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GROWTH OF TEXTILE INDUSTRY AND THEIR ISSUES ON ENVIRONMENT WITH REFERENCE TO WOOL INDUSTRY

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Abstract

Today textiles account for 14 per cent of India's industrial production and its export earnings are around 27 per cent. The textile industry covers a wide range of economic activities, including employment generation in both organized and unorganized sectors. Starting from growing its own raw material such as cotton, jute, silk and wool to providing value added products It is the second largest employer after the agriculture sector in both rural and urban areas. The growth also leads to some serious environmental issues associated with pollution in terms of textile effluents, which posed a major challenge to environmental scientists as well as the textile coloration processors. This paper deals with the growth of textile industry with special to woolen industry and their impact on environment.

GROWTH OF TEXTILE INDUSTRY AND THEIR ISSUES ON ENVIRONMENT WITH REFERENCE TO WOOL INDUSTRY

1. INTRODUCTION

The textile industry occupies a unique place in our country. It accounts for 14% of the total Industrial production, contributes nearly 27 % of the total exports and is the second largest employment generator after agriculture. Textile Industry is providing one of the most basic needs of people and holds the importance of maintaining sustained growth for improving quality of life. Its vast potential for creation of employment opportunities in the agricultural, industrial, organized and decentralized sectors and rural and urban areas, particularly for women is noteworthy. A Vision 2010 for textiles formulated by the government aims to increase India's share in world's textile trade from the current 4% to 8% by 2010 and to achieve export value of US $ 50 billion by 2010.

The phenomenal growth of the textile industry brought about prosperity, but also the deterioration of environmental surroundings called pollution. Apart from the air pollution due to chimney gases, fiber dust and the noise pollution, it is the water pollution due to discharge of liquid effluents into public sewers; inland surface water like ponds, rivers and lakes or irrigation land is posing a threat to the environment. Textile wet processing (i.e. preparation, dyeing, printing and chemical finishing) has always been considered one of the major industrial sectors in terms of water consumption and pollution (**Table 1**).

In treating 1 ton of cotton fabric the composite waste stream may have 200-600 ppm BOD, 1000 to 1600 ppm of total solids and 30 to 50 ppm of suspended solids contained in a volume of 50 to 160 m^3. For wool the effluent load is even higher, for 1 ton of scoured wool the composite waste stream would have 430 to 1200 ppm BOD and around 6500 ppm total solids contained in a volume of 100 to 230 m^3. Only some of the processors tried to treat the effluents before discharging into receiving bodies. However the treatments were inadequate and the effluents were not conforming to the norms set by the pollution control board. Based on this, the growth of textile industry and their impact on environment with special to woolen textile industry has been discussed in this paper.

2. WOOL HISTORY

In around 1800 BC the civilization of Babylonian was famous for its wool. The earliest remains of true fine wool came from the Greek colony of Nymphaeum in the Crimea, dating back to the 5th Century BC. The oldest wool cloth was found in a bog in Denmark, which was made in about 1500 B.C.The finest wool during Roman times came from Tarentium in about 37 BC. During the Middle Ages wool was England's main export trade, with every European country relying on England for it. The woolen industry, which had been established in the Middle Ages, was based on the domestic system. Leeds in Yorkshire eventually became the main center for the trade of wool cloth to be finished. In the late 18th Century, the Industrial Revolution began a movement, which took the textile industry from the home into the factory. Bradford in Yorkshire, England, became the center of the wool textile industry. The demand for sound, fine wool was capitalized on by the fledgling colony of Australia. Australian grazers found that the vast areas of dry pastureland were suited to the fine-wool breeds of sheep. Rams of the Spanish Merino breed were imported and these provided the basic breed lines on which the Australian Merino was established. World wool production is 2158767 Mt and its world market share is currently about 3.5 percent. Today, the United States and Spain each provide only one percent of total world wool production. The United Kingdom comes in at three percent. Australia, which produces 450 million kilos of Merino wool annually, has a 34-percent market share. New Zealand, the world’s second largest wool producer, has a 13-percent share, followed by China, Uruguay, Argentina and South Africa.

