Environmental Concerns in Textiles

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Abstract
Textiles have a very primary relationship to the pursuits of human kind. Human greed to look appealing & wear glamorous clothes has ended up causing harm to the environment. Textile industry is one of the most pollutants releasing industries of the world. Textile processes utilize the ever depleting natural resources and they lead to air, water, land, noise and visual pollution affecting the balance of the environment. A great deal of effort is being exerted by textile companies to reduce the harm that textile production is doing to the earth. Technical textile applications are also playing their part in reducing the pollution. This paper reviews the different means by which the textiles are polluting environment, the harm caused by this pollution to the environment and the ways to mitigate the textile pollution.

Key words : Air, Environment, Land, Noise, Pollution, Textile, Visual, Water.

1.0 Introduction

The existence of human beings on earth is the result of a fortuitous set of circumstances in which conditions for development of the species are present so that evolution could take place allowing human beings to reach present state of being. This tenuous continuation could be jeopardized at any time by changes in environment conditions, and this far-reaching effect could result from shifts which might be totally insignificant by cosmic standards. Environment could bring about, for example, inability to breathe, or stay warm or cool enough, or grow the food needed for survival. Thus, human beings are only able to survive because planet provides all the sustenance needed without major effort on part of living beings.

The exposure to this set of conditions is defined as environment. One of the minor ways by which premature extinction can be reduced is to guard human bodies from excessive temperature fluctuation by the use of textiles. Textiles are also used to make life more comfortable and convenient. Without them, one would find life to be harsher, and probably not survive with the same life expectancy as it is found today.

The interaction between textile materials and the environment is a complex one taking two distinct forms. There is, first, the effect of a change in properties that the environment can bring about in the textile, generally classed as degradation. Second, there is the manner in which the production or use of textiles can impinge on the environment, generally classed under the term' pollution for the negative impact', but also including environmental protection by pollution reduction where, say, a landfill liner is used to prevent leaching. A further need is for the production of textiles to be possible by using the resources available on the earth without depleting them irreplaceably. Each of these factors is important and should be considered separately in order to build up a complete view of how textiles and the environment can impinge on one another (1).

2.0 Textile industry overview

The textile industry is a significant contributor to many national economies, encompassing both small and large-scale operations worldwide. In terms of its output or production and employment, the textile industry is one of the largest industries in the world.

The textile manufacturing process is characterized by the high consumption of resources like water, fuel and a variety of chemicals in a long process sequence that generates a significant amount of waste. The common practices of low process efficiency result in substantial wastage of resources and a severe damage to the environment. The main environmental problems associated with textile industry are typically those associated with water body pollution caused by the discharge of untreated effluents. Other environmental issues of equal importance are air emission, notably Volatile Organic Compounds (VOC)'s and excessive noise or odour as well as workspace safety (2).

3 Textile sources of pollution

3.1 Introduction.

The textile industry is a complex one. The production, coloration, finishing and distribution of fibres, yarns or fabrics are carried out with the aid of large, complicated, expensive machines and a range of chemical substances. The difficulties inherent in manipulating the textiles mean that there are many opportunities for materials, either textile components or reagents added to them, to escape from the equipment. It is this difficulty in maintaining control over movement of materials that is responsible for pollution. Inevitably, the effort to produce all the goods needed leads to the dispersion of impurities into the air, water or land, as well as to undesirable noise levels or visual ugliness. These can be considered in turn with a view to establishing how much responsibility the textile industry must bear in each case.

Textile processes produce significant amount of discarded substances. Discarded substances find their way into the environment as contaminants, and presence of contaminants lead to concerns for the environment (1).

3.2 Air pollution

Processes performed in textile mills produce atmospheric emissions. Gaseous emissions have been identified as the second greatest pollution problem (after effluent quality) for the textile industry. Speculation concerning the amounts and types of air pollutants emitted from textile operations has been widespread but, generally, air emission data for textile manufacturing operations are not readily available. Air pollution (Fig1) is the most difficult type of pollution to sample, test, and quantify in an audit (3).

Air emissions can be classified according to the nature of their sources

Point sources

•Boilers
•Ovens
•Storagetanks

Diffusive

• Solvent-based
• Wastewater treatment
• Warehouses
• Spills

Textile mills usually generate nitrogen and sulphur oxides from boilers. Other significant sources of air emissions in textile operations include resin finishing and drying operations, printing, dyeing, fabric preparation, and wastewater treatment plants. Hydrocarbons are emitted from drying ovens and from mineral oils in high-temperature drying/curing. These processes can emit formaldehyde, acids, softeners, and other volatile compounds. Residues from fibre preparation sometimes emit pollutants during heat setting processes. Carriers and solvents may be emitted during dyeing operations depending on the types of dyeing processes used and from wastewater treatment plant operations. Carriers used in batch dyeing of disperse dyes may lead to volatilisation of aqueous chemical emulsions during heat setting, drying, or curing stages. Acetic acid and formaldehyde are two major emissions of concern in textiles (2).

