Industrial Energy Efficiency Project in South Africa

Case Study – ESO Interventions

Company name	**AMKA PRODUCTS**
Sector	**FAST MOVING CONSUMER GOODS**
Year joined IEE Project	**2014**
Year of interventions	**2014**
Contact person	**MR JAPIE HERBST**
Systems of intervention	**STEAM SYSTEM**

1. BACKGROUND

1.1 Company profile

AMKA Products manufactures personal care products, hair care products and home care products. Products in the company's portfolio include shampoos, lotions, skin creams, hair relaxers, bubble baths, cleaning chemicals and dishwashing liquids. Product is distributed throughout South Africa, the company's home country, but also to 34 other countries throughput Africa.

The company produces over 400 products in total, and employs over 1000 people. Manufacturing is carried out at 4 facilities, and the company is in the process of a significant expansion which will see the commissioning of a new facility in Sunderland Ridge, Centurion, close to the South African capital, Pretoria.

Plant profile

AMKA Products' Sunderland Ridge factory was the Candidate Plant for a Steam System Assessment. This factory manufactures hair care and personal care products, and comprises a blending facility and several high-speed packaging lines. This site employs 500 people.

1.2 Nature of challenges

AMKA Products operates in a competitive market where cost leadership is the key to market share. The company's steam-related costs were considered to be a significant challenge, and AMKA Products' management recognised that these were out of line with those of competitors. Energy efficiency in the steam area was considered to be an opportunity to both reduce these costs and mitigate the company's emissions. AMKA Products did not however possess the necessary skills to improve efficiency, and hence participation in the IEE Project was considered a way to access expert support with respect to this strategic issue.

2. OVERVIEW OF IMPLEMENTATION

2.1 Steps taken and Interventions

AMKA Products focused on “low-cost/no-cost” implementation options, which included maintenance tasks such as steam leak and steam trap repairs, optimisation tasks such as excess air reduction and plant modifications, such as the installation of piping for increased condensate recovery and the insulation of heated vessels.

Specific interventions implemented were:

- Repairs to steam leaks
- Repairs and replacements to faulty steam traps and implementation of a routine trap maintenance programme
- Insulation of the hot reverse osmosis water storage tanks
- Insulation of the hotwell, including the installation of a new boiler feedwater pump to cope with increased NPSH requirements
- Insulation of the heated petroleum jelly storage tanks
- Recovery of condensate from the reverse osmosis heating units
- Recovery of condensate from hot water production
- Installation of a variable speed drive on the boiler forced draft fan, and optimisation of flue gas oxygen

2.2 IEE capacity building programme

3 of AMKA’s employees attended Advanced Steam Systems Optimisation training through the IEE Project. These were:

- Sarish Harisunkar – Industrial Engineer
- Brian Kuppusami – Environmental and ISO Systems Manager
- Jaco Odendaal – Projects Technician

3. KEY ACHIEVEMENTS

Key findings table -

Implementation Period (yyyy-yyyy)	**2014**
Total Number of project	**8**
Monetary savings in ZAR/annum	**R1,260,181/annum**
Energy savings in KWh/annum	**1,261,827 kWh/annum**
Total investment made ZAR	**R437,000**
Payback time period in years	**0.35 YEARS**
GHG Emission Reduction (ton CO2)[1]	**330 TONS CO_2/ANNUM**

The site was assessed using the Steam System Scoping Tool (SSST), and measurements were taken. These included ultrasonic and thermal analysis of steam traps, surface temperature measurements, boiler flue gas analysis and boiler forced draft fan power measurements. Mass and energy balances were used to allow modelling of steam consumption and condensate recovery rates. Individual elements of the steam system were evaluated followed by a systems-level analysis using the Steam System Assessment Tool (SSAT). Opportunities were identified and potential savings were quantified, with the most attractive options prioritised for implementation.

