

Industrial Pollution Prevention

Case Study: Textile Sector

Combining Preparatory Processes A Low Cost, High Productivity Solution

Giza Spinning, Weaving, Dyeing and Garments Co., Giza, Egypt
Misr Beida Dyers Co., Alexandria, Egypt

INTRODUCTION

Desizing, scouring and bleaching are frequently undertaken as three separate steps in the preparatory stages for textile wet processing. Through chemical substitution and process optimisation, it is possible to combine two of the three processes, thereby reducing water and energy consumption as well as shortening the processing time. As combined scouring and bleaching requires that bleaching by sodium hypochlorite is replaced with hydrogen peroxide, the overall processing sequence generates effluents that are less harmful to the environment.

Combined desize and scour was undertaken at Misr Beida Dyers and combined scour and bleach was implemented at Giza Spinning and Weaving. These modifications have reduced operating costs and increased production capacity through a shortened processing sequence. Net benefits are LE 256,413 per annum.



Production scale trials for desize and scour at Misr Beida Dyers

DESIZING, SCOURING AND BLEACHING

Desizing enzymes then removes size from the fabric, so that chemical penetration of the fabric in later stages is not inhibited.

Scouring is carried out to remove impurities that are present in cotton, both natural (e.g. waxes, fatty acids, proteins, etc.) and processing (e.g. residual size, dirt and oil). This is usually done with sodium hydroxide and produces strongly alkaline effluents (around pH 12.5) with high organic loads.

Bleaching is used to whiten fabrics and yarns, using sodium hypochlorite or hydrogen peroxide. Many cotton processing factories in Egypt use sodium hypochlorite as it is cheaper than hydrogen peroxide. It is, however, toxic and is now not preferred or banned in many countries.

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FACTORIES WHERE IMPLEMENTED

Misr Beida Dyers Company is a public company in Kafr El-Dawar, Alexandria. It was established in 1938, and occupies a 264 feddan site.

The factory pre-treats, dyes, prints and finishes cotton fabrics and cotton/ synthetic blends; processes yarns;

cotton. During 1997/8, Misr Beida Dyers pre-treated about 1,182 tons of woven fabric on jiggers, of which about half were pre-treated using separate processes (kamilase desizing, scouring and half bleaching). The remaining fabric was pre-treated using a combined process consisting of desizing/scouring, using a proprietary chemical, followed by half bleaching.

Giza Spinning, Weaving, Dyeing and Garments Company is a private company located at Kafr Hakeim in Giza. The factory, established in 1984, covers 25 feddans and employs 2,400 staff.

The factory processes and manufactures cotton and polyester/cotton garments and finished fabrics. In 1996/7, 1,440 tons of fabric were processed, of which 240 tons were full bleached and 1,200 tons half bleached and dyed. Full bleaching is carried out using hypochlorite and half bleaching with hydrogen peroxide only. About 90% of the fabric produced by Giza Spinning and Weaving is knitted, the remainder woven.

ENVIRONMENTAL AND PRODUCTIVITY RELATED CONCERNS

Through an industrial audit at the 2 factories, a number of environmental and productivity related concerns were identified in the desizing, scouring and bleaching processes, as follows:

- ❖ Sodium hypochlorite, a toxic and hazardous chemical, was used in the bleaching process at Giza Spinning and Weaving.
- ❖ Strong odour of chlorine, resulting from the use of sodium hypochlorite in the bleaching process.
- ❖ Worker safety issues were noticed, associated with the handling of toxic and hazardous chemicals such as sodium hypochlorite.
- ❖ High steam, energy and water consumption was noted during the desizing, scouring and the bleaching processes.
- ❖ Some re-processing of fabric was required due to insufficient fabric whiteness and uniformity of dyeing.

CLEANER PRODUCTION APPLICATIONS

The cleaner production option consisted of adopting combined processing. The actions taken by the SEAM Project and the benefits achieved are summarised below.

Combined Desize and Scour - *Misr Beida Dyers*

Seven production trials were conducted to improve the efficiency of the combined desizing and scouring process. Four fabric samples of 250-313 kg size were treated on the normal wide jiggers and three samples of 750-850 kg were processed on the existing Vald Henriksen jiggers.