2.1.INDIAN WOOLEN INDUSTRY

India consumes nearly 103 million-kg of wool at the industry level, out of which apparel sector accounts for 32 per cent. The non-apparel sector has a much bigger share of 68 per cent. The product from wool contains tops, worsted yarn, fabrics, knitwear, shawls in apparel category and floor coverings of both handmade rugs, durries and machine made wall-to-wall carpet types, blankets, bedding and furnishing fabrics in non-apparel product ranges. The woolen industry in the country is small in size and scattered. It is primarily located in Punjab, Haryana, Rajasthan, U.P., Maharashtra and Gujarat, with 40% of units being in Punjab, 27% in Haryana, 10% in Rajasthan, while the remaining 23% in rest of the States. The industry provides employment to approximately 12 lakh people and contributes significantly to industrial production. The overview of Indian woolen industry is given in **Table 2**. The production details of indigenous wool in the country during the last three years are given in **Table 3**.The production details of different woolen items in India is given in **Table 4**.

3. ENVIRONMNETAL IMPACT OF TEXTILE INDUSTRY

The textile industry is a group of related industries, which uses a variety of natural (cotton, silk, wool, etc.) and/or synthetic fibers to produce fabric. The sequence of the manufacture of textiles is illustrated in the flow diagram in **Figure 1.** About 60% of the energy are used by dyeing and finishing operations. Environmental problems associated with the textile industry that is typically associated with water pollution. Natural impurities extracted from the fiber being processed along with the chemicals used for processing are the main sources of pollution. Effluents are generally hot, alkaline, strong smelling and colored by chemicals used in dyeing processes. Some of the chemicals discharged are toxic. Other environmental issues now considered equally important and relevant to the textile industry include air emissions, notably Volatile Organic Compounds (VOC). **Table 5** provides a list of some of the waste streams generated at each level of textile processing. The environmental and ecological effects of textile processes are complex issues. Processing procedures and social and legal constraints vary widely from country to country. The following environmental and ecological problems were arises from woolen industry.

4.ENVIRONMENTAL PROBLEMS IN WOOL PROCESSING INDUSTRY

The processing of wool fiber into valuable garments involves many steps and they are indicated in **Figure 2**. The three distinct processes shown in this diagram are stock, yarn and fabric finishing. An important aspect of the environmental impact of wool processing is the use of pesticides on sheep. Another impact at this early stage is the methane generated globally by the many hundreds of millions of sheep. Methane is a powerful greenhouse gas and contributes to the effect of global warming. Raw wool contains a significant amount of impurities including wool wax, suint, mineral and organic dirt and vegetable matter. Most of these impurities are removed in the scouring process. It contains high concentrations of water-soluble (suint), solvent soluble (wool wax) and dirt in a stable emulsion. The rinse water contains primarily low levels of dirt but comprises about two thirds of the liquid waste volume (6 – 7 l/kg greasy wool). Dry wastes include the material removed from the wool by the various opening operations and fiber removed by strainers in the contaminant recovery loops. They contain dirt, short fibers, dag material and some vegetable matter. Another environmental problem is that many of the dyestuffs available for obtaining good dark shades on woolen fabric or yarn are mordant dyes containing chromium.

4.1.PROBLEMS CAUSED BY SCOURING EFFLUENTS

The effluent discharged from wool scouring poses a number of problems in terms of effluent treatment. These problems include:

1. Organic load - The organic load from a typical wool scouring line (two meters wide) is equivalent to a population of 50,000 people. About 75% of the organic load come from the wool wax. Wool scouring effluent has a pH between 8 and 10, with a COD between 5000 and 35000 mg/l and a suspended solids content of anything up to 20000 mg/l.

2. Bio refractory nature of wool wax - Wool wax is very difficult to degrade by biological microorganisms, because of its chemical and physical characteristics.

3. Pesticide residues - Pesticides are applied to wool on the farm to control various sheep parasites. The type of pesticide and the amount found in the effluent depends upon the nature of the parasite, the rate of breakdown of the pesticide on the fleece and the time of treatment in relation to the time of harvesting of the wool.

4. Detergent residues - The most commonly used detergents used to wash wool are alkylphenol ethoxylate nonionic detergents. When these detergents are biodegraded one of the byproducts is alkylphenol. This chemical can be highly toxic to some species as well as causing possible environmental problems.