The site repaired all steam leaks identified over the course of the assessment during a planned shutdown of the steam system. Passing and blocked steam trapped were removed and either repaired or replaced. Routine steam trap surveys have now been included in the maintenance programme for the site. Condensate return lines were installed to allow for the recovery of condensate from hot water production and from water heating in the reverse osmosis water treatment facility.

Insulation opportunities were handled as a single project in order to limit costs. In total, 6 vessels were insulated, and these were the hotwell used to collect condensate and blend this with make-up water, the three petroleum jelly storage tanks and the two reverse osmosis water storage tanks. The vessels were insulated with mineral wool and cladded. This reduced heat losses from the steam system, and hence reduced required heat input.

During the assessment an attempt was made to reduce excess air by modulating airflow using the forced draft fan damper valve. This exercise showed that the fan was oversized, and hence a variable speed drive was recommended in order to reduce airflow. The variable speed drive was used to reduce fan speed, and hence flue gas oxygen could be reduced to 3%, thereby significantly reducing stack losses.

[1] Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA, Conversion factor set at 2.69 kg CO_2 per litre of paraffin.

4. HIGHLIGHTS OF ESO INTERVENTIONS

Please populate the table below with the information required.

System	Energy Carrier (i.e. electricity, LPG,etc.)	Intervention	Period of Implementation (yyyy-yyyy)	Investment ZAR	Savings ZAR/annum	Payback Yrs	Energy saving (kwh)	GHG Emission Reduction (Kg CO2/year)
Boiler Forced Draft Fan	Paraffin	Installation of a variable speed drive and optimisation of excess air	2014-2014	30,000	175,000	0.17	185,223	48,531
Petroleum Jelly storage tanks	Paraffin	Insulation of the three tanks to reduce heat losses, thereby reducing steam requirements.	2014-2014	150,000	293,000	0.51	299,533	78,481
Hot water production	Paraffin	Installation of a condensate recovery line to allow collection of condensate from hot water production	2014-2014	2,000	35,000	0.05	28,577	7,488
Reverse Osmosis Plant	Paraffin	Insulation of the reverse osmosis water storage tanks and recovery of condensate from the concentric pipe heat exchangers used to heat the water	2014-2014	120,000	458,000	0.26	439,244	115,087

4. HIGHLIGHTS OF ESO INTERVENTIONS (CONT.)

System	Energy Carrier (i.e. electricity, LPG,etc.)	Intervention	Period of Implementation (yyyy-yyyy)	Investment ZAR	Savings ZAR/annum	Payback Yrs	Energy saving (kwh)	GHG Emission Reduction (Kg CO2/year)
Boiler Feedwater system	Paraffin	Insulation of the hotwell used to store returned condensate and make-up water	2014-2014	80,000	90,181	0.88	185,223	25,008
Steam distribution system	Paraffin	Repair passing steam traps and steam leaks	2014-2014		209,000	0.51	299,533	78,481

If the energy carrier is not electricity, please specify the specific energy content factor used as well as the source.

4.2 Details of interventions

Details of the different ESO interventions:

Opportunity 1: Excess Air Reduction

- Opportunity identified and objective: Excess air levels in the boiler flue were too high, leading to excessive stack losses. The aim of the intervention was to reduce the excess air to benchmark levels for the fuel used.
- Changes made: A variable speed drive was installed on the forced draft fan to allow the amount of air used to be reduced
- Results of changes: Flue gas oxygen levels were reduced to 3%, reducing stack losses from 16.9% to 14.8%

Boiler with Fan visible in foreground

Initial attempts to reduce excess air using the damper valve were marginally successful because the damper valve position was too "closed". Use of a VSD allows this valve to be opened and for air flow to be controlled by the fan speed. This gives a more linear response characteristic, finer control of excess air and hence improved management of stack losses.

