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Project

Industrial Pollution Prevention

Case Study: Textile Sector

Water and Energy Conservation

El-Nasr Company for Spinning and Weaving, Mahalla El-Kobra, Egypt

INTRODUCTION

A range of opportunities relating to water and energy conservation have been identified and are currently being implemented by El-Nasr Company for Spinning and Weaving, in Mahalla El-Kobra, Egypt. This will involve a total investment of LE283,500 and result in annual savings of LE843,056.

A summary of how these improvements were identified and the underlying problems solved, follows.

THE FACTORY

This factory is one of the larger public sector textile factories in Egypt, with annual production of over 52 million metres of fabric and around 7,000 employees. The factory was built in 1963 and is located in Gharbiya Governorate on 90 feddans of the Mahalla El-Kobra textile manufacturing centre.

The main activities are spinning, weaving and wet processing. It processes an average of 8,000 tons of raw fabric per year, of which 20% are spun cotton yarns, 12% are polyester blend yarns, and 68% is grey fabric (50% commissioned by clients), using about 1,000 ton of different processing ingredients (chemicals, dyes, auxiliaries, etc.) per year.

The main products are cotton or blended yarns, white and dyed cotton and blended fabrics, as well as terry fabrics, upholstery fabrics, and bed covers and sheets.

Installed condensate recovery system comprising collection tank, pumps, flow meter and control panel. Annual savings are LE135,100

Process Description

There are 6 main processing departments within the factory:

Weaving - warp yarns are wound, starch sized, dried and woven with the weft yarns.

Cone Pre-treatment and Dyeing - cone yarns are half or full bleached, dyed with vat, reactive or napthol dyes, soaped and then softened in Thies Kires.

Fabric Bleaching - continuous pre-treatment is either carried out in Brugman or Gaston Country bleaching ranges (rope form for pure cotton), or in the Kyoto range (open width for blends), while semi-continuous pre-treatment is carried out in the Bennenger range (open width for bed sheets). Mercerisation is carried out using either Bennenger or Textima ranges.

Fabric Dyeing and Printing - dyeing is performed by exhaustion (jiggers, hasples, jets) or by padding (continuous or cold batch). Naphthol dyeing is also carried out. Printing is carried out using reactive or pigment dyes; the fabric is printed with the printing paste, dried, and thermofixed.

Fabric Finishing - this is performed on Artos Stenters, usually as normal, resin or silicon-elastomer finishing.

Fabric Packaging - fabrics are cut, rolled or folded, then covered and packaged.

Service Units

Factory service units include boilers, cooling towers, a caustic recovery plant, water and wastewater treatment plants, laboratories, storage and maintenance facilities.

Energy Consumption

The are two main sources of energy; electricity and different types of fuel:

- Mazot, solar and natural gas are used in steam generation. 1980 ton of Mazot, 220 ton of solar, and 29 million m^3 of natural gas are consumed annually.
- Naphtha is also used in the singeing of fabric.
- 24 million kWh per year of electricity is billed by the public electricity network, of which 20% is for factory lighting.

Water Consumption

The factory uses about 1.9 million m^3/year of water, of which:

- 33% is artesian water for general use.
- 17% is used for boiler feed water.
- 50% is used in processing, consisting of water from the Mahalla Canal which is treated in the factory treatment plant.

Wastewater Generation

The factory generates around 1.5 million m^3/year of industrial wastewater from different factory departments. This is disposed to the public sewerage network, normally in compliance with the legislative discharge levels of Law 93.

POLLUTION PREVENTION OPPORTUNITIES

Pollution prevention opportunities were identified by means of an industrial audit, undertaken by the SEAM Project. This identified various improvement opportunities; a description of the most important being:

1. Dyestuffs are stored with the lids unsecured, such that hydrolysis sets in and dye shelf life is reduced.
2. Final fabric products are not given adequate protection during storage, so that soilage can easily occur.
3. Various parts of steam and hot water pipes are not insulated and a great amount of heat is wasted.
4. Steam condensate from all departments is put directly to the drain rather than recirculated as feed water, causing an unnecessary wastage of water.
5. Huge amounts of thermal energy are lost in the flue gases of the boiler which are exhausted to air.
6. Considerable amounts of hot effluent from the different units in the pre-treatment and dyeing departments are directly discharged to the sewer, with great heat losses.
7. Huge quantities of final washing water in the bleaching ranges are directly discharged without reuse.