Air pollution can also arise from use of textiles after manufacture. For indoor furnishings, many pollutants are related to building materials, but furniture, carpets, draperies and wood or fabric furnishings probably give rise to more consumer complaints. This may be because of the presence of formaldehyde or volatile organic substances from wood and office furniture. Guidelines on chemical levels are available (though they do not cover non-industrial buildings), but research to investigate biological pollutants (potentially of more interest in the textile context) is much less extensive. Secondary emissions from floor coverings include harmful substances (especially formaldehyde) given off, for example from back coatings. Tests which can be carried out in order to provide a 'green' certification for carpets using suitable chemicals, processes, dyes and colorants are slowly becoming available (1).

Air pollution within the textile industry affects people, machinery and products. There is an increased incidence of health problems, especially byssinosis, tuberculosis and asthma (1).

Fig 1: Air pollution

Textiles can, though, play a valuable role in contributing to the reduction of air pollution. Many types of filter fabrics are produced, with an ability to remove particles with a range of sizes. The fine pores in a fabric are ideal for preventing the transmission of impurities while allowing air flow to take place. Filter fabrics, indeed, form a major class of technical fabrics and are used throughout the world in all kinds of situations (1).

3.3 Water pollution

Water pollution(Fig 2) is more apt than any other type of pollution to be associated with the textile industry by the general public, mainly because, when it occurs, evidence of its existence in the form of coloured dyestuffs from dyeing and printing or detergent foam from scouring or washing is clearly visible. The textile industry uses high volumes of water throughout its operations, from the washing of fibres to bleaching, dyeing and washing of finished products. On average, approximately 200 litres of water are required to produce 1 kg of textiles. The large volumes of wastewater generated also contain a wide variety of chemicals, used throughout processing. These can cause damage if not properly treated before being discharged into the environment. Of all the steps involved in textiles processing, wet processing creates the highest volume of wastewater (4 &5).

Fig 2: Water pollution

Pollution in wet processing has reached alarming levels, and measures are being developed to reduce water consumption by changing or modifying processes, by lowering the concentration of waste products in water, by using only the optimum quantities of dyes or chemicals of an ecofriendly nature, and by carrying out appropriate restorative treatment. Using less water in manufacturing, reducing the number of steps in bleaching, and recovering chemicals from waste streams reduces both costs and pollution (1).

Sizing agents and starch are frequently considered to be the most serious sources of pollution in the textile industry, primarily from the volume of emissions present. The total cost of desizing is about 2.1 times the cost of sizing and is responsible for 3–4% of the cost of a loom state fabric. Starch/PVA (polyvinyl alcohol) size discharge can easily exceed legally permitted levels.

In the public mind, though, it is almost always the dyeing process which is associated with textile pollution, particularly with metals such as chromium, cobalt, nickel and copper. The dyeing process itself, possible substitutes, alternative reactive or acid dyes, and ways of minimizing residual dyestuff content may all be able to make some contribution to the overall aim of ecological improvement. Natural dyes are not without their environmental problems and colour removal does not necessarily mean toxic substances have also been removed; the carcinogenic and toxic effects of dyes are of crucial importance. Mutagenic changes caused by ingesting textile effluents may mean that toxic effects will still be present after biological treatment, a fact which may form a basis for selecting dyes and chemicals for textile plants (1).

Many finishes can produce pollutant byproducts in the water stream. The use of oils, resins or other chemicals in finishing treatments is so diverse and so widespread that it is impossible to consider them all in a brief survey of this kind, but the application of flame-retardant, softening, durable-press, antistatic, soil-release, stain resistant, waterproofing or oil-repellent finishes invariably uses materials which are harmful to the environment if discarded. Loss of lubricating or spinning oil from machinery can result in the accidental release of harmful substances, and spillage of diesel or other fuels from vehicles can occur. All of these products can bring about harmful side effects in either or both of the two ways mentioned earlier, by the poisoning of aquatic life or the enhancement of species such as algae, which remove oxygen from water and deprive aquatic creatures of this vital element. Waste discard of other kinds, from floor sweepings to excess chemical leachate from containers, can find its way into streams, either during a storm or by careless handling in cleaning or tidying. As mentioned earlier, an entire industry involving technical textiles has developed with the sole purpose of constraining, as far as possible, damage brought about by such unfortunate polluting events(1).