Opportunity 2: Petroleum Jelly Tanks Insulation

- Opportunity identified and objective: The three petroleum jelly storage tanks were found to be uninsulated, leading to heat losses that had to be compensated for through the use of additional steam in the vessel jackets. The objective of the intervention was to reduce heat losses by insulating the storage tank surfaces.
- Changes made: Mineral wool insulation and metallic cladding were used to insulate the tanks while also providing a pleasing appearance to the modifications.
- Results of changes: Heat losses from the vessels were minimised, with an estimated reduction in losses of 87%.

Insulation of the Petroleum Jelly storage tanks was one of the most significant projects carried out. Condensate recovery from these tanks was rendered unnecessary due to the significant reduction in steam required to maintain temperature.

Tanks Before Insulation

Tanks After Insulation

Opportunity 3: Recovery of condensate from Hot Water Production

- Opportunity identified and objective: Condensate from the heat exchanger used to produce hot water for bucket cleaning was discarded to drain, leading to a loss of water and energy. The objective of this intervention was to return the condensate to the hotwell, where it could be used to supplement boiler feedwater.
- Changes made: A pipeline was installed downstream of the steam trap, and connected to a common condensate return line. All of the condensate from hot water production was recovered.
- Results of changes: Roughly 44 kg/hr of 6barg condensate is being recovered as a result of the pipeline.

Hot Water Steam Trap Discharging to Drain

The steam trap downstream of hot water production was discharging to drain. The site has piped this into the condensate return line.

Opportunity 4: Insulation of RO Water Tanks and Condensate Recovery from RO Water Heating System

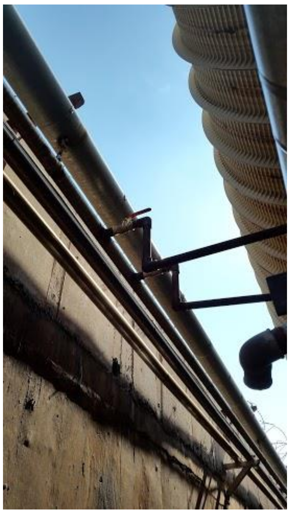
- Opportunity identified and objective: The Reverse Osmosis Water Storage Tanks were uninsulated, leading to excessive heat losses from their surfaces. In addition, the condensate from the heat exchangers used to heat this water was being discarded to drain, leading to losses of energy and water. The objective of the intervention was to minimise heat losses and eliminate condensate losses.

- Changes made: Mineral wool insulation and metallic cladding were used to insulate the tanks while also providing a pleasing appearance to the modifications. The two heat exchanger condensate lines were connected to a common condensate return line directing all condensate from these heat exchangers to the hotwell.

- Results of changes: Heat losses from the RO Water Storage Tanks were reduced by 91.5%. An average condensate flow of 190 kg/hr is now being recovered to the hotwell as a result of the insulation and condensate recovery changes

The condensate discharged from the RO Plant heat exchangers used to go to the drain. It is now recovered to the hotwell.

Before: Condensate Discharged to Drain



After: Condensate Recovered to Hotwell

Opportunity 5: Hotwell Insulation

- Opportunity identified and objective: The hotwell was uninsulated, leading to excessive heat losses. The objective of the intervention was to reduce heat losses by insulating the hotwell.
- Changes made: Mineral wool insulation and metallic cladding were used to insulate the tanks while also providing a pleasing appearance to the modifications.
- Results of changes: Heat losses from the vessels were minimised, with an estimated reduction in losses of 87%.

Hotwell Before Insulation

Hotwell After Insulation

Previous Pumps

Insulated Hotwell

New Pumps

Insulation of the hotwell and the increase in condensate recovery rates increased feedwater temperature significantly. Due to NPSH limitations, the feedwater pumps had to be replaced.

Opportunity 6: Fix Leaking Steam Traps

- Opportunity identified and objective: A steam trap audit identified 13 passing steam traps, which would transfer steam either into the atmospheric condensate recovery system or discharge this steam to atmosphere where condensate was not being recovered. The objective of this intervention was to eliminate the losses arising from these traps.
- Changes made: Each of the failed steam traps was either repaired or replaced. An annual steam trap audit programme was instituted.
- Results of changes: Resolution of the steam trap problems is estimated to have reduced the total steam requirement for the site by 2.6%.

