NHS Sustainable Development: 14th February 2012

‘Reduce Energy Consumption Through Steam System Modernisation’

Presentation by: Andy Bennett
National Key Account Manager
Overview

1. Thermal Energy International — Who Are We?
2. Government Energy Reduction Targets
3. Why is steam still used in Industry?
4. Steam system Walkthrough
5. Key components of the steam system
   1. Boiler
   2. Steam distribution system
   3. Heat exchangers
   4. Steam Traps
   5. Condensate return system
   6. Hotwell
6. Where do these energy losses occur
7. How to fund these improvements
Thermal Energy International

- Committed to reducing waste energy and reducing consumption through steam system modernisation

- Two key product ranges
  - GEM Condensate Return Systems
  - Flu Ace Flue Gas Condensing Economisers

- Working closely within a variety of industries with
  - Private Sector Organisations
  - Public Sector Organisations
Government Targets

<table>
<thead>
<tr>
<th>Year</th>
<th>Target</th>
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<tbody>
<tr>
<td>2020</td>
<td>34% Reduction</td>
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<tr>
<td>2050</td>
<td>80% Reduction</td>
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</table>

How Can These Targets Be Achieved?

- Climate Change ACT
- Carbon Budgets
- SOGE Targets
- CRC Energy Efficiency Scheme: 20,000 large private and public sector organisations are involved in the CRC Energy Efficiency Scheme

Source: [www.decc.gov.uk](http://www.decc.gov.uk)
Best Practice in steam system operation

↑ Efficiency

ŷ Productivity

ź Costs

ź CO₂ Emissions
Best Practice in steam system operation

- Decrease CO₂ Emissions
- Decrease Costs
- Increase Efficiency
- Increase Productivity
Why use steam? More efficient

Available energy

Steam Pressure (bar)

Energy (kJ/kg)

Latent
Sensible
Why use steam? More practical

- Easy to control temperature / pressure relationship
- Relatively constant temperature
- High temperatures
- Non toxic
- Freely Available

Variation of temperature with steam pressure

Steam Pressure (bar)

Steam Temperature (°C)
Steam system walk through

- Boiler
- Distribution system
- Heat Exchanger
- Steam Trap
- Condensate Return
- Hotwell
- Distribution system
Steam system walk through

- Boiler
- Distribution system
- Heat Exchanger
- Hotwell
- Condensate Return
- Steam Trap
Boiler heat losses

Fuel 100%

Boiler Flue gasses 18%

Steam 75%

Shell Losses 4%

Blow down 3%
Boiler economiser

Conventional Economiser
 Extract sensible heat from flue gasses
 Limited by the dew point temperature
 Used for preheating boiler feed water
 Typical savings = 2 to 4 %

Condensing Economiser / Heat Recovery
 Extract sensible and latent heat
 Limited to gas boilers
 Lower heat recovery temperature
 Typical savings = 15-18 %
Condensing Heat Recovery System

Waste Flue Gas Sources:
- Institutional & Industrial Boilers
- Gas Turbine or Engine Cogen

Energy Recycling for:
- Process Make-up Water
- Heating
- Boiler Make-up Water Heating
- Process Liquid Heating
- Dryer Make-up Air Heating
- Combustion Air Heating
- Ventilation Make-up Air
- Heating
- Mixed Air Heating
- Perimeter Radiation Heating
- Domestic Hot Water Heating

15% to 18% Typical Energy Savings
How FLU-ACE® Works

• Extract Sensible and Latent Heat

• The blue area to the right represents latent heat, the brown area sensible heat

• Heated water is circulated at up to 65°C to various heat users

• With indirect design the primary circuit water can be raised to 90°C
Flu Gas Economiser Case Study

Belfast NHS Trust

Benefits

- 3 Hospitals Converted
- £400,000 + saved annually in energy
- Payback within 12 months.
Flu Gas Economiser ï Case Study

St George’s Healthcare NHS Trust

Benefits

Å Recently Converted
Å Savings of 1.5mW/h,
Å Circa £330,000 + saved annually in energy
Å Payback reduced by 12 months from original estimate.
Steam system walk through