Again, textile effects on water pollution are not entirely negative. Indeed, one of the most important developments of the past few decades has been the use of geotextiles to contain pollution. Industrial waste in harbours and oil spills near sensitive coastal regions have been prevented from causing irreparable damage by the effective use of geotextile membranes to prevent widespread dissipation of the polluting substances, while ditch liners, landfill liners and stabilization fabrics for banks of vegetation have prevented the loss of valuable topsoil and the movement of soil containing pesticides or other harmful reagents into water supplies (1).

3.4 Land pollution

Land pollution (Fig 3) can arise when a textile, or a substance used during its production, is thrown away on a landfill site. Fibres or chemicals can be harmful if their decomposition (as mentioned earlier) under the influence of air, water or sunlight produces a toxic agent. It is surprising and sad to see that there is virtually no attention paid to this problem in the textile literature, perhaps because it is so obvious and yet so easily accepted that it seems not to be interesting. Examples illustrating the omnipresence of the problem include a range of toxic breakdown products from materials such as polyester, nylon, or other polymers which have been discarded into the waste stream and find their way into a landfill site. Steps taken to render them 'biodegradable' include the use of starch as a source of bacterial nutrition or the incorporation of a substance decomposed by ultraviolet radiation, both of which facilitate disappearance of the waste material.

Fig 3: Land pollution

Unfortunately, ultraviolet decomposition is only effective until the polymer is buried, and breakdown products are not attacked by either biodegradation technique, but aided in entering the soil more rapidly. From there, they can find their way into the water supply, acting as contaminants in the same way as if they had been discarded into a stream initially. The valuable contribution of technical textiles in the form of barriers to this transfer cannot be forgotten, and may well prevent serious escape of pollutants from taking place (1).

3.5 Noise pollution

Noise pollution(Fig 4), ignored as an annoying but essentially harmless nuisance until recently, is becoming of more concern in the general population, though not, apparently, in the textile industry. The impression received from a review of the literature is that all that can be done to reduce noise has already been accomplished, and the residual problem is one that has to be tolerated. High noise levels are still generated in, for instance, twisting, spinning and weaving processes. Unpleasantly loud noise can also arise from the use of vehicles or other equipment in loading, shipping or handling raw materials or finished goods. There is evidence to indicate that the effects of noise pollution are numerous, the most obvious one being hearing loss. Exposure to high intensity noise leads to deafness, at a rate which increases rapidly as the decibel level of exposure increases. The usual assumption made in legislation is that continuous exposure to a sound pressure level of 90 dB(A) is permissible throughout an eight-hour working day, but that exposure to higher noise levels, or to that level for a longer continuous period of time, must be restricted. This is accomplished by using some kind of derating curve or equation, with permitted exposure time continuously reduced as sound level increases, until no exposure at all is legally permitted at levels of 125 dB(A) or higher.

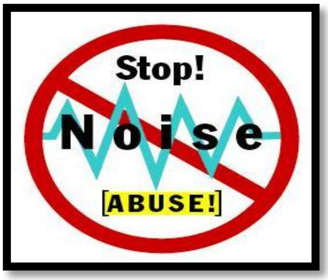

Fig 4: Noise pollution

Other effects of noise exposure are less easily identifiable. There is a growing body of evidence to indicate that high noise levels bring about psychological changes, which may include frustration, carelessness, withdrawal or sullenness. Noise exposure over long periods of time has also been associated with increased absenteeism and even willful destruction.

As before, textile products (and especially technical textiles) can be of service in controlling the effects of noise pollution. They enjoy widespread use as acoustic absorbent materials to reduce the annoyance of high sound levels for human beings (1).

3.6 Visual pollution

Visual pollution (Fig 5), often not considered as a problem, is in fact all pervasive. Not only are textile materials evident as waste strewn around the countryside, but advertisement hoardings frequently includes material intended to increase the sale of these goods. Paper documentation and packaging, or plastic sheets used to wrap textiles displayed for sale, often find their way into landfill sites or are scattered around, from such sites or haphazardly, to offend the viewer by ruining the pristine sight of a peaceful natural vista. Landfill sites themselves, even where they manage to contain the waste goods, are gradually encroaching on more and more of the beauty of the earth and, once they are full, can often not be safely capped for fear of toxic breakdown substances being leached into the water table, as mentioned already. Once again, there appears to be little or no interest in developing research to alleviate the problem.

