THE ECO MOVEMENT

Brian J McCarthy

Introduction

The global human population is now increasing at the rate of 0.9% per annum. As a result, more than 11% of the world's terrestrial landscape has been converted to cropland. A further 25% is occupied by pastureland. Humans use 8% of the world's available fresh water each year. As a result of these factors, significant environmental damage has occurred across the world with global implications.

Growing legislation and public concern about the impact of industry on the environment has firmly established this issue on most business agendas in the 1990's. For example, more than one third of UK FT-SE 100 companies produced separate environmental reports in 1994. Concern about environmental issues is no longer limited to extreme environmental activists.

The Eco-movement may be said to have begun in the second half of the 19th century with public reactions to urban pollution and species depletion (e.g. the over-hunting in the USA of the North American bison). Similarly, the publication of Silent Spring by Rachel Carson in 1962 greatly stimulated public awareness of the impact of pesticides on the environment.

Public awareness in turn has led to the formation of local, national and international pressure and lobbying groups. For example, the Friends of the Earth Limited was established in the UK in 1971 and now operates in some 35 countries. FoE campaigns on a wide variety of environmental issues. Related organisations include Greenpeace, World Wide Fund for Nature, Royal Society for Nature Conservation and The Pesticides Trust.

Public awareness and concern relating specifically to textile materials and their environmental and human ecology impact, may be illustrated by the significant 1994 media coverage given in Germany to dioxin levels found on textiles in contact with the skin and the media coverage in the UK associating cot deaths to added flame retardants. Consumers in general are becoming more environmentally aware.

The following sections are intended to give a general overview of an increasingly complex and highly topical field.

Cotton and Pesticides

Cotton is the world's most important fibre crop and the major non-food crop. It is grown in over 60 countries on more than 80 million hectares, or 5% of all cultivated land. Cotton production involves over 180 million people and has an annual value of some $20-24 billion. Cotton cultivation represents the largest single market for insecticidal products, accounting for almost 25% of the $7.4 billion global market. The Bhopal factory in central India was

producing pesticides for cotton production prior to the tragedy.

The most recent Pesticide Manual (10th Edition) profiles over 700 pesticide active ingredients used globally. According to UN sources, some 250 pesticides are banned or restricted by various governments. Pesticide usage may lead to some unwanted side-effects. The recent UK Drinking Water Inspectorate Fourth Annual Report states that having tested over one million samples involving 54 pesticide parameters - they found that 2.13% were in contravention of EC guidelines. Similarly, the UK government's food residue surveillance programme for 1993 revealed that 1% of samples were found to contain pesticides above the maximum residue levels indicative of poor pesticide application and excess usage.

Cotton farmers may apply up to eight to ten different herbicides and/or pesticides to provide overall crop protection. Environmentalists therefore continue to associate cotton production and widespread pesticide use. These green issues are now creating niche market opportunities. The UK Designer Katharine Hamnett provided a series of Summer 1994 designs - jeans made from organic cotton. THE GAP (manufacturers and retail stores), who operate in the US and Europe, now supply organic cotton underwear.

Similarly ESPRIT, the US-based fashion designer, is selling organic clothing (including T-shirts, sweat shirts and jeans) under the new ECOLLECTION label. ESPRIT would like all their production to be organic cotton by 1996 - requiring 125,000 tonnes by 1996.

Organic cotton production has significantly increased over the last four years. It currently represents 15,000 tonnes of the 18.2 billion tonnes of cotton produced world-wide every year. The INTERNATIONAL FEDERATION OF ORGANIC AGRICULTURE MOVEMENTS (IFOAM) requires that for a crop to be called organic, no chemicals whatever should come into contact with it. The ground on which the crop was grown should be free of chemicals for at least three years prior to planting. In the US in 1993 growers received $2.77 per kilogram for organic cotton and $1.32 per kilogram for conventional cotton. But, organic cotton can lead to crop yield losses of 30-40%.

Re-cycling may also feature. Burlington recently announced the addition of a new fabric - Reused Denim - to its line of environmentally friendly denim products. The re-used denim is made from 50% reclaimed cotton denim scraps used in the fill. The warp is virgin cotton. Other Burlington denims include Ecospun denim (made from cotton and recycled polyester) and Tencel denim (cotton and tencel). As a major fibre, cotton is likely to be the focus for further initiatives with environmental consequences (e.g. genetic manipulation).

Eco-Labelling

Recent years have seen the appearance in Europe and elsewhere of a variety of textile labels reflecting environmental concerns. Such schemes are normally non-statutory and self-financing.

For example, a number of years ago, the Austrian Textile Research Institute in Vienna presented a test regulation for harmful substances, the OTN 100, which has since been applied to textiles, clothing and carpets. Similarly, since 1991, the Hohenstein Research

Institute in Germany has been carrying out pollution analyses in accordance with the "Hohensteiner Oeko-Check".

Their combined experience was utilised by bringing the Austrian Textile Research Institute and the Hohenstein Research Institute together as the "International Association for Research and Testing in the Field of Textile Ecology". BTTG is now the official U.K. laboratory of the International Association for Research and Testing in the field of Textile Ecology - the host organisation for the Öko-Tex scheme. From an initial partnership between the two European Institutes, the Association has rapidly expanded and now comprises twelve Textile Research Institutes distributed throughout the European Union.

