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Project

Industrial Pollution Prevention

Case Study: Food Sector

Water and Energy Conservation

Edfina Company for Preserved Food, Alexandria, Egypt
Kaha, Company for Preserved Food, Kaha, Egypt

INTRODUCTION

Energy consumption was reduced through a number of low cost interventions at both Edfina Company for Preserved Food (Edfina) and Kaha for Preserved Food (Kaha). Total cost of implementation at both factories was LE462,185 and resulted in annual savings of LE548,572. At Edfina additional measures to reduce water usage were implemented at a cost of LE98,165 and yielded annual savings of LE119,400.

THE FACTORIES

Edfina is a public sector company and its factory at Montazah, Alexandria is one of the largest producers of preserved foods in Egypt. Built in 1958 on 56,000 m^2 the companys workforce has been recently reduced, ahead of Government privatisation plans, to its current level of 600 employees. Kahas factory was built in 1976 on 83,800 m^2 and is located in Kaha within the Govenorate of Qalubiya. The factory was privatised in 1998 and employs 650 staff.

Steam pipe insulation in progress in the boiler house

Process Descriptions

Production lines in the factories are typically:

- ***Fruit Juices*** - fresh fruits are received, sorted, washed and squeezed. Pulp is heated, screened and mixed with ingredients. The mixture is heated, screened, homogenised, either bottled or canned then pasteurised. Product is incubated before final packaging and storage.
- ***Jam*** - fresh fruits are sorted, washed, peeled then cut. The fruit is then mixed with sugar, steam cooked and concentrated under vacuum. Concentrate is packed in tin cans, or jam pots, sterilised and stored.
- ***Frozen Vegetables*** fresh vegetables are received, weighed, sorted, trimmed, peeled and cut manually. Peeled vegetables are sorted, blanched, frozen, sieved, and packed.
- ***Canned Beans*** - green beans are received, weighed, sprayed with insecticide, sieved, sorted, dip and spray washed, and soaked. This is followed by steam cooking, rapid cooling and final sorting. Cooked beans are seasoned, canned and sterilised.

- ***Tomato Paste*** - raw tomatoes are received from suppliers, weighed, sorted and washed. Clean sorted tomatoes are pressed for juice and screened. Seasoning is added and juice is concentrated under vacuum and heat treated. Paste is automatically canned, sterilised, sealed, cooled and stored.

Production at both factories is seasonal and is summarised below. Production levels are currently below full capacity.

Production of Preserved Foods for 1996/97

Production Line	Edfina (tons)	Kaha (tons)
Fruit juice	4,484	1,997
Jam	3,839	1,358
Canned vegetables	231	69
Canned beans	1,428	3,150
Frozen vegetables	812	253
Tomato paste	519	840
Other	258	109
TOTAL	**11,571**	**7,776**

Process and Service Units

Both factories have can making, canning facilities and freezing units on site. Service units include a water treatment facility, boiler station, quality control laboratories, freeze-storage and refrigerators in addition to cooling towers, garages and maintenance workshops.

Energy Consumption

Electricity is generally used for the process machinery, process control and lighting. Mazot is used as boiler fuel and solar is used for vehicles and in the varnishing and printing plant. Kaha is switching its boiler fuel from mazot to solar.

Electricity and Boiler Fuel Consumption, 1996/97

	Edfina	Kaha
Electricity (kWh)	5.95 million	2.78 million
Boiler fuel oil (tons)	2,419	1,890

For steam raising there are 2 boilers (each 12t/h) at Edfina and 4 boilers (3x12t/h, 1x6t/h) at Kaha. At Kaha 75% of the steam is used in concentration, 14% in sterilisation and 11% in cooking. By production line, 48% of steam is used in the juice and jam section, 30% in tomato paste and 22% for frozen vegetables and beans.

Water Consumption and Wastewater

Edfina uses municipal water while groundwater, pumped from 6 wells and softened using an ion exchange unit, is used at Kaha. Water is used extensively in vegetables and food washing , cooling processes, in inducing vacuum in the evaporators and for equipment and floor washing. Typical consumption and usage is given below.

Water Consumption

	Edfina	Kaha
Water consumption	700,000m^3	936,000m^3
Water use		
- process and washing	41%	67%
- cooling	42%	32%
- domestic use	17%	1%

Edfina discharges around 520,000m^3/year of untreated effluent into the public sewer system and is in the process of installing a wastewater treatment plant. At Kaha 784,680m^3/year are discharged into the El-Qalubiya Drain.

CLEANER PRODUCTION OPPORTUNITIES

Industrial audits at both factories had highlighted excessive energy and water consumption. Follow up energy and water audits identified the following problems:

Energy Issues

- Steam leaks from the process and steam lines are evident throughout both plants.
- Significant heat losses through poor steam line insulation.
- Condensate is frequently discharged to the drain.
- Poor maintenance resulting in steam losses from existing steam traps.
- Lack of steam traps on some jacketed equipment.
- Can sterilisation done by direct steam injection in water resulting in excessive steam losses.

