CLEANER PRODUCTION IN THE TEXTILE INDUSTRY – LESSONS FROM THE DANISH EXPERIENCE

[1]GEORGE WYNNE, [2]DHIRAJ MAHARAJ and [2]CHRIS BUCKLEY

[1]South African Dyers and Finishers Association, Natal Branch

[2]Pollution Research Group, School of Chemical Engineering, University of Natal, Durban, 4041

ABSTRACT

DANCED, the Danish Cooperation for Environment and Development is funding a demonstration project to promote the application of Cleaner Production in the South African textile industry. This three-year project involves a life cycle approach to textiles and includes the cotton growing sector and the manufacturing sector. The total value of the project is approximately R18m. A study tour to Denmark was arranged late 2000. Participants included representatives of the textile industry, educational institutions, local authorities and government officials. This paper will describe the cleaner production approach taken by the textile pipeline in Denmark. The consolidated views of the 17 South African participants are summarised, together with Cleaner Production wet processing options that were thought to be relevant for the South African industry.

KEYWORDS

DANCED, environment, reactive dyeing, rinsing, score system, study tour, wet processing, and waste minimization.

INTRODUCTION

Cleaner Production is a new and evolving approach to environmental management in South Africa. It has been successfully applied in Europe and the United States in the textile sector, with impressive financial savings and environmental improvement. The Danish Ministry for Environment and Energy are at the forefront of promoting global expertise in Cleaner Production (CP), and has formulated a programme of assistance to selected newly industrialised countries in implementing CP. This paper will describe the concept of CP, the environmental consequences of textile wet processing, and the approach to environmental improvement through CP. The role of the Danish Co-operation for Environment and Development (DANCED) in the South African (SA) textile sector will be discussed together with the demonstration project for the SA textile industry.

Danish textile industry and Cleaner Production

The Department of Environment and Energy, through the Danish Environmental Protection Agency (DEPA), had developed a strategy for promoting CP that resulted in 3 outputs, the total budget of which was DKK 620 million [9]. These were:

1. Cleaner Production development programme, 1986.
2. Cleaner Technology action plan, 1990.
3. Cleaner Technology action plan, 1993.

These action plans led to environmental improvement and realised large cost savings for the metal plating and textile sectors. Savings of approximately $ US 26 000 (converted from Rands at current exchange rates), and reductions in chemical waste and water use of 95% and 85% respectively were realised [9]. However, the Danish textile industry has shrunk since 1987, from about 200 textile firms to 150. Clothing and design organisations currently number about 250. The annual turnover of the Danish industry is approximately DKK 3.2×10^9 (about R21 billion); this makes the fifth largest contribution to Gross Domestic Product of Denmark [9]. Denmark's main textile export markets are Scandinavia (63%) and Germany (13%) [9]. The Danish textile industry currently provides jobs for about 14 471 people in all sectors [9]. Since the mid 1980's, a significant feature of the Danish textile industry is the large-scale relocation of clothing manufacturers to Eastern Europe. This has caused local job losses in clothing-manufacture. The kinds of work functions that have been relocated are the piecework operations such as cutting, sewing, folding and packing. The main driver behind this move is the relatively low wage rate in Eastern Europe. The average wage rate in Poland, Lithuania and the Ukraine is approximately 8% of the Danish wage rate (see **appendix** for wage rates in Denmark and elsewhere). Eastern Europe and the Baltic states are being targeted as future markets for Danish exporters, who have already captured a significant portion of the EU region.

Cleaner Production in the global context

Global industry is striving to remain profitable in a competitive market whilst having to account for all their environmental impacts. The challenge is one of maximising economic gain while taking steps to minimise environmental degradation caused by their products, processes and activities. The response to environmental degradation has historically occurred in four successive steps [1]:

1. Ignore pollution
2. Dilute waste streams
3. Control pollution
4. Prevent pollution

Cleaner Production promotes a preventative approach and originated as a response to the overwhelming financial burden brought about by costs of controlling pollution through end-of-pipe means [1]. In its broadest sense, CP may be defined as [12]:

"Cleaner production is the continuous application of an integrated preventative environmental strategy applied to processes, products and services to increase eco-efficiency and to reduce risks for humans and the environment."

(United Nations Environmental Programme, Eco-efficiency and Cleaner Production: Charting the Course to Sustainability)

For manufacturing processes, CP includes:

- Conserving raw materials, water and energy.
- Eliminating toxic raw materials.
- Reducing the quantity and toxicity of all emissions.
- Reducing wastes at source.

For products, CP means reducing all the negative environmental impacts along the life cycle of the product, from raw material extraction through to end use and final disposal. The introduction of CP into a manufacturing environment requires innovative thinking and know-how, improving technology and processes and most important, changing attitudes to environmental management from top management to the shop floor. Because CP brings about a powerful combination of financial cost savings and environmental improvements, it has been recognised by Agenda 21 as one of the best means of reconciling industrial growth with environmental protection.