RO Plant Steam Traps

The steam trap audit conducted during the assessment identified 13 passing traps and 9 plugged traps. All of these were repaired. In addition the site repaired a number of steam leaks during a shutdown scheduled for shortly after the assessment was completed. In general, steam leaks are not a major problem at Amka Products.

Opportunity 7: Fix Steam Leaks

- Opportunity identified and objective: A small number of steam leaks were identified from the plant walkthrough. The objective of this intervention was to eliminate the losses arising from these leaks.
- Changes made: Each of the identified leaks was fixed during a scheduled plant shutdown. A leak management programme was instituted.
- Results of changes: Resolution of the steam leak problems is estimated to have reduced the total steam requirement for the site by 0.3%.

5. PROCESS CHALLENGES

AMKA Products experienced a few challenges during implementation:

- It was not possible to insulate the tops of the Petroleum Jelly Storage Tanks since these are stood upon by workers during the offloading process. It has been proposed that platforms be constructed to at the tops of each tank to allow them to be insulated.
- The increased condensate recovery rate and the insulation of the hotwell led to an increase in the water temperature inside the hotwell of approximately 20 deg.C. This caused cavitation of the existing boiler feedwater pumps. The pumps had to be replaced with a new multistage centrifugal pump in order to meet net positive suction head (NPSH) requirements.
- The initial excess air reduction recommendations involved use of the FD fan damper valve to reduce the oxygen concentration in the boiler flue gas. Upon use of the valve, it was found that even when it was almost completely closed, oxygen levels still could not be reduced much below 5%, while the target specified was 3%. This effectively meant that the existing FD fans are too large for the duty, and hence it was then recommended that the speed of these fans be reduced to reduce the airflow. This was achieved through the use of a variable speed drive.
- It was initially recommended that the steam flow supplied to the shrink-labelling tunnels be stopped when each packaging line was stopped in order to save steam. It was however subsequently found that the time required for the tunnels to warm up was too long to make this recommendation practical, and hence it was not implemented.

6. FUTURE PLANS

The major outstanding initiatives at AMKA Products are:

- Installation of a feedwater economiser, which would reduce flue gas temperature and increase boiler efficiency.
- Installation of a blowdown energy recovery system which would produce low-pressure steam and recover energy from low-pressure saturated liquid produced in the flash tank. This options would require a modification to allow for continuous surface blowdown.
- Switching fuel to natural gas or heavy fuel oil.

All of these opportunities are possibilities for implementation at AMKA Products. In the short-term, the site is looking into a switch to heavy fuel oil as a fuel. Cost savings are significant at R2.6M/annum, but some modifications are required to the site's fuel-handling system to allow for heating of the oil prior to use.

The installation of the economiser and blowdown energy recovery systems require a decision to be made about the long-term future of the site, since a new manufacturing facility is being built and management have yet to decide on whether the current facility will be retained, or if steam generation assets will be relocated. The new facility is planned to come on stream in 3 years' time.

7. BENEFITS & LESSONS LEARNED

AMKA Products did not really have any systems in place for the management of steam systems prior to the completion of the project. The biggest learning to come out of the project was therefore with respect to the key performance indicators required for ongoing steam system management, and how these relate to actions taken throughout the steam system to drive efficiency.

The IEE project has reduced the costs of AMKA Products' steam system, ultimately allowing the company to increase profits. The project has also raised awareness with respect to the benefits of energy efficiency, so much so that AMKA Products has commissioned a special project to design energy efficiency into the new facility that the company is planning to build. This marks a significant shift in the company's culture towards one in which energy efficiency is integrated into everyday decision-making.

"Energy Efficiency is about systems. Not just the technical systems involved in the use of energy, but also the broader system encompassing markets, technology, people, shop floor work practices and management processes."