Boiler

Hotwell

Distribution system

Condensate Return

Steam Trap

Heat Exchanger
Steam Distribution system

Steam mains contain:
- Steam
- Condensate
- Air
- Dirt / debris
Dirt pockets

- Every 30-40m (more frequently on uphill sections)
- Before a rise
- Before CVs and PRVs
## Insulation

<table>
<thead>
<tr>
<th>Insulation thickness (mm)</th>
<th>Bare pipe loss (W/m)</th>
<th>Insulated pipe loss (W/m)</th>
<th>Installed cost (£)</th>
<th>Annual heat saving (kWh)</th>
<th>Annual cost saving (£)</th>
<th>Payback (months)</th>
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<tr>
<td>25</td>
<td>1,300</td>
<td>118</td>
<td>361</td>
<td>47,808</td>
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<td>489</td>
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<td>739</td>
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Steam system walk through

- Boiler
- Hotwell
- Distribution system
- Heat Exchanger
- Condensate Return
- Steam Trap
Steam system walk through Heat exchangers
Plate vs. Shell and Tube heat exchangers

Plate heat exchangers

+ Improve heat transfer, compact, more responsive, no annual pressure tests

- More susceptible to leaks, small diameter flow paths
Plate vs. Shell and Tube heat exchangers

S & T heat exchangers
+ More robust design, can cope with suspended solids, no leaks
- High surface heat losses, bigger footprint
Steam system walk through

Boiler → Distribution system → Heat Exchanger

Hotwell → Condensate Return → Steam Trap
What is a steam trap?

- Differentiates between steam and condensate
- Discharges condensate, air and incondensable gasses
- Retains steam within the system until it has given up its energy
Types of steam trap

- Mechanical
  Oversized orifice, opening and closing mechanism
    - Float
    - TD
    - Inverted Bucket

- Orifice plate
  Sized orifice, Constant conditions

- Venturi orifice
  Sized orifice, self regulating over varying loads
Types of mechanical traps

Float Trap
Types of mechanical traps

Inverted Bucket Trap
Problems with mechanical traps

- Parts, Parts and More Parts
- High Failure Rates – Typically 10% per year
- Oversized Orifice, Significant Failure Path for Steam
- Complex Mechanisms, Millions of Cycles
- Live Steam Passes to Operate Trap by Design
# Losses through failed traps

<table>
<thead>
<tr>
<th>Trap size</th>
<th>Orifice dia (mm)</th>
<th>Steam loss kg/hr</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>6 barg</td>
</tr>
<tr>
<td>DN15</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>DN20</td>
<td>5</td>
<td>24</td>
</tr>
<tr>
<td>DN25</td>
<td>7.5</td>
<td>55</td>
</tr>
<tr>
<td>DN40</td>
<td>10</td>
<td>98</td>
</tr>
<tr>
<td>DN50</td>
<td>12.5</td>
<td>152</td>
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</table>

No of traps on site = 150
Average size = DN20
Steam pressure = 6 barg
Steam loss/ failed trap = 24 kg/hr

*Reference Spirax Sarco website
Losses through failed traps

Annual steam loss
3,132 tonnes/yr

Steam cost
£20/tonne

Cost of failed traps
£62,640/yr

Plus 476 tonnes CO$_2$ / yr

Equivalent to removing 144 cars off the road!
The GEM Venturi Steam Trap
How Does The GEM Trap Work?

- High Pressure
- Steam
- Low Pressure
- Condensate

FLOW
University lab results:
Most efficient over variable loads

Condensate flow (expressed as flow level in cm of liquid in evaporative column of test rig (cm))

Steam loss (kg hr\(^{-1}\))
The Operational Benefits of the GEM trap system

- No moving parts = increased reliability
- Energy Savings of 11% +
- Permanently Eliminates Live Steam Loss
- 10 year performance guarantee
- Project Payback Typically 12 to 24 months
GEM® Condensate Return System ï Case Study

Salisbury District Hospital

Benefits

Â Eradicated steam trap failure
Â 10% Reduction In Steam Consumption
Â £40,000 Saved Annually
Â Project Payback Within 18 months
Steam system walk through

- Boiler
- Hotwell
- Condensate Return
- Distribution system
- Steam Trap
- Heat Exchanger
Condensate return system