Environmental issues in textile wet processing

Textile wet processes consume dyes, auxiliaries, chemicals, detergents and finishing agents in the conversion of raw materials to finished product. The specific water use varies from 60 to 400 l/kg of fabric, depending on the type of fabric wet application [2]. Generally, textile effluents are highly coloured and saline, contain non-biodegradable compounds, and are high in Biological and Chemical Oxygen Demand (BOD, COD). These factors combine to present numerous operational problems in municipal wastewater treatment works, which are biological processes and not intended for the breakdown of complex organic molecules. The presence of metals and other dye compounds inhibits microbial activity and in some cases may cause failure of biological treatment systems. Various indicators may be used to classify strength of effluent from the textile process; these are shown in Table 1 [2].

Table 1. Overall effluent characteristics for textile mills

DETERMINAND	WOVEN FABRIC	KNIT FABRIC	YARN DYEING/FINISHING
Biological Oxygen Demand (mg/l)	550	250	200
Suspended Solids 9mg/l)	185	300	50
Chemical Oxygen Demand (mg/l)	850	850	524
Sulphide (mg/l)	3	0 – 2	-
Colour (ADMI)	325	400	600
PH	7 –11	6 – 9	7 – 12
Water Use (l/kg)	297	277	297

Emissions from the textile industry take the form of liquid effluents, wet fabric/fibre wastes from dye processes, solid wastes from the dry processes, hazardous wastes and air emissions. Liquid effluents contain many different components such as: dyes and chemicals, levelling and dispersing agents, alkalis and salts, metals and acids [2].

Table 2 shows the effluent characteristics from different types of operations in textile processes [2].

Table 2. Effluent characteristics from the textile industry

PROCESS	EFFLUENT COMPOSITION	NATURE
Sizing	Starch, waxes, carboxymethyl cellulose (CMC), polyvinly alcohol (PVA), wetting agents	High in BOD, COD
Desizing	Starch, CMC, PVA, fats, waxes, pectins	High in BOD, COD, SS, Dissolved Solids (DS)
Bleaching	Sodium hypochlorite, chlorine, sodium hydroxide, hydrogen peroxide, acids, surfactants, sodium silicate, sodium phosphate, short cotton fibre	High alkalinity, high SS
Mercerising	Sodium hydroxide, cotton wax	High pH, low BOD, high DS
Dyeing	Dyestuffs urea, reducing agents, oxidizing agents, acetic acid, detergents, wetting agents	Strongly coloured, high BOD, DS, low SS, heavy metals
Printing	Pastes, urea, starches, gums, oils, binders, acids, thickeners, cross-linkers, reducing agents, alkali	Highly coloured, high BOD, oily appearance, SS
Finishing	Inorganic salts, formaldehyde	Slightly alkaline, low BOD

In addition to high volumes of liquid effluent (wet processes have a high specific water usage), solid wastes comprising waste fibre and fabric, paper waste, sludge from effluent treatment and dyebath wet wastes are also produced [19]. Most dyes are not readily biodegradable. The microbial populations present in the aerobic systems of municipal works cannot breakdown the molecules that cause colour in the effluent. Some dyes though, particularly those containing the azo bond, may be partially reduced by anaerobic microbes in biological systems. Other dyes may be adsorbed onto the sludge in the digesters or sludge beds of aerobic systems. Generally, acid and reactive dyes have poor adsorption capabilities due to their solubility in the effluent. Direct, disperse and vat dyes are readily adsorbed onto the sludge [2].

Life Cycle Assessment studies the environmental aspects and potential impacts throughout a product's life (i.e. cradle-to-grave) from raw material acquisition through production, use and disposal. The general categories of environmental impacts needing consideration include resource use, human health and ecological consequences. For the textile manufacturing system, an inventory of all the relevant inputs and outputs is compiled, the potential impacts of all the inputs and outputs is then evaluated and finally, the results of the inventory analysis is assessed in relation to the goals of the study. In this way, all negative environmental impacts can be accounted for at every stage of the processing. The European Union Eco-label Flower is a set of environmental and ecological criteria that a manufacturer or importer must satisfy, under the Council Regulation No. 880/92. The ecological criteria require scientific assessments of the environmental impacts of the product for each part of its life cycle. This label is awarded only to products that have a reduced environmental impact. The label can be used throughout the 15 member EU as well as Norway, Liechtenstein and Iceland.

In a related activity, the Council for Scientific and Industrial Research (CSIR), division of Textile Technology (TEXTEK), will be offering courses on Life Cycle Assessment. They will also be running training workshops in LCA. TEXTEK have carried out surveys and visited the majority of textile mills in SA as part of their preparatory work on ecolabels.

Woolworths have recently drawn up an environmental code of practice for their suppliers of textile products. This document provides guidelines for textile manufacturers on environmentally friendly processing, as well as a list of undesirable chemicals.

This is just one more driver for local manufacturers to apply CP in their textile wet processes. A list of chemicals has recently been made available from the European Union for textile manufacturers (see **appendix**).

Cleaner Production vs. End-Of-Pipe

Traditionally, the main areas of waste management practices were concerned with treating waste and effluents once they were generated, in expensive end-of-pipe systems [5]. These treatment systems often came about as a result of strong pressures by government and other regulators.