CLEANER PRODUCTION APPLICATIONS

The measures which have been identified for implementation by the SEAM Project are briefly outlined below. During the audit stage, particular attention was paid to those improvements which could be carried out at low or no cost to the factory. These are easy to implement and often entail significant savings.

Measures Implemented

Improve Storage Facilities - Dyes and Fabrics

The storage conditions in the dyehouse store were investigated and recommendations made to prevent the hydrolysis and lumping of reactive dyestuffs. This was very simply achieved by ensuring that the dye containers were tightly closed and the storage space closed when not in use. The benefits of this action have included:

- the preservation of expensive dyestuffs,
- improved final shade and colour fastness,
- minimisation of dye discharges in the wastewater.

Similarly, proper storage practices were implemented in finished fabric storage to prevent soiling.

Implementation Cost: none
Annual Savings: LE 22,800

Material Substitution

Optimisation of Chemical Usage

The different process chemicals used in the factory were thoroughly examined, with the aim of identifying optimum process chemicals, taking into account process and fabric requirements, resource and environmental constraints. The following alternatives were identified:

Chemical Substituton

Application	*Original*	*Substitute*
Neutralisation	acetic acid	formic acid
Dyeing	sulphur and naphthol dyes	other dyes
	dyes which involve the use of heavy metals	dyes which do not involve heavy metals
Printing	ammonium phosphate	ammonium sulphate
Desizing/Scouring poly/cotton blend	Leonil LB-ET	ammonium persulphate

Benefits from this include:

- savings in process chemicals,
- reduced water consumption;
- optimised energy consumption
- reduced processing time;
- reduced wastewater loads, and
- improved operation and productivity.

Implementation Cost: none

Annual Savings: LE 35,000

Water and Energy Conservation

The factory was thoroughly inspected to determine the sources of water and energy losses. It was found that the pre-treatment and dyeing departments offered the greatest potential for savings and efforts were focused in these areas.

Collection and Reuse of Steam Condensate

Around twenty percent (310,000 ton/year) of the steam being used in the different processing departments is now being recovered in the form of condensate. This is stored in a water collection tank and is then recirculated to the process water feed lines by means of pumps and a piping network.

The benefits achieved from implementing this intervention are as follows:

- Consumption of hot water (at 95°C) will be reduced by 60,000 m^3, with associated financial savings of LE24,000 per year.
- Savings made in energy recovery will be LE84,100 per year, which is equivalent to recovering 4,200 million Kcal.
- Reduction in wastewater volume saving LE27,000 in treatment costs.

Implementation Cost: LE 45,000
Annual Savings: LE 135,100

Upgrade Insulation of Steam and Hot Water Network

In the pre-treatment department, the steam network was assessed to identify areas of heat losses. This was shown to result almost entirely from inadequate insulation.

Once all necessary insulation was completed, energy consumption was reduced, such that 6,576 million Kcal of heat will be saved annually.

Implementation Cost: LE 48,000
Annual Savings: LE 135,126

Counter Current Flow in the Kyoto Range

In the 8 washers of this bleaching range, the least contaminated water from the final wash is reused 1-2 times in the preceding wash, before being finally discharged. Using this approach, water is fed to 3 wash units instead of 8.

This has required the installation of new pipelines, tanks, pumps, valves and filters, with an investment of around LE44,000.

Total annual savings are:

- Water: 117,600 m^3 valued at LE47,040
- Energy: 6,090 million Kcal valued at LE121,800
- Wastewater treatment: 117,000 m^3 valued at LE52,920

Implementation Cost: LE 44,000
Annual Savings: LE 221,760

Additional Measures for Implementation

Installation of Automatic Shut-Off Valves in Bleaching Ranges

An evaluation of all bleaching ranges revealed that process water and steam were being consumed even when the ranges were not in use. This excess consumption can be eliminated by the installation of shut-off valves at different control points to eliminate the waste of water, steam and chemicals.