Recycles the remaining energy in the condensate by returning it to the hotwell. 3 main types:

1. **Discharge to drain** - total loss of all energy and treated water
2. **Vented return system** - reuses condensate and sensible heat
3. **Pressurised return** - Reuses the condensate, sensible heat and flash steam
Flash steam recovery check list

Need a low pressure application
  ▪ Similar demand profile
  ▪ Located close to high pressure system
Flash vessel require insurance inspections

Examples
  ▪ Large air heaters
  ▪ Boiler feedwater temperature increase
  ▪ Space heating systems (seasonal)
Steam system walk through

- Boiler
- Distribution system
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- Hotwell
Steam system walkthrough - Hotwell
Energy Losses In A Typical Steam System

100% fuel input

18% stack losses
3% standing loss
2% blowdown loss
5% condensate loss/flash
5% pipework insulation loss
10% steam trap loss
2% pipe leakage

55% useful heat output
For every £1 spent on fuel you only get 55p of useful energy!!!

TEI can recover

- Steam Traps ì 10%
- Stack Loss ì 18%
- Flash Steam ì 5%
- Boiler Blowdown ì 2%
- Insulation ì 5%

40%

For every £1 spent on fuel you get 95p of useful energy!!!
How To Fund These Improvements
Subscription
Subscription is a managed service paid for out of savings

Immediate savings
Subscription

Includes everything

Use of Equipment
Support
Maintenance
Replacement parts

....it’s all about SERVICE
Subscription Principles

Subscription puts focus on benefits and delivers a service capability.

- All-inclusive subscription
  - installation
  - Hardware
  - Systems
  - On-going Services

No customer ownership
“If it appreciates, buy it; If it depreciates, rent it”

J. Paul Getty
EVERY DAY YOUR MONEY IS GOING DOWN THE DRAIN

The Thermal Energy managed service will cut your energy cost and reduce your carbon footprint WITHOUT INVESTING A PENNY.
Private Finance – Capital Purchase

Example – Capital Purchase
Capital Cost = £100,000
Energy Savings Per Year = £50,000
Project Payback = 2 Years

ON BALANCE SHEET REQUIRES CAPITAL SANCTION. COST NEGATIVE FOR 2 YEARS
Subscription Example

5 year rental paid quarterly inline with savings = £22,000 per year
Energy Savings Per Year = £50,000
Net Annual Saving = £28,000

- OFF BALANCE SHEET OPERATING LEASE
- RENTALS OUT OF SAME OPERATING BUDGET THAT ARE MAKING THE SAVINGS
- CASH POSITIVE FROM THE START
- NO DEPRECIATING ASSETS
- QUICK DECISION
- AFTER 5 YEARS HAVE OPTION OF TERMINATING RENTAL, CONTINUATION AT REDUCED FAIR MARKET VALUE RENTAL, OR CAN REFRESH THE TECHNOLOGY ON NEW AGREEMENT
Impacting Your Emissions Targets

Further reducing up to 19% of overall carbon emissions through steam system modernisation.
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Case Study: Royal National Orthopaedic Hospital, Stanmore

Presentation by: Matthew Hardy
General Manager (Estates)
GEM® Condensate Return System
Royal National Orthopaedic Hospital, Stanmore

- Used on RNOH since 1998
- No trap Maintenance required
- Energy and Carbon Reduction
- 10 year Guarantee
- Sized for each application
GEM® Condensate Return System
Royal National Orthopaedic Hospital, Stanmore

Benefits

- Circa 10% Reduction In Steam Consumption
- Circa 10% Reduction In Carbon Emissions
- Project Payback Within 18 months
FLU-ACE® Condensing Heat Recovery System
Royal National Orthopaedic Hospital, Stanmore

- Recovering waste Heat for Boiler Flues
- Preheats Boiler Feed water and tops up Hydronic loop
- Reduces load on Boilers
- Includes kWh and Carbon metering
Benefits

- 578 Tonne Reduction In Carbon Emissions Per Year
- £68,929 Saved Annually
- Looking at extending heat use for further savings
Any Questions?

Stand 16: The Brewery