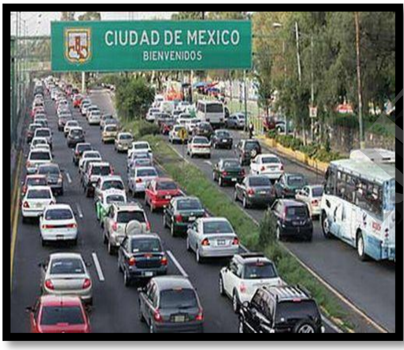

Fig5: Visual pollution

Textiles, once more, are useful in alleviating the problem by exploiting their aesthetic qualities to beautify our domestic surroundings.

4.0 Effects on the environment

As with all modern industries, substances released into the environment by textile producers are generally not harmless and are likely to have far-reaching effects if their release is at concentrations above safe levels. This limit is difficult to decide, as we do not know that a substance will be sufficiently diluted before it is absorbed by an organism, nor can we be certain that that organism will not concentrate toxic materials before any harm is caused. Hence, the most serious concern should be felt (and is often demonstrated) for the discharge of chemical pollutants into the natural environment via air or water or land. Special consideration needs to be given to water contamination levels from dyeing, printing and finishing, and there is a need to make available adequate information on the ecological impact of chemical products. Some of the better recognized problems include abnormal pH levels, suspended or settleable solids, oxygen demand, toxicity, colour, persistent bioaccumulative organic substances, mutagenic chemicals and a fish-flesh tainting propensity.

It is usually accepted that many substances that are discarded in textile production can bring about untold harm to nature. Fish can ingest toxins, can even be killed by them, and birds can be rendered sterile. Even if the lower creatures survive in spite of all these hazards, the potentially harmful contents of their bodies can be transmitted up the food chain to affect human beings. Because of concentration at each stage in this process, the end-consumer is exposed to a relatively high level of toxin that may have similar effects on human beings, in terms of sterility, altered genetic structure, or deformed births, as it could have had on other species. Animals (including human ones) are also subjected to additional pollution related risks in the form of long-term exposure to harmful substances, such as carcinogenic or other disease-causing agents, as a result of breathing contaminated air or being exposed to harmful agents. Toxic emissions from solvent spinning or tentering operations, and increased incidence of liver cancer among dyehouse personnel, have been noted and are examples of this type of hazard in the textile industry.

Plants can also suffer from the use of insecticides, herbicides or fertilizers which can cause stunted growth, sterility, or death from disease. Once again, even if the plant does not die, the presence of a harmful material can be passed up the food chain until it eventually reaches human beings and causes them harm as before (1).

5.0 Environmental harm reduction

In view of the damage which our careless attitude to planetary welfare has brought about in the past when our awareness was much lower, it is hardly surprising that a great deal of effort is being exerted by textile companies to reduce the harm that production is doing to the earth. The ideas put forward for ecological conservation can be divided essentially into four classes. These are, respectively, the adoption of recycling as a means to cut down resource depletion, the use of ecologically friendly fibres or other materials, a reduction in the amount of pollution produced and improvement in methods of removing pollution after it has been generated.

Technical textiles may provide particular difficulties with respect to recycling. They are frequently used in conjunction with other materials, such as coatings and hardened oils, or as components of fibre-reinforced composites. These end-products may be difficult or impossible to break down satisfactorily into their original constituents, so that the textile polymer would be decomposed by any attempt at recovery.

In addition, even where some degree of recovery is possible, the environmental cost of the extensive energy and reagent use needed may make the process prohibitively unattractive. Some use of the undestroyed materials may occur, though; if they are suitable for incorporation into, say, road-bed construction or concrete reinforcement, their chemical inertness and ability to resist mechanical stress may be of considerable advantage.

Ecofriendly textile processing is presented as a global challenge, as ecological criteria are increasingly accepted in all parts of the world in selecting consumer goods and 'green' products can command a higher price. Two aspects of textile production, the limitation of harmful products and the reduction in air or water pollution, should be tackled in particular. Public interest in environmentally friendly processes is increasing, and examples of this trend can be found (in addition to the use of recycled bottles in making polyester) by a tendency to use organically grown cotton with naturally coloured dyes. Caution must be used, though, in order to prevent the real nature of so-called green products being overlooked when the green designation is a marketing ploy rather than a genuine benefit to the environment. Perkins notes the transition towards green management, stating that good environmental management can lead to a quick return on investment. He discusses the new ISO standards in this context. Tyagi discusses the environmental audit process, dividing it into the three sections of preaudit, at-site audit and postaudit. Arcangeli feels that environmental management is here to stay, giving details of British developments and information on how companies can obtain accreditation.