Waste may be considered as unused raw materials or intermediates that may be useful, or have some commercial value and represents financial losses to the companies in terms of raw materials, useful by-products and the added costs of implementing expensive end-of-pipe waste treatment facilities. Cleaner Production is about preventing this situation and more. Its primary focus is on practices for reducing or eliminating waste at the point source, or recycling waste for its original or some other purpose [4, 6]. The core aspect of all waste management programmes should focus on waste minimisation, and its associated practices of source reduction and recycling of waste. The driving force lies in the simple philosophy that it makes more sense to prevent the generation of waste, rather than develop expensive treatment schemes to treat waste once it is generated. Thus, elimination, source reduction and recycling should feature as high priority options on a waste management strategy. Treatment and disposal of wastes must be treated as low priority options for obvious reasons. This is shown in Figure 1 (Welford, 1995).

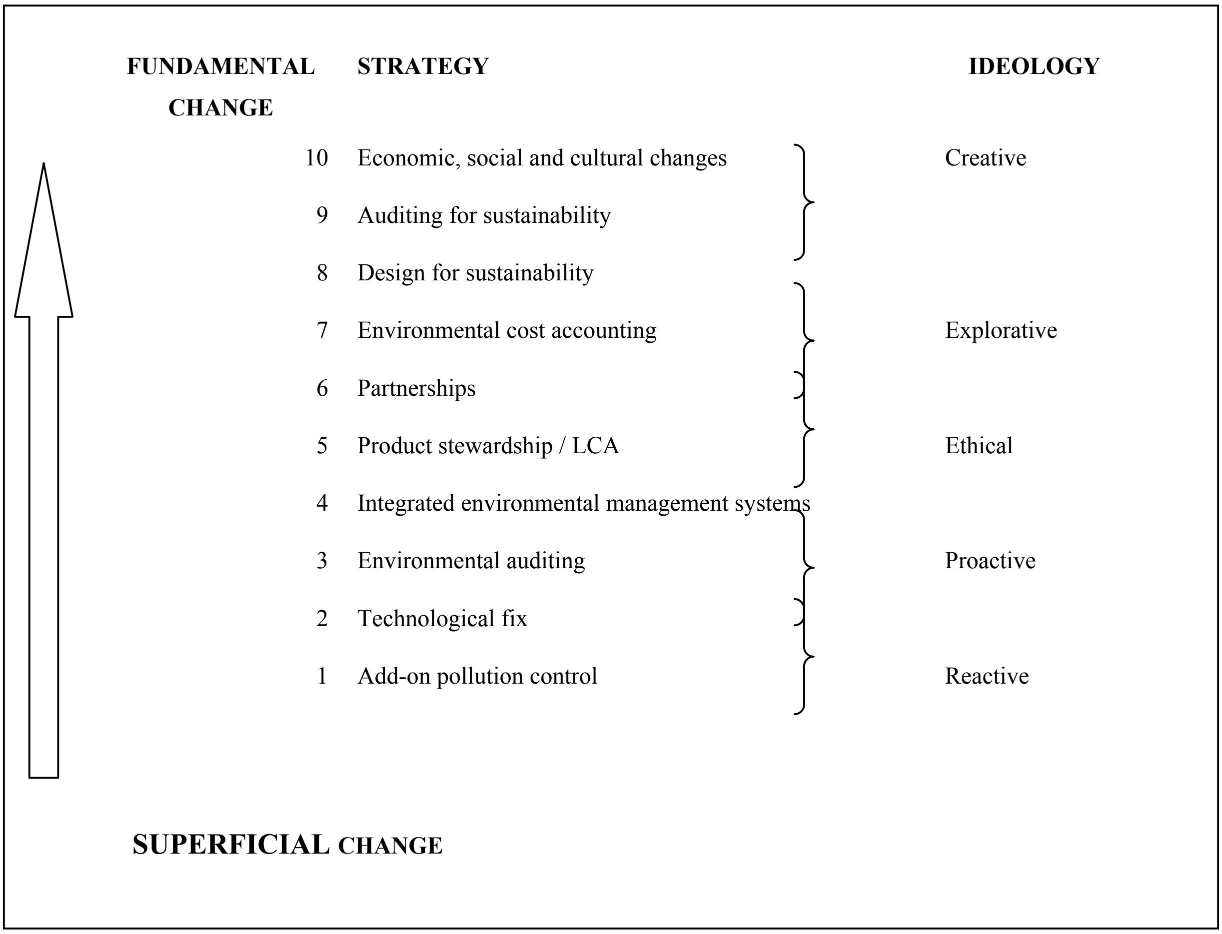

Figure 1. Wellford's spectrum of greening (after Wellford, 1995)

THE DANISH CORPORATION FOR ENVIRONMENT AND DEVELOPMENT

The Danish Co-orporation for Environment and Development (DANCED) was established in 1993 as a follow up to the United Nations conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992. The overall objective of DANCED is to contribute to the global aim of environmental improvement in accordance with the recommendations of UNCED Agenda 21. DANCED is managed by the Danish Ministry of Energy and Environment. Countries falling under the DANCED Southern Africa programme include Botswana, Namibia, Lesotho, Swaziland and South Africa [7]. DANCED is committed to technology transfer and skills development related to environmental improvement; and thus renders direct Cleaner Production support to the private sector. Danced has focused their support on the following industrial sectors in South Africa [7]:

- Fishing and fish processing
- Abattoirs and dairy
- Wood and furniture
- Metal plating
- Textiles

The South African textile industry was chosen because the industry has now recognised the need to implement CP practices in line with global aims of sustainable development and also because [7]:

- It has a disproportionate specific water use and significant environmental impact.
- It is represented by a sectoral association, the Textile Federation of South Africa, (TEXFED), which would ensure dissemination of DANCED supported activities.
- It is supported by research and other related organizations that can act as a service body to ensure that skills and environmental expertise obtained during the project are sustained.

THE CLEANER TEXTILE PRODUCTION PROJECT – SOUTH AFRICA

Project design and development

Initiatives by the Department of Environmental Affairs and Tourism (DEAT) and Department of Trade and Industry (DTI) had prompted DANCED into formulating a programme of assistance to CP in South Africa (SA). One of the first actions was a DEAT-DANCED organised study tour to Denmark in November 1996, as part of their joint strategy to promote the concept of CP in South Africa. The major outcome of this tour was the commitment of DANCED to direct CP support in about five industrial sectors in SA, one of which was the textile industry [7]. This project is a three and half-year initiative that started in 1998 with the project design. The inception took place in September 2000. The **Cleaner Textile Production Project - SA** (CTPP) is due to run to June 2003. A life cycle approach has been adopted for the CTPP. This ensures the careful examination of all the impacts of a particular textile end product, from raw materials extraction through the end use and final disposal. The focus of this project is therefore on the entire textile pipeline, but concentrating mainly on cotton growing and textile manufacturing, as this is where the highest environmental impacts occur. The project aims to reduce the negative environmental impact of the textile-manufacturing sector, through a preventative approach. The project aims to:

- Implement CP options with measurable reductions in water, energy, chemical inputs and effluent discharge.
- Transfer knowledge on CP and build local capacity to sustain the process.
- Create awareness on environmental problems and the possibilities of solving them through CP.

The project is a demonstration project that is being promoted as an industry-led initiative. This places a broad ownership of the aims and objectives on the industry and other stakeholders, such as government departments, regulators and industry trade associations. The main outputs in the manufacturing component's project document that have been decided upon in order to realize the long term development objective are [8]:

1. CP orientation and training in generic CP auditing
2. Environmental audits and CP option identification
3. Detailed feasibility studies and CP action plans
4. Demonstration investments and subsidies for improved management practices
5. Dissemination of CP outputs and investments

The project inception phase was completed in September 2000, and one of the immediate actions thereafter was a study tour to Denmark for the Project Steering Committee members and selected industry representatives.

The purpose of the tour was to learn about the Danish experience in implementing CP in their textile industry and to gain knowledge on CP practices. Following the tour, a number of practical CP options had been scheduled for implementation in local dyehouses. The current phase of the project for the manufacturing sector deals with:

- CP awareness and project publicity campaign.
- Training needs assessment for environmental training
- CP training for auditors.

This project has two components: the cotton growing sector, and the textile-manufacturing sector. Each component has its own immediate objectives, but both follow the common development objective of reducing the negative environmental impact of the SA textile industry through a preventative approach. The project partners are the **Pollution Research Group (University of Natal)**, **Cotton South Africa** and **Darudec.** Darudec are responsible for the management and administration of the project. A project steering committee chaired by the Department of Trade and Industry (DTI) and comprising representatives from other government departments, metropolitan regulators, trade associations, labour, and research institutions act as the executing body for the project. A project management group consisting of the Chief Technical Advisor and a local Project Co-coordinator for the manufacturing component and a proposed coordinator for the cotton growing component oversee the co-ordination and everyday running of the project. The current phase of the project involves a training needs analysis and planning for generic training of CP auditors. A publicity and awareness building campaign for the project is also underway. The main output of the project to date has been a study tour to Denmark for the steering committee members and some industry representatives.

Study tour to Denmark

The purpose of the study tour was to increase environmental awareness in the local textile pipeline and to impress upon them, the importance of Cleaner Production in reducing negative environmental impacts, particularly during wet processing of cotton, synthetics and their blends. This tour also achieved the all-important objective of team building and fostering deeper meaningful relationships between all the role-players in our textile industry. The tour was arranged and administered by Darudec. Senior officials represented government from the Department of Trade and Industry, Department of Environmental Affairs and Tourism, and Department of Arts, Culture, Science and Technology, Department of Water Affairs and Forestry and Durban Metropolitan Council.

Finally, the local industry represented by Mr. Roy Sable (Frame Group), Mr. Selwyn Gershman (Gregory Knitting Mills), Mr. Geoffrey von Klemperer (Frame Textiles), Mr. Gerry Vermaak (Gelvenor Textiles) and Mr. Rob McIrnerny (Ninian and Lester Textile Division).

