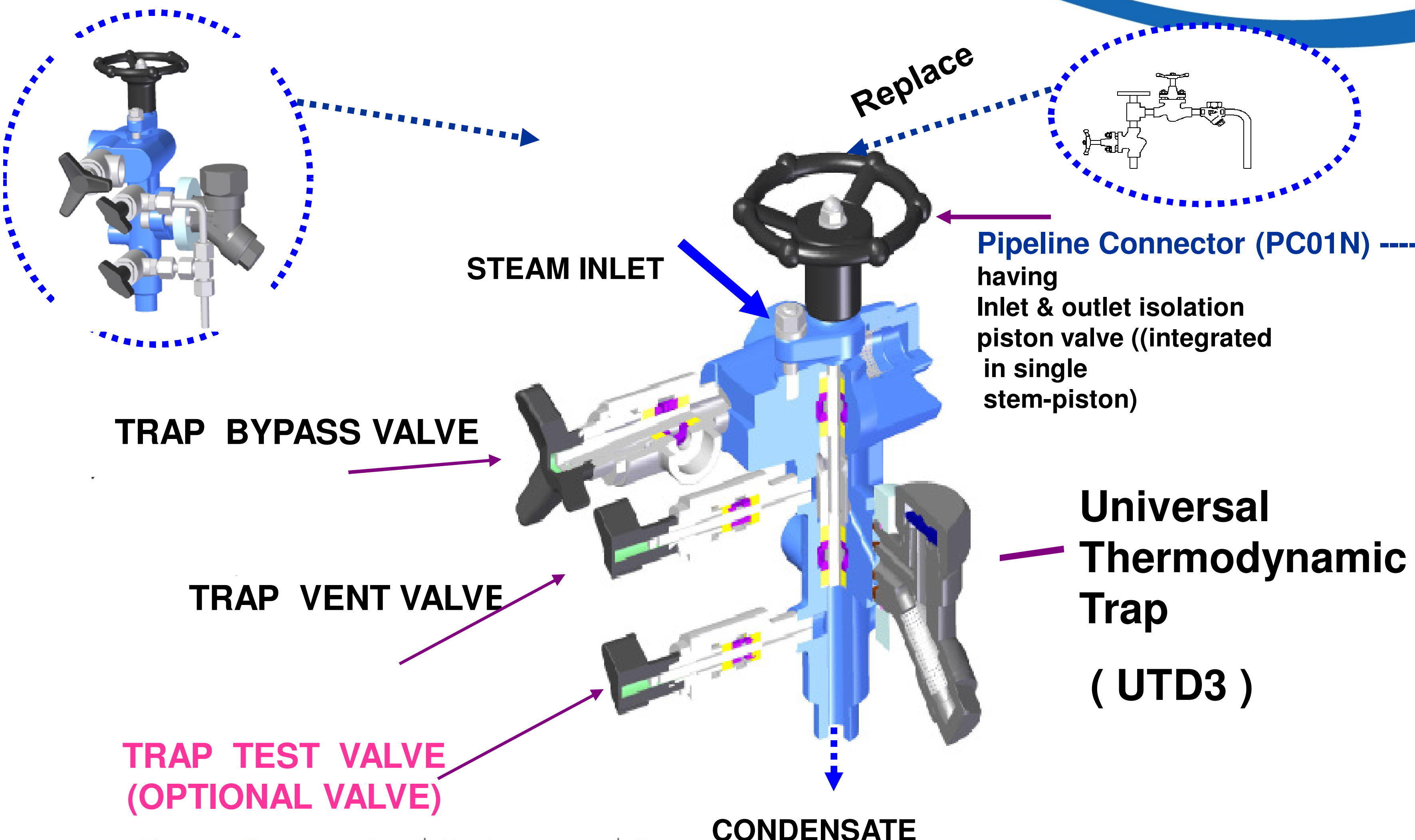



**Estimated weight : 8 kg** **3.5 kg**

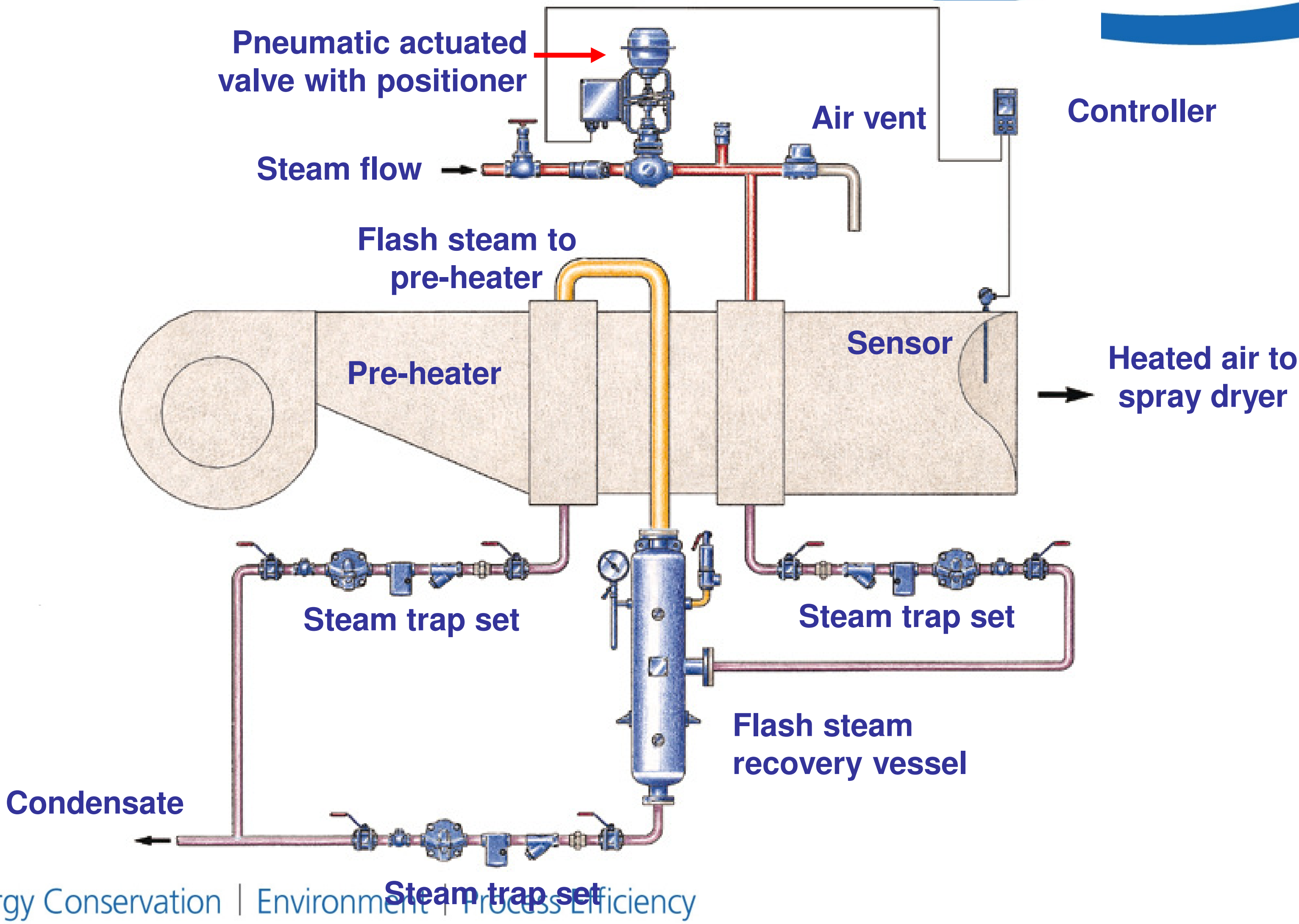
**MODEL : PC01N + UTD3**

# PC01 N with UTD3 for MAIN DRAINS

Forbes Marshall
Trusted Partners.
Innovative Solutions.



# Air Heater Control System With Flash Steam Pre-Heater



# Case Study

Forbes Marshall

Trusted Partners.
Innovative Solutions.

- A dairy plant in Surat had 5 TPH Gas Fired Boilerwas consuming
  - 4500 scfm gas per day to produce 9 lac lit milk
  - They were having zero condensate recovery
  - FWT was maintained at 50 Deg C by direct steam injection
  - Un insulated FWT and no level management
  - There was no Pressure reduction and all equipment were consuming steam @ 7 barg Pr
  - Steam trap selection on Pasteurizer , Ghee Vat and other equipment was mostly Thermodynamic and most location there were no traps
  - CIP PHE was facing stalling problem
  - All Pasteurizer were using Hot water tank with direct steam injection for Hot water generation

Forbes Marshall

Trusted Partners.
Innovative Solutions.

- We studied the plant and recommended to
  - Install Pressure Reducing station and Operate all Equipment @ 3 barg
  - Improving condensate recovery from all pasteurizers and CIP
  - Insulating FWT and installing proper level management
  - Automatic pumping trap on PHE
  - PPRS system instead direct injection Tank based steam system.
  - Rightly sized Ball Float steam traps for all Equipment
  - After implementation of entire system

# Result

Forbes Marshall

Trusted Partners.
Innovative Solutions.