5. Volatile organic compounds - Aqueous scouring is one of the major sources of wastewater from textile operations. Solvent scouring has been adopted as an alternative to wool scouring operations to some extent. Minor quantities of 1,1,1-trichloroethane (TCA), trichloroethylene (TCE) and CFC-113 are used for the scouring of wool. These solvents are coming under VOC. VOC emissions are a concern because they can be flammable, explosive and sometimes toxic. They can also form secondary pollutants in the atmosphere, and potentially cause depletion of the ozone layer

4.2.PROBLEMS CAUSED BY DYEING EFFLUENTS

Wool, like all other fibers, is usually dyed with almost all types of dyes. Some dyes include heavy metals, which do not break down in the environment. The problem of unacceptable levels of these heavy metals in dyeing effluent is common to all textile fiber dyeing. Dyes containing chromium are used extensively in the wool textile industry because of their high colourfastness and the wide range of colours available at an economic cost.

4.3.PROBLEMS CAUSED BY FINISHING EFFLUENTS

1. **Shrink Resistance:** To prevent wool felting and shrinking when washed, shrink-resist processes were developed where the outer scale layer of each wool fiber is chemically modified and covered by a thin film of polymer. This enables the fibers to slide smoothly over one another when wet. One shrink-resist process produced unacceptably high levels of organohalogens (AOX) in effluent. The main source of AOX arose from chlorine used in the pre-treatment stage. Smaller quantities arose from the chlorine-containing polymers also used in the process. Non-chlorine based shrink resist processes are commercially available for batch treatments. These do not produce AOX in the treatment bath and are therefore environmentally acceptable.

2. **Mothproofing:** Wool's natural protein composition makes it comfortable to some moths and beetles and mothproofing has been an integral part of quality wool carpet manufacturing for many years. It is a mandatory requirement for Woolmark wall to wall carpeting. While mothproofing carpets are totally safe in use, investigations have shown that effluent produced from conventional mothproofing processes may exceed permitted discharge concentrations and pollute rivers.

5.ENVIRONMENTAL MANAGEMENT

There are different ways to prevent the pollution caused by the woolen textile and processing industry as follows

5.1.RIGHT-FIRST-TIME PRODUCTION

One very important principle in textiles is right-first-time production, which reduces waste by avoiding chemically intensive adds and reworks. Right-first-time production is not discussed as a pollution prevention technique, but a large body of literature and experience exists on improving right-first-time production.

5.2.DESIGN-STAGE PLANNING FOR FACILITIES, PROCESSES, AND PRODUCTS

The planning stage for new processes, products, and facilities is essential because it offers the opportunity to design in pollution prevention. Ultimately, pollution prevention must become integral to all parts of the textile operation

5.2.1.Design-Stage Planning for Processes

Design-stage planning for processes focuses on arranging production activities in such a way as to avoid the generation of pollution and waste. Although pollution prevention can produce substantial gains through tweaking or optimizing existing processes, effective, long-term pollution prevention requires an examination of processes at the fundamental design level to improve quality and reduce costs and waste

5.2.2.Design-Stage Planning for Products

Many consumers now expect and seek out environmentally well designed products. To be competitive in today's market, textile manufacturers need to adopt a new attitude in which they consider product properties required by the customer, including environmental aspects, at the design and raw material selection stage. For example, fiber, yarn, and fabric waste must be eliminated or preplanned to facilitate recycling. Shades and colors should be selected that use the most environmentally benign dyes.

5.2.3.Design-Stage Planning for Facilities

In many cases, facility design factors are based on well-known, sound engineering practices. Some of the more common design factors can be very helpful when designing new mills or expanding existing mills. In other cases, optimizing facilities for pollution prevention might require a departure from existing facility design practice.

5.4.STANDARD TESTS, METHODS, AND DEFINITIONS

One of the greatest needs in improving pollution prevention industry wide is the ability to transfer the successes of one plant to another and from other industries to the textile industry.

Transfers of pollution prevention ideas and cleaner technologies produce successful results and require minimal cost and effort. Standardization of tests, terminology, and reporting formats is a useful tool for achieving successful transfer of information. Standardization also reduces potential dis-information and misunderstandings about processes and products.

5.5.PROCESS ALTERNATIVES

New, cleaner technologies and process alternatives can simultaneously reduce pollution and cut processing costs. Equipment manufacturers, responding to changing environmental priorities, are offering equipment (e.g., dyeing machines) that is more energy efficient, features reduced water consumption, accommodates recovery and recycle of waste streams, and allows for more precise control over operating parameters, an important factor in preventing pollution.