The "Öko-Tex Standard 100" specification is for testing textiles, clothing and carpets based on their human ecological characteristics. This standard contains detailed analytical procedures for specific substances which are ecologically hazardous for humans and also stipulates individual limit values based on scientific research. If a textile product complies with the conditions laid down in the Standard, the Supplier is awarded the right to label the goods as being "Confidence in Textiles - Passed for Harmful Substances according to Öko-Tex 100". Harmful substances within the context of this standard refer to substances which either exceed a specific amount in a textile product or in accessories or evolve in a specific amount during normal use and may have some kind of effect on people during normal use and may, according to current scientific knowledge, be injurious to human health. The International Association is committed to an on-going policy of researching and reviewing standards, test methods, guidelines and health implications.

The mark is not a quality label and relates only to the as-produced-state of the textile. When all the conditions specified in the standard are fulfilled, and the tests show no deviations from the details provided by the applicant, and that the test values do not exceed the limit values specified in the special standards, a certificate (copy attached) will be issued giving the applicant the right to mark his products with the Öko-Tex mark valid for the duration of one year.

A related scheme has been introduced to cover the carpet sector. In 1991, the European Carpet producers formed their own organisation - Gemeinschaft umweltfreundlicher Teppichboden (GuT) - the Association of Environmentally Friendly Wall-to-Wall Carpeting.

In 1992, for example, over 920 million square metres of textile floor coverings were sold in Europe. The ecological impact of carpet production and subsequent disposal could potentially be significant. The scheme is voluntary and is member-based. GuT members are obliged to manufacture their products applying ecologically harmless methods (e.g. no formaldehyde, pentachlorophenol, etc.). GuT member companies can be identified in the marketplace by the label which states "Carpet tested for pollutants".

In contrast, the European Union remains keen to promote eco-labelling across industrial sectors. The stylised flower of the EU eco-labelling scheme is granted on the basis of a complete life cycle analysis (cradle to grave evaluation). Work is currently underway, with Denmark leading, on T-shirts and bed linen. A series of problems will need to be addressed before the EU label is introduced into the textiles sector. Moreover, the EU will not make

the label available to all manufacturers who attempt to limit environmental impacts. The label will be limited to a defined percentage of manufacturers who can demonstrate best practice. Again, this scheme will be voluntary and self-financing.

Environmental Initiatives

Environmental issues will remain central to commercial operations. Textile manufacturers seeking to comply with existing and proposed environmental legislation and to adopt best practice generally require advice. The 1994 UK Environmental Business Club Directory identifies over 80 separate clubs and networks providing help and advice to business (some aimed specifically at the Textile Sector e.g. BTTG's Environment Club).

Again in the Textile sector, both Comitextil and the British Apparel and Textile Confederation (BATC) have created dedicated Environmental Committees.

In the U.K., 1996 will see the merging of Her Majesty's Inspectorate of Pollution, the National Rivers Authority and the regional waste regulation authorities to form the UK Environment Agency and the Scottish Environmental Protection Agency. This body will take an integrated approach to environmental protection. The Department of the Environment has also created the UK Round Table on Sustainable Development.

Similarly, the EU has formed the European Environment Agency based in Denmark. All of these initiatives will maintain focus on environmental matters.

Environmental management is gaining attention. Textile businesses will continue to become more aware of the implications of BS7750 and the EU Eco-management and Audit scheme (EMAS).

Textile Initiatives

The textile sector has responded to environmental concerns in a variety of ways. Basic and applied research in academic and industrial laboratories have in recent years resulted in novel cost-effective products and processes designed to reduce ecological damage. Most aspects of manufacture have been addressed. It is interesting to note that U.K. legislation has driven environmental technology sales in 1994 by over 25%. Examples include:

Water re-use and recycling
Size recovery/recycling
Energy Efficiency
Noise and dust reductions
Dyestuff selection
Biocide/Pesticide selection
Volatile organic compounds

Further initiatives will be required as legislative guidelines continue to be tightened.

Conclusions

The textile sector will continue to experience increasing national, European and global pressures and costs associated with environmental issues. Greater attention will be paid in future to integrated managed schemes with supporting documentation (e.g. BS7750 and EMAS).

Environmental concerns will continue to apply from fibre production (e.g. pesticide usage) to finished garment (including packaging). Eco-labelling will become increasingly visible as further manufacturers join the supply chain resulting in greater recognition in the consumer market place.

Greater demands will be placed on technology solutions, requiring an on-going policy of research and development investment at company, national and international levels to devise economically-viable best practice. Environmental pressure groups and informed consumers will demand constant innovation.

WASTE - THE POLITICS AND PHILOSOPHIES

Barry G Hazel

Introduction

The Stone Age lasted for 50,000-100,000 years, the Bronze Age for 3,000-4,000 years, the Iron Age for 2,000-3,000 years and the Plastics Age has been underway for around 100 years. So, what age exists now? The current age is typified by two things:

- synthetic chemicals and derived products
- throwaway products

Both economically and environmentally this age is not sustainable.