The Gaston County range possessed the highest savings in water and steam:

- Water savings of 27,000 m^3/year
- Energy savings of 1,095 million Kcal per year
- Wastewater treatment savings of 27,000m^3/year valued at LE12,150

Implementation Cost: LE 36,500
Annual Savings: LE 44,850

The same measure could be replicated in all other bleaching ranges with estimated yearly savings of LE258,570.

Recycling of Final Washing Water in the Bleaching Ranges

In the Brugman and Gaston County bleaching ranges, the final, clean washwater coming from the bleaching stage can be reused in another, earlier washing stage, for washing after scouring.

In each of these two ranges, the final washing unit has been connected to the washing unit for the scouring process. This required the installation of pipelines equipped with pumps.

Savings from Recycling Final Washing Water

Bleaching Range	*Savings (per year)*	
	Water (m^3)	*Energy ($x10^6$ Kcal)*
❖ Brugman	25,000	750
❖ Gaston County	60,000	2,700
Total	**85,000**	**3,450**

By implementing this action, it is projected that:

- Water and energy savings corresponding to LE103,000 per year can be achieved.
- Wastewater treatment costs can be reduced by LE38,250 per year.

Implementation Cost: LE 30,000
Annual Savings: LE 141,250

Recovery of Thermal Energy and Re-use of Spent Rinse Water from Yarn Scouring and Dyeing Liquids

Approximatley 50% of hot liquors from the yarn scouring and dyeing (72,600m^3/year) are diverted into an insulated storage tank, instead of being sent to the drain. This liquor is then passed through a heat exchanger where around 30% of the heat (2,279 million Kcal) is recovered, resulting in savings of LE45,500.

Reuse of final rinsing water of dyed yarns results in savings of 72,600m^3 of water, equivalent to annual savings of LE29,000.

In addition savings in wastewater treatment would yield further savings of LE32,670.

Implementation Cost: LE 80,000
Annual Savings: LE 107,170

ECONOMICS

Throughout industry, pollution prevention and environmental protection measures can offer real financial benefits in terms of:

- reduced raw materials consumption;
- waste minimisation and
- reuse or recycling of in-plant materials.

Implementing these measures will also result in reduced environmental pollution and movement towards discharge consent limits. A summary of the cost benefits is given below.

Cost Benefits, Water and Energy Conservation

Factory Department	*Action*	*Capital & Operation Costs (LE)*	*Yearly Savings (LE)*	*Payback Period (month)*
Measures already Implemented				
All	*Improve Storage Facilities*	*0*	*22,800*	*Immediate*
	Optimise Chemical Usage	*0*	*35,000*	*Immediate*
	Steam Condensate Recovery	*45,000*	*135,100*	*< 4*
	Upgrade Insulation of Steam and Hot Water Networks	*48,000*	*135,126*	*< 5*
Fabric Pre-treatment	*Counter Current Flow in Kyoto Range*	*44,000*	*221,760*	*< 3*
Subtotal		***137,000***	***549,786***	***< 3***
Additional Measures for Implementation				
Fabric	*Install Automatic Shut-Off Valves , Gaston County Range*	*36,500*	*44,850*	*< 10*
Pre-treatment	*Recycling Final Wash Water*	*30,000*	*141,250*	*< 3*
Yarn Dyeing	*Heat Recovery from Hot Liquors*	*80,000*	*107,170*	*< 9*
Subtotal		***146,500***	***293,270***	***< 6***
OVERALL COST BENEFITS		***283,500***	***843,056***	***4***

BENEFITS AND ACHIEVEMENTS

- Water consumption has dropped by 20%.
- Thermal energy consumption has dropped by 5%.
- Boiler fuel consumption has decreased by 5%.
- Wastewater volume has decreased by 20%.
- Chemicals and dyestuff costs have dropped by 5%.

Steam pipe insulation in the factory has saved LE135,126 per year

Washwater collected and counter flowed, Kyoto Range. Annual savings LE221,760

CONTACTS

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

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The SEAM Project

Support for Environmental Assessment and Management (SEAM), is a multi-disciplinary

Department for International Development (DFID). This project is being implemented by the Egyptian Environmental Affairs Agency (EEAA) through the Technical Co-operation Office for the Environment (TCOE) and *En*tec, a UK engineering and environmental consultancy.

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

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.