Textile plants, clothing and garment manufacturers, municipal works, educational institutions and textile design houses were visited in order to learn more about the Danish experience in implementing generic CP practices. These visits helped to forge partnerships and key linkages between SA industry representatives and their Danish counterparts. The tour was an overwhelming success in that it has succeeded in its initial goal of impressing the value of CP to the industry members. At the end of the tour, a number of practical, achievable options for CP in wet processing had been devised. These options are scheduled for implementation in local dyehouses and a summary of the results will be made available through the project steering committee documentation and through local dissemination bodies (e.g. SADFA, TEXFED). This study tour was an important first part of the chain of events that is going to make this project a success and make a positive lasting impact on our local textile industry.

Lessons learnt

At the end of the tour, a meeting was held for consolidating all the useful information collected by the tour party members. Approximately 38 good ideas for Cleaner Production, during wet processing of cotton, polyester and their blends were discussed and tabulated [8]. They were generally ideas for:

- Process modification
- Equipment changes
- Chemical substitution/elimination
- Recycling and/or reuse

Process Modification

a) Control and monitoring of chemical and water consumption in continuous processes.
b) Controlling machine cleaning with a timer for water consumption.
c) Efficient removal of print pastes from buckets, squeegees and screens before washing these items.
d) Applying softeners to fabric by spraying at the stenters, rather than at the jets.
e) Counter current washing/rinsing on continuous machines.
f) Control water addition to screen and squeegee washing by timers.

Equipment changes

a) Modify jiggers by making use of sprays and vacuum slots – enhances rinsing efficiency.
b) Replace high liquor ratio winches with jets.
c) Install heat exchanges for recovering heat from hot dyebath effluent.
d) Fit shut-off nozzles onto manually held hosepipes.
e) Install reversible pumps on printing lines to save unused print paste.

Chemical substitution and/or elimination

a) Eliminate use of heavy metal based dyes.
b) Replace mono-reactive dyes with bi-functional ones to increase exhaustion.
c) Eliminate use of detergents in "washing off" after reactive dyeing.
d) Eliminate neutralisation with acetic acid after alkaline reactive dyeing.
e) Avoid bleaching with sodium hypochlorite.
f) Use enzymes instead of persulphates in desizing.
g) Avoid use of optical brighteners.
h) Avoid Sulfapol as a detergent during wool scouring.
i) Avoid white spirits in print pastes.
j) Avoid using carriers in polyester dyeing.
k) Avoid "after chroming" for dyed polyamide or wool.
l) Avoid use of acetic acid to neutralise after reactive dyeing.
m) Use biodegradable knitting oil
n) Do not use resins that release free formaldehyde.

Recycling and/or reuse

a) Recover indigo after denim dyeing by ultrafiltration.

b) Size recovery.
c) Recover and reuse salt after reactive dyeing by reverse osmosis.
d) Recover heat from stenter exhaust.
e) Recycle cooling water and condensate.
f) Reuse dirty water for washing printing buckets, to dampen ash from boilers and cleaning and flushing water.

Housekeeping

a) Collect all unused print pastes for bulking-up; do not allow dumping of print pastes to effluent drain.
b) Carry out leak tracing and repairs on water pipes and valves.
c) Check non-return valves for reverse leakage.

CASE STUDIES

A number of options for environmentally friendly wet processing, particularly in dyeing and washing of cotton fabric, has been summarised from the dyehouses visited [8]. These options deal with the use of a score system for evaluating the environmental impact of chemicals, reducing the number of chemical inputs during dyeing and washing of cotton, efficient ways of applying softeners onto fabrics, and modifying rinses of yarn dyeing machines to reduce water consumption.

The Score system

A system for selecting more environmentally friendly chemicals has been designed by the Danish government and been in operation since 1992 [9]. It is an administrative method, utilising information on chemical, amounts, biodegradability, bioaccumulation and toxicity to develop a score. A comparison of scores of different chemicals results in a priority selection of chemicals for further testing or evaluation. The parameters A (discharged amount), B (biodegradability), C (bioaccumalation) and D (toxicity); are each assigned a numerical value between 1 and 4, with 1 having the least impact and 4 having the most impact. The numerical scores; A, B and C; are then multiplied and plotted against D. See Figure 2 for an example of such a graph. This graphical representation can be used in setting benchmarks for the use/selection of chemicals, substitution by chemicals with better scores and could be used in effecting overall environmental improvement through the elimination of high-score chemicals. A proposal has been submitted by the Pollution Research Group to the South African Water Research Commission, for a project on assessing the application of the score system in SA.