Nature, without the influence of man, is the perfect, totally closed recycling system. Think of the many features designed into the natural cycle, deciduous trees in Europe produce their leaves in the Spring, take advantage of the Summer sunshine to produce food and in the Autumn lose their leaves because they would be at a disadvantage in strong winter winds and water supply is difficult from frozen ground. But the leaves are not lost, they fall to the ground, are converted into fertilisers by the action of worms, microbes, bacteria, and the chemical energy is then re-absorbed by the tree roots to give additional energy for the production of the leaves in combination with sunlight for the following Spring.

All animals are dependent on that plant growth for their food and survival. Plants also take in carbon dioxide and by photosynthesis convert it into carbohydrate and give off oxygen; the oxygen is an essential requirement for all animals and plants for respiration. They take oxygen in and give out carbon dioxide, thus completing the cycle. In times of food abundance, many animal species expand in numbers and, equally, in times of food scarcity many starve. Nature is cruel, but only by being cruel can it maintain its eco-balance.

In comparison with the natural cycle, the industrial system is a very wasteful system. Can it be improved without introducing the cruelties of nature? The answer to that is "yes" and "no". Yes, by introducing many of the techniques and technologies which are currently available and no because there are certain products and processes which are so polluting that to continue with them would be to put the total environment at risk.

With regard to recycling, the textile industry has always had an enviable record. The recycling of textiles may be divided into two parts:

- recycling within the processing chain and
- recycling post-consumer waste

Recycling Within the Processing Chain

We have recently been carrying out a study for the Department of Environment on where waste goes, because it is recognised that one man's waste is another man's raw material.

Some key facts from our study were:

1. In spinning and weaving less than 1% of the textile product is lost, most waste goes into the reclamation industry.

2. More waste is generated from packaging than from any other source.

3. The introduction of plastic containers has increased the waste disposal problem.

4. Waste from textile finishing is mainly water and chemicals and studies on recovery and recycling are underway.

Recycling Post-consumer

This is an area where society seems to have gone backwards in recent years; for instance, wool reclaiming was a more significant industry in the past than now. It has been reduced by the introduction of blends of wool and other fibres but legislation, for other environmental reasons, can reduce recycling, eg. the recent proposed German legislation on the use of azo-dyestuffs will reduce recycling because the reclaimers do not know which dyestuffs were used for the original dyeing. The Italians are most concerned about this as, in the Prato region of Italy, re-cycling is a major part of the textile industry, and much of their raw material is wool rags which are imported from Germany and from which, a new product is exported back to Germany. This cannot be done and guarantee to meet the new legislation if azo-dyed wool is to be banned.

The end-use of most cotton materials was as rags and, forty years ago, in any engineering works there were always rags available to wipe up with or to wipe hands clean. These have generally been replaced by paper and even if available polyester/cotton blends are not as good as pure cotton because of reduced absorbency.

Simply to recycle waste should not be an end in itself, it must be both cost and environmentally efficient. It must be remembered, however, that recycling can be polluting in itself and, for some waste, efficient incineration and energy recovery may be the best method.

Post-consumer textile waste raises a number of political questions. Official EU statistics indicate that 7% of dustbin waste is of textile origin and begs the question of what the textile industry can do about it. In every country of the community the general public consumer pays taxes for municipal disposal of waste and so it may be said that it is not the textile industry's responsibility for consumer waste from textiles, although this may change. Currently, however, there is new initiative in Germany by the carpet industry, so that when a carpet is purchased an old carpet is returned for disposal through official routes. This may work with carpets, it would be difficult to operate from other consumer textiles. That does not mean that the textile industry has no responsibilities, it has an important responsibility

in designing for disposal so that the products it sells can be disposed of in the most environmentally friendly conditions possible.

Environmental Management and Auditing Schemes

In recent years, there have been major changes in the method of thinking about waste and its minimisation. This includes minimisation of the polluting effects of the processing chains and this can be done by a variety of methods:

- reduction of input of raw material
- changes in processing to reduce waste consumption or air pollution
- elimination of polluting products or substitution of a polluting product by a non-polluting product

Before anything can be controlled, it is necessary to be able to measure it, and this is an essential requirement in order to undertake the recently introduced Environmental Management and Auditing Schemes (EMAS).

EMAS is an EC voluntary scheme, very similar to BS7750. EMAS is designed to encourage companies to adopt a proactive approach to environmental management, rather than to wait and respond passively to demands of legislation. EMAS compliments legislation by giving official recognition to companies who volunteer to go further, by setting their own objectives and targets and committing themselves to continuous improvement. Effective environmental management is an integral part of good company management, as it leads to better control in the use of raw materials and energy and enables companies to minimise waste and reduce their costs.

It comprises a series of stages:

1. The production of an environmental policy.

2. The company must carry out a thorough environmental review of the site.

3. In light of the review policy, the company introduces an environmental programme for the site.

4. The company sets up an environmental management system to implement the policy and programme.

5. The management system must be audited periodically.

6. The company produces an environmental statement designed for the public, setting out information on the environmental performance of the site, including the success in meeting targets, as well as setting new targets for the future.

7. The validation of the statement is undertaken by an independent accredited environmental verifier.

The environmental audits at the site must be conducted at least every three years.