In the trials concentrations and rates at which chemicals were added were varied as well as temperature, number and timing of washes. Initial problems of attaining

acceptable fabric wettability and whiteness index were eventually overcome. The final acceptable processing recipe for desize/scour followed by half bleaching of 1 ton of fabric appears below:

Recipe for Combined Desize and Scour Woven Fabric - <i>Misr Beida Dyers</i>		
Processing Recipe (for 1 ton of fabric)	Combined Desize & Scour	Half Bleaching
NaOH (38° Be) (l)	133	75
Espycon 1030 (kg)	4.8	1.5
Egyptol PLM (kg)	2.4	-
Ammonium persulphate (kg)	1.2	-
Na ₂ SiO ₃ (kg)	-	16
H ₂ O ₂ (35%) (kg)	-	13.3



Combined scour/bleach at Giza Company using Jet Machines

Fabric quality after bleaching and dyeing with Cibachrome Orange R, showed improved wettability and whiteness and consistent colour properties. A comparison of results follows:

Comparison Between Fabric Quality Before and After, Using the Combined Process <i>Misr Beida Dyers</i>		
Fabric Characteristics	BEFORE (Conventional 3-Stage)	AFTER (Modified Combined)
After Bleaching:		
Handle	harsh	soft
Wettability (seconds)	6	2
Whiteness Index	68.3	70.1
Tensile Strength (kg/cm ²)	50	52
Residual Strength (%)	69.4	72.2
After Dyeing:		
Colour uniformity	uniform	uniform
Colour fastness		
- Perspiration-alkaline	4	4
- Perspiration-acidic	4	4
Washing fastness	4	4

In optimising the modified combined process it was possible to eliminate two hot washes in the half bleaching process. More expensive chemicals were phased out and replaced with ammonium persulphate and Egyptol. Overall there was a reduction in water, energy and steam consumption. Processing cycle time was shortened by 2 hours (18% reduction in processing time).

Combined Scour and Bleach - Giza Spinning and Weaving

Trials were undertaken to combine the scour and bleach processes more efficiently and to phase out the use of sodium hypochlorite in bleaching. Hydrogen peroxide was used to substitute sodium hypochlorite in the full bleaching process.

Tests were initiated on a laboratory scale winch using four standard 9 kg samples of different fabric types (i.e. rib, riblycra, single jersey and interlock). Using and refining the preferred laboratory scale recipe, pilot scale trials (95 kg) and production scale trials (351-452 kg) were carried out on single jersey fabric. Tests were conducted for both half and full bleach fabric. Single jersey was used as it is the main processed fabric.

Final recipes for pretreating 1 ton of knitted fabric are summarised below:

Recipe for Combined Scour and Bleach Knitted Fabric - Giza Spinning and Weaving		
Processing Recipe (for 1 ton of fabric)	Combined Scour & Half Bleach	Combined Scour & Full Bleach
Nionil N (kg)	10	10
NaOH (47%) (l)	75	105
H ₂ O ₂ (50%) (kg)	30	105
Organic stabiliser (kg)	10	30
Optical brightener - Uvitex 2B (kg)	-	5
Softening - Knit Soft (kg)	-	30
Softening - Acetic acid (11%) (kg)	-	50

Tests on fabric quality gave comparable results (see below) between the conventional and modified combined processes. Subsequent dyeing of the modified half bleached fabric also gave acceptable depth shades.

Comparison Between Fabric Quality Before and After Using the Combined Process, Giza Company			
Fabric Characteristics		Half Bleach	Full Bleach
Whiteness index	Before	67.1	103
	After	66.2	104
Wettability (seconds)	Before	3.0	2.5
	After	1.5	1.5



Checking quality of full bleached fabric at Giza Company

Adopting combined processing meant that a number of stages could be combined or eliminated entirely. Stages were optimised for greater productivity and financial savings as outlined below:

- ❖ Two hot washes and one cold wash in the half bleaching process were eliminated.
- ❖ One hot wash, two cold washes, and three flotation rinses in the full bleaching process were eliminated.
- ❖ Reuse of bleaching bath for the optical brightening step in full bleaching process.

One of the greatest benefits has been in the processing time for half bleaching which has been more than halved. This has increased the production capacity from a previous maximum of 4.5 to 9.0 tons per day, an equivalent of 480 tons per year.