Water Issues

- Excessive water consumption due to open cooling cycles and water leaks.
- Some cooling towers out of order.
- Insufficient cooling water recovery systems.
- High water use in vegetable washing.
- High water use for equipment and floor washing.
- Taps and hoses left running.

CLEANER PRODUCTION APPLICATIONS

The energy audit focused on fuel and steam consumption. The factories had previously addressed electricity usage and hence only power factor measurements were recorded by SEAM. Power factors were less than the Utility contract value of 90%, which may result in contract penalties. Upgrading the correcting capacitor will allow optimisation of the power factor.

Similar measures to reduce steam and heat losses, thereby saving energy and water, were implemented by the SEAM Project at both factories. Interventions to reduce water usage were only undertaken at Edfina. It should be stressed that the savings indicated are based on current production levels and would increase 2-3 times when the factories are operating at maximum capacity.

Energy Saving Measures

Insulation of Bare Steam Pipes

Heat losses occurred due to a lack of insulation on many steam pipes and poorly maintained lagging on others. Rockwool insulation of 80kg/m^3 density was used to insulate 1475m of bare steam pipe at Edfina and 485m at Kaha. Steam pipe diameters varied from 1 inch to 24 inch and insulation thickness ranged between 50-75mm.

Steam savings are estimated at 5,394m^3/y at Edfina and 2,123m^3/y at Kaha. Fuel savings are 440t/y and 162t/y respectively.

Replacement of Leaking Steam Traps

Kaha and Edfina use steam jacketed equipment in fruit and tomato pre-cooking, juice pasteurisation, jam vacuum cooking, tomato paste concentration and bean pressure cooking. Only some of the equipment was fitted with steam traps. In addition, many existing steam traps were defective resulting in wasted steam and higher output of the boiler. At Kaha 24 steam traps (thermodynamic type) were installed on pipes varying from 0.5-2 inch diameter, and 35 steam traps were installed at Edfina on 0.5-1 inch diameter pipes.

Steam savings are estimated at 1,362m^3/y at Edfina and 933m^3/y at Kaha. Fuel savings are 111t/y and 71t/y respectively.

Replacement of Leaking Steam Valves

Steam was often wasted through leaking steam valves. At Kaha 74 high pressure (16 bar) leaking steam valves, ranging in size from 0.75-6 inches were identified in the juice, jam, tomato and frozen vegetable lines. At Edfina 98 leaking steam valves were identified varying in size from 0.5-4 inches. Each defective valve leaks 7.5kg/h of steam.

Replacement of the defective valves resulted in steam savings of 799m^3/y at Kaha and 1,055m^3/y at Edfina. Fuel savings are 61t/y and 86t/y respectively

Installation of Pressure Regulators on Sterilisers

Sterilisers for the juice, jam and tomato paste production use water heated with direct steam. To avoid excessive steam losses in these production lines 4 temperature controllers with automatic pressure regulators were installed (in each factory) on steam lines entering the sterilisers. The temperature controller-steam regulator regulated steam flow according to hot water temperatures; reducing steam pressure from 8 bar to 2 bar resulted in steam savings of 1,000kg/h per regulator.

Steam savings are estimated at 3,600m^3/y at Edfina and 3,600m^3/y at Kaha. Fuel savings are 294t/y and 343t/y respectively.

Recovery of Steam Condensate

Condensate recovery systems existed for 2 of Edfinas 3 tomato evaporators (double and triple effect evaporators) while Kaha had none. A condensate recovery system was installed for Edfinas third and most frequently used batch evaporator that has a capacity of 15t/d. For Kaha the most suitable jacketed equipment for condensate return were the tomato pre-cookers and the evaporators used for tomato juice concentration to tomato paste. Maximum capacity of the Kaha evaporators is 40t/d.

Each ton of paste required 3.75 tons of tomato juice, releasing 2.75 tons of water vapour. The evaporators operate at 0.7 bar and 80°C. By recycling the condensate water savings of 3,867 t/y and 10,670 t/y were achieved at Edfina and Kaha respectively. Fuel savings were correspondingly 29t/y and 74t/y.

Improving Boiler Efficiency

Flue gas analyses were undertaken in order to assess the fuel to air ratio. Boiler efficiencies at Kaha were 86% for two of the boilers and around 79% for the other two. At Edfina boiler efficiencies were 80.6% and 83.5%. By reducing the air fuel ratio to 20-30% excess air, boiler efficiencies were improved at both factories by an average of 3%, thereby saving fuel costs. Fuel savings were estimated at 85t/y for Edfina and 77t/y for Kaha.