On the general political front there is environmental legislation, which may originate from either the EU in the form of directives which are translated into National law or from the National Governments. In spite of often being considered "the dirty man of Europe", the UK has probably the widest and most stringent legislation on the environment in Europe. It certainly has the most comprehensive monitoring system; some countries may have more legislation, but no body which consistently monitors that legislation. The UK continually fights for a level playing field or, as some have pointed out, "a level battleground" in this area, because there are considerable commercial advantages in not having to meet certain items of legislation on the environment.

The concepts of the eco-movement and "Ecolabels" are now well-established. The industry generally supports the concept of a single Ecolabel, which deals with controlling pollution, but has strong doubts about some of the private labels which only refer to human health and not to the environment and are used primarily as marketing tools.

The environmental campaigners' "single issue" approach to the environment is naïve. These campaigners take no note of the effect of what they want on upstream or downstream sectors with respect to a given product or process. An example of this in the textile clothing chain is the use of easy-care treatments in the finishing of garments and bedlinens. These reduce pollution by the consumer by up to 60% because they improve ease of laundering (both in terms of reduced detergent and energy usage), but many green campaigners would wish to see them removed because they involve the use of formaldehyde.

In conclusion, the protection of the environment is an issue for producer, consumer, legislator and regulator alike. It can only be effectively addressed if all participants understand all aspects of the problem and act in concert. Fortunately, there are forces in society which are driving environmental progress forwards within an acceptable economic framework and, hopefully, these will create a better, more sustainable environment.

DYESTUFFS, THE MYTHS EXPLODED, THE PROBLEMS AIRED

Brian C Burdett

Introduction

Colour sells merchandise, whether apparel, furnishings or household. To satisfy the public demand for this colour, an excess of some 700,000 tonnes of dyes are consumed annually [1]. Their application to textile materials is varied and, in may instances, not at all beneficial to the environment. Those of us who work in or are connected with, the colour using industries have a long way to go before we can say that we are satisfied with the environmental friendliness of our procedures. Of course, this is not to denigrate the changes that have already taken place through the excellent work of dye manufacturers, research organisations and universities. Reduction in liquor ratios and salt additions, the increasing use of pigments for printing, and the introduction of the ink jet TruColor system [2] are but a few examples of increasing changes to dye application technology. More changes are necessary and those changes must affect the whole of the life cycle of the product, from removing the cause of the pollution in the first place to enabling disposal to take place in a controlled environmental manner.

What happens to all that tonnage of dye? Eventually the textile merchandise becomes the owner's waste. It is taken to landfill, or incinerated, or recycled or reclaimed. In all these instances, pressure is increasing for knowledge of the characteristics of the dyes used and their method of application, so that the disposal of the merchandise can be controlled to manage emissions to air or through ground leakage to sensitive areas such as groundwater or rivers. In fact landfill and dumping will not be tolerated in the future, not only from an ecological point of view, but also from an economical view. Disposal ecology, that is the disposal of textile products through recycling, re-use, non-hazardous decomposition, or safe burning without air pollution and with the recovery of energy, will become more and more significant issues in the life-cycle of any project.

Safe Dyestuffs - Natural Dyes

Unless there is a change in human behaviour, the demands for coloured textile merchandise will continue despite advertisements such as the example below, which was for duvet covers, bed sheets, pillowcases and bath robes:

> "Commitment to the environment comes in many forms. Processing cotton normally produces large amount of waste and pollution, By using 100% unbleached and undyed cotton in the manufacture, these environmentally damaging elements have been reduced. Consequently, chlorine, optical bleaching agents and formaldehyde are not present in the fabric making all these items ideal for use next to the skin"

According to some evangelistic members of the public, including some in the textile and

garment industries, synthetic dyes should be replaced by the classical, traditional natural dyes. "Natural" to these peoples equates with environmentally friendliness. Many, and in particular some environmental activists, have no conception of the problems involved in the commercial use of such dyes.

There is no doubt that the use of natural dyes on a commercial scale is gradually increasing. There is no difficulty in accepting the challenge of a retailer selling merchandise dyed or printed with natural dyes. If the public wishes to purchase unlevel, lower fastness coloured textiles, that is their prerogative. What is of concern is the belief that the use of such dyes will solve all the environmental ills of the industry; the dyes are 'natural', so all is well. That kind of belief is due to ignorance, and those in the industry who disseminate information, or who describe themselves as scientists, must be held partly responsible. From personal experience, when explanations are given as to why there cannot be whole scale return to a previous technology, there are mixed reactions from incredulous disbelief to a genuine desire to be educated, and that is the key. Careful education is required by scientists and non-scientists alike. It is the responsibility of industry to maintain an awareness of the underlying chemistry of environmental issues and to promote such awareness. Of course, that is to assume that the audience has an appreciation of basic chemistry or at least basic general science. Again experience shows that this is not always true and the educational system must then examine its part.

Natural Dyes and the Environment

Technologically, natural dyes may be classified as substantive or direct dyes, vat dyes or mordant dyes. Whereas some are obtained from animal sources, the majority are from vegetable sources. The extraction and application of many of these dyes is not only very time consuming, but also environmentally, not at all friendly.