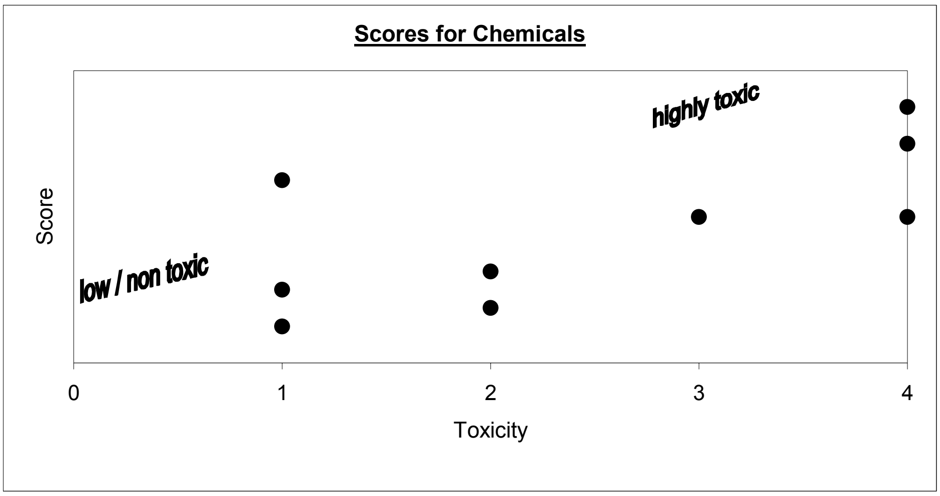

Figure 2. Graphical representation of chemical scores

This proposal is currently under review, and the Pollution Research Group expects to initiate the project in the next financial year. Subject to approval, the CTPP will provide technical assistance and the Danish database to assist in the implementation of this project.

Frame Weaving in New Germany (KwaZulu Natal) have undertaken to pilot the implementation of the score system for evaluating chemicals. This has helped greatly in negotiating new effluent discharge permits with Durban Metro Wastewater.

Reducing chemical inputs during washing of dyed fabric

Avoiding the use of detergents and acetic acid during washing/soaping off of fabric after reactive dyeing will: reduce input chemical costs, reduce the COD of the effluent and reduce effluent charges. A recent DANCED project showed that eliminating the use of detergents during washing of reactive-dyed fabric had no adverse effect on the fastness [9]. Fifty full-scale tests were conducted in Denmark to investigate the effects of eliminating detergents and complexing agents during washing (after reactive dyeing of cotton). Twenty different recipes were tried, with shades varying from very light to very dark. The dyestuff colours chosen were: brown, red, black, wine red, marine blue, turquoise, rose, pink, purple, green and mint.

Changes to the recipe included temperature, neutralisation with acetic acid, detergents and complexing agents and number of rinses. The quality tests conducted on the fabric from the trials were washing fastness, water fastness, wet rub fastness, dry rub fastness, colour and shade. The results and quality tests showed no adverse effects on the fabric. The quality tests (scale of 1 to 5 for fastness) were all positive even when:

- Neutralisation with acid was omitted before hydrolysate washout.
- Complexing agents and detergents were omitted.
- The cold overflow rinse was replaced one cold batch rinse followed by a few 95 °C hot rinses.

The investigators showed that the **temperature** was the decisive factor in washing out the dyestuff hydrolysate [10, 11]. The results of their tests showed that raising the temperature from 75 to 95 °C almost doubled the dyestuff content in the rinse water (see Figure 3). Similarly, the concentration of dyestuffs in the rinse water did not show any dependence on the dosing of complexing agents [10]. It was shown that the use of complexing agents might be avoided altogether with no effect on fastness, so long as soft water (less than 3 degrees hardness) was used in the wet processing and subsequent rinsing [11].

A proposal for funding trials at SA dyehouses has been submitted to the CTPP management group. The trials are for eliminating the use of detergents in rinsing after exhaust reactive dyeing of woven cotton fabric. Dyehouses in KwaZulu Natal and a dyehouse in Gauteng have been targeted as the trial sites. Gregory Knitting Mills, in Gauteng have already carried out some of these trials. The results proved to be inconclusive on the low liquor ratio machines.

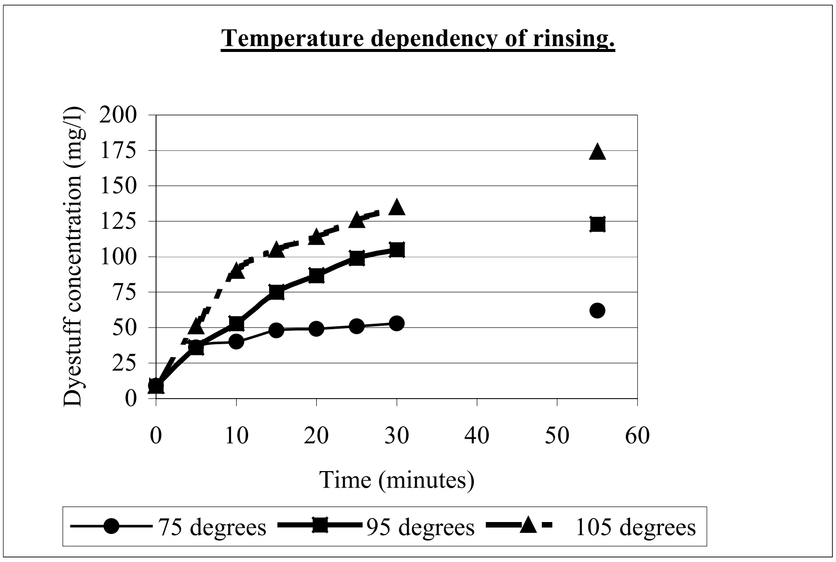

Figure 3. Concentration of dyestuffs in rinse water at different temperatures (after Wenzel).