Water Saving Measures (Edfina Only)

Overall water consumption is 650-750m^3/d. Water saving measures implemented are summarised below. In addition water meters were placed in 13 locations in the factory to monitor water consumption.

Installation of Hose Nozzles

clean tanks and wash floors in the tomato paste section, resulting in excessive water use and floor flooding. On/off spray nozzles were fitted to allow flow only when required. Water savings are estimated at 9,000m^3/y.

Improving Water Collection on the Dowe-Pack Juice Line

Cooling water from the Dowe-Pack juice line is collected in a tank and recycled. The tank is undersized resulting in overflows. A larger tank was installed together with a new water pump. Annual water savings are 24,000m^3/y.

Installation of a Cooling Tower for the Bottled Juice Line

Juice bottles are sterilised in tunnel sterilisers at 85-90°C and then cooled using municipal water in an open cycle. To recover and recycle cooling waters a cooling tower with a capacity of 60m^3/h was installed with associated collecting sump, pumps and piping. Water savings are 86,400m^3/y.

COST SAVINGS

Cost savings have been estimated on current production levels and would increase 2-3 times when both factories are at full production. Annual savings indicated are based on fuel savings, which account for 85% of the cost of steam. Cost benefits for the various interventions are summarised below.

Energy Savings - Cost Benefits, Edfina

	Mazot Savings (tons/year)	Costs of Works (LE)	Annual Savings (LE)	Payback (months)
Insulation of steam pipes	440	124,212	80,080	19
Replacement of leaking steam traps	111	13,976	20,202	9
Replacement of leaking steam valves	86	46,990	15,652	36
Installation of pressure regulators	294	43,560	53,508	10
Recovery of steam condensate	29	33,182	9,060	44
Improved boiler efficiency	85	0	15,470	0
TOTAL	**1,045**	**261,920**	**193,972**	**17**

Energy Savings - Cost Benefits, Kaha

	Solar Savings (tons/year)	Costs of Works (LE)	Annual Savings (LE)	Payback (months)
Insulation of steam pipes	162	61,946	72,900	10
Replacement of leaking steam traps	71	14,477	31,950	6
Replacement of leaking steam valves	61	38,860	27,450	17
Installation of pressure regulators	343	45,170	154,350	4
Recovery of steam condensate	74	39,812	33,300	15
Improved boiler efficiency	77	0	34,650	0
TOTAL	**788**	**200,265**	**354,600**	**7**

Water Savings Cost Benefits, Edfina

	Water Savings (m^3/year)	Costs of Works (LE)	Annual Savings (LE)	Payback (months)
Hose nozzles	9,000	4,900	9,000	7
Rehabilitation of the Dowe Pack collection system	24,000	8,453	24,000	5
Cooling tower for juice steriliser	86,400	84,812	86,400	12
TOTAL	**119,400**	**98,165**	**119,400**	**10**

Washing of incoming tomatoes

Steam leaking from defective steam traps

BENEFITS

- Steam savings were 15,278m^3/y at Edfina and 18,125m^3/y at Kaha.
- Fuel oil consumption was reduced by 40% at Edfina and 34% at Kaha.
- Water consumption was reduced by 17% at Edfina.
- Wastewater volumes reduced.
- Energy savings implemented with an overall average payback of 11 months.
- Water savings implemented with an average payback of 10 months.

CONTACTS

More information on this project and the SEAM Project, are available from:

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The SEAM Project

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SEAM: Pollution Prevention

This is being implemented under the National Industrial Pollution Prevention Programme (NIPPP). NIPPP focuses on the introduction and promotion of low-cost improvement measures, which can be easily and quickly implemented by factories. It also emphasises the importance of economic benefits of any such intervention, particularly those with short pay-back periods.

Methodology - A Description

Pollution prevention opportunities can be identified through an industrial audit[1]. This systematically reviews the factorys operations and processes, focusing on reducing waste, improving efficiency and alleviating pollution. This aims to identify and prevent losses from occurring in the first place, rather than resorting immediately to a treatment facility.

The SEAM Project has carried out audits in 32 factories in the food, textile and oil and soap sectors, which identified a wide range of low-cost pollution prevention opportunities, including water and energy conservation, the importance of good housekeeping, in-process modification and hazardous materials substitution. The SEAM Project is presently implementing 23 of these opportunities as demonstration projects.

Benefits of Pollution Prevention

It can ***REDUCE :***

- production costs;
- losses of valuable raw materials;
- on site treatment costs;
- energy and water costs;
- the volume of solid and liquid wastes generated;
- the risk of spills and accidents.

. . . and ***IMPROVE :***

- overall operating efficiency;
- generation of income through reuse and recycling of wastes;
- this approach can be easily replicated in sister factories to achieve similar savings;
- safety of employees;
- legislative compliance;
- company image.

1 Guidelines for Industrial Audits have been prepared by the SEAM Project.