The production of Turkey Red dyeings and prints, based on the use of madder, probably represent the ultimate in length of procedure. Although the precise nature of the process has never been established beyond doubt, typically there were 5 or 6 separate stages, described as oiling, sumaching (tanning), mordanting, dyeing, and clearing [3], the whole process carried out after a lengthy extraction of the dye from the plant root. The plant tops were fed to cattle, which then produced milk of a reddish hue and butter that had a distinct bright yellow tinge; the roots produced red bones.

Tyrian Purple is obtained from a family of carnivorous shell-fish, the most common of which is found in the Mediterranean, that is *Murex Brandaris*. Enormous numbers of shell-fish were necessary to yield a very small quantity of dye. According to one calculation, to obtain 1.4g of the dye, about 12,000 shell-fish would have to be collected and crushed. If the dye was to be used for all present blue dyeings, let alone in mixtures with other natural dyes, it would result in some 200 square miles of land being deep in shells [1]. The extraction of the mucus from the appropriate gland and the application to textiles was not a clean job and ancient writers have described dyers' hands shining in brighter colours: nothing ever changes! The peculiarity of the dye, of spreading an unsavoury smell when exposed to the sun, and remains of countless shells, made the centres of trade places of unsavoury odour [4].

Cochineal requires about 150,000 dried insects reared on cactus to produce about 1kg of dye [3]. The female insects are collected in a cloth or bowl and immediately killed. This is carried out by means of a hot oven, steam, or hot water. Under these treatments the insect bursts and turns red and is then finally dried.

Dyes from vegetable sources, including roots, do not offer any easier environmental alternatives. Glover and Pierce [1] have stated that in dyeing of wool, assuming an average depth of colour of 1.7%, some 43,000 tonnes of synthetic dyes are used. To replace the synthetic dyes with natural dyes, 15 million tonnes of fresh plants would be required. In the cotton sector, the analogous figures are even more dramatic. Taking the average depth of colour as 2%, about 400,000 tonnes of synthetic dyes are used. The weight of fresh plants, from which it would be necessary to extract the natural product to replace the synthetic dyes, would be 176 million tonnes. To grow that amount of vegetable matter for subsequent dye extraction, at least 30% of the world's agricultural land would be required. This is all in despite of anticipated R & D successes regarding extraction techniques of these natural products and concern to improve the environment with the wider use of natural dyes [5]. The sustained growth of some of the resources would present formidable challenges, such as the planting and management of *Haematoxylon Campechanium* which is the botanical name of the logwood tree, which reaches a height of over 15 meters. Furthermore, once grown, cut down, and treated to extract the colorant there would be a need to dispose of millions of tonnes of waste vegetable matter every year.

Whilst the banning of natural dyes on a commercial basis is not being advocated, they should be considered only where they can be utilised for the benefit of the industry. For instance, despite comments above on the use of classical natural dyes, some very active work has been undertaken for a number of years at BTTG to develop, through fermentation procedures, microbially-derived anthraquinoid pigments in a high state of purity for commercial exploitation. The method of production removes the need to use environmentally polluting synthetic chemistry; modification of the pigments by classical synthetic chemistry enables useful dyes to be produced, which can be applied by normal methods and which give fastness properties higher than the synthetically produced analogues and brighter colours on dyed materials. Modification of the parent pigment by biotransformation will be a future activity in this area.

Natural Dye Mordants - Metal Ions and Effluent

The majority of natural dyes are mordant dyes; in other words they require to be applied in conjunction with a metal salt to assist in fixation and thereby achieve some degree of fastness. Even then the fastness obtained is generally not adequate for today's discerning public. Salts of tin, aluminium, iron, copper, zinc and chromium (VI) are necessary, not only for fastness requirements, but in many cases to achieve the correct colour of the final product. The majority of the application processes would not be allowed today because of their impact on the environment. Taking Glover and Pierce's data [1] a hypothetical dyeing process could give us a level of metal contamination in exhaust liquors, which would be over 1,000 times greater than that allowed by UK consent limits (see Table 1).

Table 1: **Metal contents in exhaust liquors**

Metal	Amount of metal present (hypothetical)(mg/l)	Actual UK consent (mg/l)
Al	340	2
Cr(VI)	100	0.5
Zn	200	10
Cu	260	2
Fe	480	10
Total	1380	10

The inclusion of heavy metals in the often lengthy application procedures is contrary to the current trend of reducing or even banning, the use of such metals. As we have come to expect in this complex area, different approaches are being taken to reduce the impact of heavy metals on the environment. With pollution, and waste and recycling in mind, the members of the carpet ecolabelling scheme, GuT, gemeinschaft unweltfreundlicher Teppichboden EV, have voluntarily banned the use of metal-complex dyes on certain nylon carpet products as from January 1996. As from January 1998, this ban will be extended to all nylon products and, it is thought, during the remaining part of this century, the extension of the ban may occur to include all nylon and wool carpets. To emphasise the significance of the ban, there are 85 carpet manufacturers who are members of GuT and who produce between them over 75% of carpets manufactured in Western Europe. As a check on the toxicity of the final coloured article, the Öko-tex ecolabelling scheme carries out an assessment of the extractable heavy metals from dyed or printed apparel The American Textile Manufacturers Institute (ATMI) is carrying out a study of the toxicity of metals present in textile effluents and has asked the European textile industry to participate.