Reducing chemical usage in reactive dyeing of cotton

Currently, a typical recipe for the reactive dyeing of cotton uses 6 to 7 different chemicals. A typical reactive dye cycle uses alkali, salt, dyestuff and softener. Reducing the number of chemical inputs during cotton reactive dyeing will: reduce input chemical costs, COD of effluent, effluent charges and processing time. A proposal has been submitted to the CTPP management group for funding such trials at local dyehouses. These trials are closely related to those for eliminating detergents in rinsing of reactive dyed cotton fabric.

Application of softener

Currently, most softening of fabrics is carried out in batch machines by an exhaustion process. This could limit the choice of agents to environmentally harmful cationic substances, together with the loss of 10 to 20 % of softener and the entire volume of warm softening bath. The Danish dyehouses visited have switched to applying the softener by spraying it onto the fabric [10]. Chemical and warm water losses are minimal.

There is no associated water loss in spraying softeners onto the fabric. There is clearly scope for savings in water energy and chemicals, as well as reduced environmental impact through the reduction of effluent volumes. Gelvenor Textiles and Ninian and Lester Textile Division are currently studying this option, and will probably be ready to implement this option later this year. The outcome of their initial trials will be disseminated through the project documentation and local bodies like SADFA and TEXFED.

Modified rinsing of dye machines

A large Danish yarn dyeing and finishing plant, have developed a *water displacer*, or *dummy* that takes up roughly half the empty space in the dye machine, so that water consumption is reduced by half during rinsing of the vessel with the displacer in it [9]. Developing and implementing such an option will: reduce water consumption and costs by half, reduce effluent volume from rinsing by half and reduce effluent charges. A request for engineering specifications and drawings for this equipment have been forwarded to the Danish company that has implemented this option. A proposal is being drawn up for submission to the CTPP management group for implementing this option at local yarn dyehouses.

OTHER ACTIVITIES IN THE CLEANER TEXTILE PRODUCTION PROJECT

The current phase of the Cleaner Textile Production Project SA involves activities such as awareness raising, project publicity campaign, identification of environmental issues and training for auditors. Textile organizations have also been requested to participate in the project through an awareness letter and questionnaire that was sent out to the industry in February 2001 via TEXFED. An important output of the project is demonstration investments for pilot projects in industry. A summary of the procedures for applications (for funding) by the companies is shown below.

Companies

All textile plants that have committed in principle to environmental improvement through CP should be involved in this project. An awareness letter and environmental questionnaire has been sent out to textile plants through TEXFED, earlier this year. As this is a demand-driven project, requests have to be made by the industry for particular environmental or technical inputs from the Project. Companies may write to the PMG requesting specific consulting expertise, and apply for technical assistance for environmental or CP audits. Provision has been made for the financial assistance in this regard for successful applications. Thereafter, the companies may apply for funds for specialist feasibility studies and demonstration projects. These are described further below.

Consultants and service providers

Environmental consultants and textile specialists may also be involved in the audits and specialist studies at textile plants. Requests for resumes of these persons have been made, so that a pool of experts can be created. This pool of experts will be called upon and matched with companies requesting assistance.

Cleaner production auditor training

The Pollution Research Group (University of Natal) has submitted a proposal for a CP audit-training course to the Project Management Group. This course consists of lectures and practical training at factories where the course participants will undertake CP site audits. The training is designed to be carried out over a period of about 5 months and will result in a detailed waste minimization report from each participant. Each course is limited to 8 participants, with 4 from industry and the remaining people from academia or consulting organizations. The primary course output will be a thorough waste minimization survey, and implementation of waste minimization options at the factories. Courses will be given in Durban, Port Elizabeth and Cape Town. The total budgeted amount for all the courses is in the order of R113 000.

Rules for administration of subsidies

The four different types of subsidies that are covered by the Cleaner Textile Production Project are: 1) Danish study tour support; 2) Call down consultancy support; 3) Study subsidies; 4) Demonstration subsidies.

Danish study tour support

The project covers funding for airfare, accommodation, per diem, travel in Denmark and other training related costs for the tour participants. The participants are chosen by the project steering committee and should be (in order of preference): industry representatives relevant for CP implementation, textile and trade association members, government representatives and regulators or private consultants.

Call down consultancy support

The organisation needing technical assistance should submit an application the Project Steering Committee. The application should include a profile of the required expertise, and Terms of Reference for the assistance. This profile will be matched with those submitted to Darudec, and the organization needing assistance can then choose from those supplied by Darudec. The project will cover all consulting costs, airfares and accommodation. The consulting assignments must produce comprehensive reports for future use in the project.

Study Subsidies

The project will administer study subsidies for CP auditing and detailed feasibility studies. The audit subsidy is a once-off payment of R 5 000 for a full environmental audit. The subsidy for detailed feasibility studies is a once-off payment of R 15 000 for technical, environmental, economic and health and safety evaluations.