COSTS AND BENEFITS

No capital expenditure was necessary for implementation as the benefits were achieved by chemical substitution and process optimisation. The benefits were therefore immediate once the modifications were complete.

At Misr Beida Dyers the 1,182 tons per annum of half bleaching was split approximately equally between conventional 3-stage processing and combined processing with Leonil EB. The results of the modified combined process are compared to both methods. It is noted that the increase in chemical costs before and after was offset by savings in utilities and labour as indicated in the tables below.

Savings in LE (per ton of fabric) in Half Bleaching Woven fabrics, Misr Beida Dyers						
Savings	Compared to 3-Stage Process			Compared to Leonil EB		
	Before	After	Savings	Before	After	Savings
Chemicals	234.2	235.4	(1.2)	342.4	235.4	107.0
Water use	12.2	8.5	3.7	8.5	8.5	0
Steam use	61.5	45	16.5	45	45	0
Electricity use	17.9	14.5	3.4	14.5	14.5	0
Labour	48	39.0	9.0	39	39	0
TOTAL (LE per ton)	373.8	342.4	31.4	449.4	342.4	107.0
ANNUAL SAVINGS	for 591 tons		18,616	for 591 tons		63,237
Processing time (hrs)	10.7	8.7	2	8.7	8.7	0
Increased capacity	107 ton year		18%	-	-	n/a

A comparison of costs for Giza Spinning and Weaving before and after modification is summarised below. Processing time has been considerably shortened in the half bleaching process and enabled production to be lifted by 40%. In addition to the savings on the modified bleaching process, additional annual benefits for the increased production are realised based on a LE130 net margin per ton.

Savings in LE (per ton of fabric) for Half and Full Bleaching Knitted Fabric, Giza Spinning and Weaving						
Savings	Half Bleach			Full Bleach		
	Before	After	Savings	Before	After	Savings
Chemicals	126.6	158.6	(32.0)	542.4	579.9	(37.5)
Water use	35.4	14.5	20.9	75.8	29.4	46.4
Steam use	109.6	65.8	43.8	190.3	162.1	28.2
Electricity use	5.9	2.8	3.1	14.5	10.6	3.9
Labour	37.2	17.5	19.7	92.2	67.2	25.0
TOTAL (LE per ton)	314.7	259.2	55.5	915.2	849.2	66.0
ANNUAL SAVINGS	for 1200 tons		66,600	for 240 tons		15,840
Processing time (hrs)	7.5	3.5	4.0	18.5	13.5	5.0
Increased capacity	480 /year		40%	48 tons/year		40%
ANNUAL BENEFITS	for 480 tons		89,040	for 48 tons		3,168
TOTAL			155,640			18,979

Note: figures in brackets indicate an increase in cost

Improved Fabric Quality

The whiteness and absorbency was improved by the modified process at both Misr Beida Dyers and Giza Spinning and Weaving.

Environmental Benefits and Improved Working Conditions

Sodium hypochlorite, a toxic and hazardous chemical, has been phased out of the bleaching process at Giza Spinning and Weaving. As a result worker conditions and safety have improved and the amount of halogenated organic hydrocarbons (AOX) in the final effluent has been minimised. Water and energy consumption has also been reduced.

Summary of Economic Benefits

Summary of Net Savings (LE per year)	
Savings on operating costs, Giza Spinning & Weaving	LE 82,416
Savings on operating costs, Misr Beida Dyers	LE 81,794
Net benefit on increased production capacity, Giza Spinning and Weaving	LE 92,203
Total Annual Benefits	LE 256,413

ACHIEVEMENT HIGHLIGHTS

Savings	Giza Spinning & Weaving		Misr Beida Dyers
	Half Bleach	Full Bleach	Half Bleach
Cost of chemicals	(25%)	(14%)	(1%)
Water consumption	59%	61%	30%
Steam consumption	40%	15%	27%
Electricity consumption	53%	27%	19%
Cost of labour	53%	27%	19%
Processing time	4 hours	5 hours	2 hours

Note: figures in brackets indicate an increase in cost

Other achievements include:

- ❖ Improved productivity.
- ❖ Improved fabric quality.
- ❖ Improved working conditions.

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 Entec, 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 audit¹. 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.