Toxicity of Dyestuffs

Are dyes toxic? The normal reaction is to assume that the dyes commercially available are not toxic. Whereas it is known that three dyes are carcinogenic by themselves (see Table 2), and some are described as allergenic (see Table 3), all new dyes undergo a stringent programme of auxocyte tests before being released on to the market.

Table 2: Carcenogenic dyes

Acid Red 26
Basic Red 9
Disperse Blue 1

Table 3: Allergenic dyes

Disperse Red 1
Disperse Red 17
Disperse Orange 3
Disperse Yellow 3
Disperse Blue 1
Disperse Blue 3
Disperse Blue 106
Disperse Blue 124

However, when dyes are digested and broken down by the metabolic system, the breakdown products may be harmful.

The Case of Azo Dyes

A regulation of July 1994 emanating from Germany bans certain consumer goods containing azo dyes, which on cleavage of one or more azo groups, form any of twenty listed aromatic amines as shown in Table 4. These amines are currently classified by the German Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area (MAK Commission) as Group III A1 or III A2 carcinogens, that is, substances that have been unequivocally proved to be carcinogenic according to the Commission. The regulation has had a substantial impact internationally on consumer industries, especially in textiles and leather goods, because the ban concerns goods that remain in direct body contact for an extended period of time and includes clothing, bed linen and shoes. The difficulties are compounded by the lack of a validated analytical method for the examination of finished merchandise. Experience by test laboratories indicated that the methods currently used can give spurious results. Although many dye manufacturers, particularly those who are members of ETAD, Ecological and Toxicological Association of Dyes and Organic Pigment Manufacturers, no longer manufacture or sell azo dyes affected by this Regulation, there are some exceptions.

Table 4: Carcinogenic amines

MAK Group III A1	
4-Aminodiphenyl	
Benzidine	
2-Amino-5-chlorotoluene	
2-Aminonaphthalene	
MAK Group III A2	
2-aminoazotoluene	2-Methoxy-5-methylaniline
2-amino-4-nitrotoluene	3,3'-Dimethyl-4'4-diamino-diphenylmethane
4-Chloroaniline	4,4'-Methylene-bis(2-chloroaniline)
2,4-Diaminoanisole	4,4'-Oxydianiline
4,4'-Diaminodiphenylmethane	4,4'-Thiodianiline
3,3'-Dichlorobenzidine	2-Aminotoluene
3,3'-Dimethoxybenzidine	2,4-Diaminotoluene
3,3'-Dimethylbenzidine	2,4,5-Trimethylaniline

Ecolabelling schemes, such as Öko-tex and GuT, have already adopted the same list of 20 amines, and dyes which give rise to the amines are not to be used on textile materials if application is made for one of the respective Certificated and Logos.

However, despite the legal requirement of the German regulation, and the commercial enforcement of the ecolabelling schemes, there is no official list of dyes to be banned. To determine whether or not a particular dye will be affected by the ban, it is essential to make contact with the manufacturer.

The Need for Chemical Understanding

When exhaust dye liquors are treated in the normal course of effluent control, are we obtaining toxic breakdown products or is the parent dye, although visually abhorrent, any less or more toxic? The emphasis is on removing the colour by means of chemical attack, rather than removing the parent coloured dye molecule. What of the reactive dyes that get through the system? As this is the main environmental challenge facing the UK textile dyeing and finishing industry [6], many organisations are developing means of decolourising these dyes.

One particular research activity, a joint collaboration between BTTG and Leeds University, suggests that it is possible to attack such dye liquors with a soup of enzymes and, overnight in a batchwise situation, to obtain decolourised products. Again, what are the products? The bacterial soup may be natural, but that does not mean that the breakdown products are any safer. It is necessary to understand the underlying chemistry and to identify the products generated and to assess the environmental risks. In an endeavour to understand some underlying chemistry, structure/carcinogenic relationships of dyes and their intermediates are being studied at the North Carolina State University [7].

On a world-wide basis environmental practices differ, and there is no such thing as "a level playing field" for efficient environmental management. Exploitation of this state of affairs will continue where environmental costs are lower. How many importers and merchants know how their merchandise has been processed, or what dyes and chemicals are on the goods? Ecolabelling protocols are certainly awakening the minds of many in the textile chain to these questions, whether the goods have been coloured with synthetic or natural dyes.

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ENVIRONMENTAL HUSBANDRY

Simon Kent

Introduction

With privatisation of the water authorities legislation in the UK, and EEC harmonisation, political issues such as the "Green Vote", pollution and the environment have become an increasingly important. In addition, retailing chains are demanding that their suppliers demonstrate that their practices are environmentally acceptable.

Marketing will dominate the companies of the future and decisions on whether to manufacture or purchase will necessitate the drawing up of environmental specifications as well as physical specifications; hence companies should look to the creation of new processes which are environmentally friendly. Companies have to respond to the challenges of maintaining growth, improved flexibility and optimisation of cost and efficiency but should seek the solutions to environmental issues and their impact on a broad basis, ie. atmosphere, pollution, dust effluent and noise.