- Feed water temperature improved from 50 Deg C to 75 Deg C (w/o steam injection)
- No stalling Observed on CIP PHE
- Hot water System yielded (PPRS)
  - PRECISE TEMPERATURE CONTROL
  - NO WASTAGE OF STEAM THRU OVERHEATING / SURFACE EVAPORATION/ BUBBLING / HOT STANDBY.
  - HOT WATER ALWAYS AVAILABLE – SO NO REWORK ON BATCH
  - NEAT AND CLEAN WORKPLACE
- Fuel Consumption dropped from 4500 to 3500 scfm
- Total 22% saving on Fuel Bill

# Case Study – Dairy in Calcutta

- To study the impact of S&C on SPFC
  - Capacity of the dairy 4lakh lts/day
  - Fuel bill (FO) 93 Lakhs
- Observations in Steam Generation
  - 2 boilers of 5tph each Operating at 500 kg/hr
    - Frequent on-off operations
    - Fouling of the punker plate
    - Poor Combustion efficiency ie as low as 70%
  - Common Feed water tank Temp 51$^{o}$C
- Observations in Steam Distribution
  - Lines oversized leading to higher condensation losses
  - Inadequate main line trapping

# Case Study - Metro Dairy

Forbes Marshall
Trusted Partners.
Innovative Solutions.

- Observations in Steam Utilisation
  - Temperature overshoot — On hot water tank (ice cream plant) and crate washer
  - Pasteurization — Indirect heating DT is $6^o$
    High regeneration efficiency
    Adequate process automation
  - Reduce flow rate of water circulation on CIP

- Observations on Steam Traps
  - Check feasibility of stall conditions across Temp controlled PHEs

- Observations on Condensate Recovery
  - Condensate Recovery improvement from 38 to 78%

Result of SPFC from 163 to 210 ie savings of Rs 23 Lakhs

Forbes Marshall

Trusted Partners.
Innovative Solutions.

# Thank You