Demonstration Subsidies

This subsidy is 20% of the CP element of an intended investment and will be administered by the Project Management Group. All applications from industry should include: description of the project, technical justification, expected environmental impact of project, cost of the CP element of the project and expected payback of the option. For successful applications by industry, the subsidy will be paid out when the investment is complete and when proof of payment to suppliers is provided by the applicants (to the Project Management Group).

CONCLUSIONS

The study tour to Denmark has proven to be a significant turning point for most textile industry representatives. Options for environmentally friendly wet processing were viewed first hand on the shop-floor in Denmark. Such options could be implemented at SA dyehouses. Therefore, commitment to CP in local dyehouses has now been obtained. The practical outcome of the study tour is that:

- Some dyehouses are eager to implement CP options for reducing water consumption; chemical use and detergent use in washing of reactive dyed cotton fabric.
- Textile companies have committed to implement principles of the Score system for evaluating chemicals.
- Proposals have been submitted to the Project Management Group for implementing CP projects at textile companies, and for generic CP audit training.
- Favourable exchange of CP information has been initiated between SA and Danish textile companies.
- Business opportunities have now been created between SA and Danish textile factories.
- Knowledge and understanding of the different EU ecolabels (e.g. EU flower) has been enhanced.

ACKNOWLEDGEMENTS

DANCED for funding this project.

Darudec for project management

Cotton SA

CONTACT DETAILS

ADDRESSES	CONTACT DETAILS
DANCED Project Office Pollution Research Group School of Chemical Engineering University of Natal DURBAN 4041 DANCED Project Office PO Box 19519 Dormerton 4015	Telephone: 031 – 2603375 Facsimile: 031 – 2601118 E-mail: maharajd6@nu.ac.za www.nu.ac.za/dancedcleanerproduction

REFERENCES

1. **Signals of Change, Progress Towards Sustainable Development**, World Business Council for Sustainable Development, pp 6-11, 1992.
2. **Waste Minimisation Guide for the Textile Industry – A step towards Cleaner Production**, Pollution Research Group, University of Natal, Draft 1998, volumes 1 and 2.
3. **Guide for the Planning, Design and Implementation of Wastewater Treatment Plants in the Textile Industry**: Part 3, Pollution Research Group, 1990, pp 3-2 to 4-31.
4. **Facility Pollution Prevention Guide**, United States Environmental Protection Agency, May 1992, pp 3 to 8.
5. **Waste Minimisation Opportunity Assessment Manual**, United States Environmental Protection Agency, Government Institutes Inc., October 1988, pp 1-5.
6. **ICHEME Waste Minimisation Guide**, Institution of Chemical Engineers, United Kingdom, 1992
7. **Project Document, Cleaner Production in the Textile Sector: South Africa**, Ministry of Environment and Energy, DANCED, December 1999.
8. **Project Inception Report, Cleaner Textile Production: South Africa**, September 2000, Annex B.
9. **Consolidated Study Tour Report, Cleaner Textile Production Project SA**, December 2000, pp 3-6.
10. **Cleaner Technology Transfer to the Polish Textile Industry**, Danish Cooperation for Environment in Eastern Europe, Ministry of Environment and Energy: Denmark, 1999, pp 64-70.
11. **Environmentally friendly recipe in reactive dyeing of cotton**, Hans Henrik Knudsen and Henrik Wenzel, Institute for Product Development: Denmark, 1999.
12. **Government Policies and Strategies for Cleaner Production**, United Nations Environmental Programme: Industry and Environment, 1994, pp 1-10.

APPENDIX

EU Red List of dangerous substances

Table 3. EU Red list of dangerous substances

SUBSTANCE	AMOUNT IN EXCESS OF BACKGROUND QUANTITY IN ANY 12 MONTH PERIOD (GRAMS)
Mercury and its compounds	200 (expressed as metal)
Cadmium and its compounds	1000 (expressed as metal)
All isomers of hexachlorocyclohexane	20
All isomers of DDT	5
Pentachlorophenol and its compounds	350
Hexachlorobenzene	5
Hexachlorobutadiene	20
Aldrin	2
Dieldrin	2
Endrin	1
Polychlorinated biphenyls	1
Dichlorvos	0.20
1,2-dichloroethane	2000
all isomers of trichlorobenzene	75
altrazine	350*
simazine	350*
tributyltin compounds	4
triphenyltin compounds	4
trifluralin	20
fenitrothion	2
azinphos-methyl	2
malathion	2
endosulfan	0.50

*Where both atrazine and simazine are released, the figure in aggregate is 350 grams

Hourly wage rates in Eastern Europe and Denmark

Table 4. Comparison of hourly wage rates in Denmark and Elsewhere

COUNTRY	HOURLY WAGE (US Dollars)	WAGE INDEX (Denmark = 100)
China	0.60	3
Poland	3.20	14
Lithuania	2.10	9
Turkey	2.50	11
Ukraine	0.40	2
Denmark	23.10	100
Egypt	0.90	4