An Environmental Strategy

But where can a start be made? - what with "red lists, black lists, PCP'S, BOD, VOC, CFC'S to be phased out by 1997 and 1, 1, 1, trichloroethane by the year 2005," it all seems confusing and becomes a balancing act of meeting deadlines on an important order and keeping within budgeted costs. Environmental issues easily get pushed to the back of the queue.

At Parkland Manufacturing, the impact on the business of addressing environmental issues was considered. All sectors of the business compete for a finite resource - capital. This factor helped focus our minds on the objectives we could achieve.

The first step was to develop an environmental strategy which itemised the following actions:-

(i) Find out what the law requires. A copy of the Environmental Act 1990 is a start.

(ii) Find a partner - a problem shared is a problem halved. Someone who can help, for example The Confederation of British Wool Textile Manufacturers, The Department of Trade and Industry, Her Majesty's Inspectorate of Pollution, dyestuff companies, research organisations, local authorities, universities and water authorities with their new business account managers - they really are very approachable, and tend to be proactive rather than reactive in their attitude.

(iii) Designate a person who is responsible for environmental matters and develop a policy.

(iv) Carry out an audit of raw materials, processes and producers with regard to their impact on the environment.

(v) Carry out an environmental survey covering such items as water effluent, noise, dust and atmospheric pollution.

(vi) Make provision for emergency contingency plans.

(vii) Consider staff training.

(viii) Consider insurance implications.

(ix) Consider grants.

(x) Make provision for resources for manpower and capital.

(xi) Ensure the medium and long term stability of the company whilst maintaining a competitive edge and an excellent public image.

(xii) Review the situation every two years.

It soon became very clear that the Company had to apply the same cost justifications to the management of environmental issues as many other aspects of the business. Thus it was essential to define objectives necessary to maintain a competitive edge whilst reducing the environmental impact.

Examination must occur of the systems which provide management solutions such as eco-auditing and eco-design, quality and environmental standards such as BS5750 and BS7750 respectively, life cycle analysis and waste minimisation. It is only waste minimisation however, which will provide any pay-back.

Waste arises at every link in the manufacturing chain. Therefore, the question of spending capital on monitoring is of importance when analysis of the overall scenario and focusing on waste minimisation is the key to the problem.

The need for an integrated approach is required; tighter controls on the generating and disposal of waste are the springboard for reassessing and minimising waste. Thus the following ideas were considered:-

Elimination
Source Reduction
Recycling
Treatment and disposal

each of which is analysed in more detail below and when put into practice, have cost little to implement and all have showed significant savings.

Elimination

It became evident 2 years ago that solvent processing would become increasingly unable to meet developing legislation. At the same time, our solvent dry-cleaning machine was nearing the end of its safe useful working life and a solution had to be found. Thus the question of whether solvent processing was required was asked. All stages of manufacture were examined and those areas were identified which required changing if solvent cleaning had to be eliminated. Three main areas were identified as the main sources for the need to dry clean:-

(i) Mineral oils used in lubrication of the looms

(ii) Paraffin waxes used in weaving

(iii) General housekeeping

The mineral oils were substituted by water-soluble oils. The paraffin waxes were substituted by stearate-based water soluble products, and the level of housekeeping elevated to a much higher plane. Biodegradable blends of soap and detergents were successfully developed for scouring the Company's products and within a year the old process was phased out with no added expense, and indeed substantial savings have been made of the order of £33,000 p.a.

Source Reduction

It has been established by many water authorities that certain banned substances were appearing in the effluent much to the annoyance of companies that were not using these same substances.

It was found that these chemical contaminants were being applied by suppliers of yarn and fabric from countries where legislation did not exist or was ignored.

The problem was tackled by asking all suppliers not to supply goods which contain any of these banned substances. A comprehensive and detailed list was drawn up and forwarded to all suppliers with a statement that should any of the banned compounds be found, the goods would be returned or the suppliers would be charged with the safe removal of such substances.

This policy has been running for at least three and a half years with no breach infringements to date, and costs of such implementation were minimal. Thus, a simple letter to all suppliers has potentially saved thousands of pounds should the company have been found to be in contravention of environmental legislation.

Another source reduction was considered when dyeing and finishing units were amalgamated onto the one site. In principle, the Company wanted to double the capacity but still remain within the effluent consent limits imposed by the local water authority. Scenarios like this certainly help concentrate the mind.

New continuous aqueous scouring had already been established as one way forward but greater machine utilisation was the key, especially in piece (individual garment) dyeing, and blind (i.e. without undertaking a trial dyeing techniques were introduced over a period of time.

As a result, over a period of three years, production was doubled with only a marginal increase in effluent costs. All this was in addition to energy savings derived from a consideration of water usage and its minimisation.

A Combination of Source Reduction Culminating in Eliminisation

Heavy metals in the form of chromium, for example, present an ever increasing threat to all wool dyers. Each year, tighter and tighter discharge limits are imposed. Parkland Manufacturing has endeavoured to take a proactive approach by considering future legislation and plotting a particular course of action which will help meet that legislation before or on the due date.