The textile industry's resistance to environmental regulations was initially high because of cost, but hard work has nevertheless been carried out to reduce waste and decrease resource use. Manufacturers have now discovered that waste minimization, as well as providing environmental benefits, can be financially beneficial to the industry. Standards, though, unfortunately suffer from the usual defect of ignoring all but the process for which they are established. Thus, no real account is taken in any of the work mentioned of the environmental cost of supplying the energy to run a plant, or of the way in which the planet is harmed by the extraction of ores to manufacture the steel or other special-purpose elements, like manganese or chromium, needed to improve its properties. The environmental costs of transportation are also ignored.

It is mainly in the area of water improvement that most efforts to reduce pollution are taking place. There is need for a reduction in textile waste water to make manufacturers less dependent on changes in government regulations. Recycling cuts down waste, water use, energy and chemical costs, and Kramar proposes practical solutions for this, suggesting not using water as a substrate, or developing measures to reduce consumption and pollution such as the use of plasma under vacuum, inkjet printing, or dyeing with supercritical carbon dioxide.

Biotechnology has been recommended to reduce pollution after it has been produced and to provide a cleaner industry, while Frey and Meyer describe a new oxidation reactor that can treat heavily polluted water flows and reduce the consumption of both water and chemicals in textile finishing. They outline problems relating to current in situ disposal installations and give details of the benefits of the new system, which can convert up to 90% of the organic sewage present to carbon dioxide and water, as well as saving 80% of water and 20–30% of chemicals used.

However, most attention is being paid to the area of dyeing, presumably because the problem is seen to be greatest in that process. The recommendations of the Paris Commission18 on environmental protection introduce sweeping new restrictions with regard to dyeing and finishing processes and the growing conditions for natural fibres. Health, safety and environmental regulations for dyeing have undergone significant changes in the last 25 years19 and are now a major force in shaping the industrial workplace. Hohn summarises the methods available for treating dyehouse effluent for the purposes of purification, including reductive, oxidative, filtration, dispersion, evaporation and condensation techniques.

A cost/benefit analysis of decolorisation by means of coagulation and flocculation treatment processes indicates that the technique is very effective, but controversial because of sludge problems and ecological objections to the flocculation methods used. Activated carbon prepared from coir pith is used to decolorize waste water from reactive dyes, although other work shows that adsorption of dyes on peat has a similar extraction ability, presumably because surface changes and solution pH are important. In the finishing area, some work is in progress. Regulations pertaining to exhaust air emissions are so difficult to meet that a compromise may have to be made if finishing plants are to stay operative. Textile manufacturers have to be persuaded that the benefits of complying with existing legislation for clean air are that finishing
costs can be reduced significantly if the legal position can be met by identifying processes running optimally from the energy point of view.

6.0 Conclusion

Textile processes and environmental pollution are two sides of the same coin and they will go hand in hand. The pollution caused to the environment by textile processes cannot be completely eliminated but the efforts can be made to control the pollution within tolerable limits. Environmental damage is still occurring despite all efforts to reduce it. The future of textile production capability is also likely to be dependent to a considerable extent on environmental factors. There is current concern regarding textile chemicals, environmental protection and aspects of finishing, and the use of ecolabelling, are seen by various workers as a key to future control of pollution. Strong awareness programmes and strict legislative laws should be enforced to save the environment. Finally, the air, the water, the soil are not gifts from our parents but loans from our children and so the ever burning issue of textile pollution has to be dealt with utter seriousness.

7.0 References

1.0 A. Richard Horrocks, Subhash Anand, *"Handbook of Technical Textiles"*, Wood head Publication Limited (2004).

2.0 C Parvathi, T Maruthavanan and C Prakash, *" Environmental impacts of textile industries"* The Indian Textile Journal**,** (11) 2009.

3.0 Moustafa S. Moussa, *"Process Analysis & Environmental Impacts of Textile Manufacturing",* New Cloth Market (11), 2008.

4.0 Purifast Newsletter Next Technology Tecnotessile, *purifast.tec**not**ex.it/image_event/65/1.pdf, June 2012.*

5.0 Goel P.K*; water pollution; causes, Effects and Control,* New Age International (P) Ltd; Publishers, 1997.