The first step was to audit the dyeing processes and identify all four chrome-dyeing processes. After this, a reduced chrome technique was initiated as outlined by The International Wool Secretariat (IWS). The second stage was to replace as many chrome-dyed recipes with 1:1 and 1:2 metal complex dyes thus reducing further the amount of chromium present in liquors.

By following this path, the legislation limits were just met whilst managing to maintain and keep within the budgeted costs.

A third stage is to look at yet further reductions and hopefully the elimination of chromium. Early trials look promising. The dyes used are expensive but it is hoped that the reduced dyeing times and energy costs coupled with improved quality will make it a feasible proposition.

Energy Efficiency

Energy efficiency is yet another element to be carefully considered in the quest for improved environmental husbandry. It is claimed that up to twenty percent of energy can be saved immediately by following an energy conservation programme. The Company, therefore considered the following:

(i) The undertaking of an energy audit

(ii) The monitoring of energy consumption

(iii) Maintenance and housekeeping to make sure all energy processes are fully maintained and operated correctly.

(iv) Measurement and analysis of the material and energy flows.

(v) Implementations of best cost saving options.

(vi) Monitoring improvements by monitoring fuel consumption.

Thus energy savings are there for the taking when applying blind-dyeing techniques, and the same is true of optimisation of processes in general.

Some three years ago, work began on implementing a system which would have a major controlling influence on the reproducibility of the Company's bulk production from initial trials. The system involved objectively measuring the finished product with the system, FAST - fabric assurance by sample testing. This comprises a series of three test machines and one test method which objectively measures the tailoring characteristics of finished fabric.

The system enabled the Company to optimise its processes by reducing unnecessary and wasteful manufacturing routines and thereby save energy. Over a period of twelve months a reduction from 27 options down to 3 on one machine alone and an overall reduction of routines by at least 50% has been achieved. The value of objective measurement becomes a useful tool in the environmental arsenal thus enabling energy and unit costs to fall while helping to promote and maintain best environmental and cost efficient practices.

Recycling

Considerations were given to recycling when the Company was involved in the mothproofing of particular top-dyed fabrics. The legislation and consent limits with regard to the discharge of mothproofing agents are particularly demanding and there is a wish not to contravene this legislation. Consultations began in earnest with the dyestuff and chemical industry along with IWS. A product was selected which was the least harmful to aquatic life but conventional means of application would result in a breach of this consent limit. A pad impregnator was chosen as the best means of application. However, there was no control over the discharge so it was decided to build a mixing tank with metered water and temperature control along with a closed loop system allowing the mothproofing liquor to be mixed and added to the pad bath. A simple ball-cock mechanism maintained the correct level and a series of pipes flowing back to the tank allowed for recycling of the liquors. If the pad was to be used for something else the liquors were drained off into containers and stored ready for re-use.

Finally, when the mothproofing is completed or the liquors can no longer be used because of contamination, they are drained off into a container. Small quantities of diluted liquor are then added to wool dye batches and exhausted on to the fibre over a period of time. This will not totally remove all mothproofing agents but will vastly reduce and keep effluents within consent limits.

The main point to be stressed is that by adopting a waste minimisation policy, namely recycling of the mothproofing liquor, it paid for the mixing tank and closed loop system within one month and went on subsequently to save 25% of the cost of the mothproofing agent.

Treatment and Disposal

For some time the Company had a slight pH problem with its effluent and, as consent limits were to be tightened, it was decided to tackle the problem. It is not surprising for a wool dyehouse that the pH was, on occasions, on the acid side of the consent limits.

At the same time there was a need to improve the handle of all wool-based products and so rather than incorporate expensive dosing systems, it was decided to investigate the use of slightly alkaline scouring chemicals. Mixing the alkaline scouring liquors with the acidic dyehouse liquors thereby neutralised the acidity and addressed the pH problem. Products were experimented with and the mixing of the effluent implemented, resulting in complete success. Additional gains were that considerable savings were made by looking closely at scouring chemicals and reducing them from six down to two types. Economies of scale resulted in savings of £12,000 pa.

The final bonus was that not only had an environmental problem been addressed with some reduction in cost, but a much improved product handle was gained.

Summary

This paper has attempted to give some useful pointers on a most fascinating subject with the old adage "prevention is better than cure". It is true today as it has ever been that environmental issues are no longer a passing fancy and, if not acted upon, will become missed opportunities. The main points are:

Control the inputs,
Control the process,
Control the outputs and

solutions come in many guises. Development of an integrated approach will ensure a tangible impact on the company's performance.

There is no doubt that environmental husbandry is here to stay and will become an ever-increasing management discipline in the furtherance of profitable and environmentally friendly manufacturing.

Recycling Textile and Plastic Waste

This text contains nineteen edited papers originally presented at the first major conference on the environmental aspects of the textile and related plastics industries – 'Wealth from Waste in Textiles'. Both industries must increasingly be able to demonstrate environmentally acceptable practices while working within a framework of economic viability. Thus they must be able to make products which consumers will buy based on both price and ecological factors.

The selected papers initially overview the magnitude and consequences of excessive waste production, then proceed to discuss waste minimisation strategies and practices, focus on selected areas where recent scientific and technological advances have been made and finally set the problem within the context of current public perceptions, politics and regulations.

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