5.5.1.Clean Technology Developments

"Clean technologies" are defined as "manufacturing processes or product technologies that reduce pollution or waste, energy use, or material use in comparison to the technologies that they replace." The technologies associated in this section are:

1. Pad-batch dyeing
2. Low bath ratio dyeing
3. Low salt/high fixation dyeing
4. Dyebath reuse
5. Continuous dyeing for knits
6. Automated color mix kitchen
7. Automated chemical dosing
8. Transfer printing
9. Laser engraving of printing screens
10. Surfactant substitution
11. Recovery of synthetic sizes
12. Countercurrent washing
13. Low add-on finishing
14. Mechanical finishing

15. Waste reclamation systems for spinning
16. Technology Adoption & implementation

5.6.EDUCATION

A more long-term approach to pollution prevention can be taken through formalized employee education. Education programs are more general and less job-oriented than training programs. Several specific topics have been documented in the literature, including:

1. The need for an in-depth understanding of chemistry, reaction kinetics, thermodynamics, fluid mechanics, and fine-particle technology among process designers. This knowledge is essential to pollution prevention and long-term improvements.
2. The establishment of corporate-level work groups to develop and distribute information concerning pollution prevention engineering, pollution prevention auditing, waste exchanges, and innovative pollution prevention ideas.
3. Internal training and education through process improvement groups are a hallmark of a few major corporations as they work to improve their work force. In-house newsletters devoted to pollution prevention topics are another effective way to communicate information and educate employees.
4. The commitment to consider alternatives before adding a new chemical to a process. This commitment requires both chemical and process expertise on the part of the production process designer.

In general, most pollution prevention training is best conducted internally because job-related issues are very site-specific. On the other hand, general education can be conducted either internally or externally. Several useful external training and education mechanisms are Conferences and meetings; Equipment and trade shows; Trade organizations; Televised education; Videotape training aids; In-plant courses by outside experts or plant technical personnel; Correspondence courses from textile colleges and Evening classes at community colleges.

CONCLUSION

There are several apparent trends and research and development activities ongoing within the textile industry in the areas of pollution prevention and clean technology implementation. Technology would play a lead role in processing, which would improve quality and productivity levels. Innovations would also be happening in this sector, as many developed countries would innovate new generation machineries that are likely to have low manual interface and power cost. All fibers, both natural and synthetic, must be processed to fit them to their chosen uses. Environmental excellence can only be achieved at the processing stage by selecting the best raw materials, using best practices during manufacturing and carefully considering the environmental impacts of products during use and disposal. Researchers will continue to develop new processing technologies for the wool textile industry, which will reduce the potential for pollution.

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Table 1 - Water consumption in the textile industry		
Fiber type/make-up		Mean water consumption in l/kg material
a) by fiber type	cotton	50 - 120
	wool	**75 - 250**
	synthetic fibers	10 - 100
b) by make-up	flock/yarn	100 - 200
	knit	80 - 120
	printing	0 - 400

Table 2 : Overview Of Indian Woolen Textile Industry
a) Total number of registered units. : 718
b) Total number of people : 12 lakh (approx.) employed
c) Total exports* (excluding hand made carpets, rugs, durries, etc.) 2001-02 : Rs. 1,378.74 crore 2002-03 : Rs. 1,289.17 crore 2003-04 : Rs. 1,646.32 crore 2004-05 : Rs. 1,337.96 crore (April-Nov., 2004)
d) Total import of raw wool * 2001-02 : Rs. 72.74 Million kg 2002-03 : Rs. 73.66 Million kg 2003-04 : Rs. 84.61 Million kg 2004-05 : Rs. 57.00 Million kg (April-Nov., 2004)
e) Total import of woolen & cotton rags* 2001-02 : Rs. 68.18 Million kg 2002-03 : Rs. 52.39 Million kg 2003-04 : Rs. 82.64 Million kg 2004-05 : Rs. 47.18 Million kg (April-Nov., 2004)
(*Source: Directorate General of Commercial Intelligence and Statistics, Kolkata)

Table 3 Yearwise production of Indian wool		
Year	Quantity in million kg	P: Provisional E: Estimated (Source: Department of Animal Husbandry, Ministry of Agriculture)
2000-01	49.2	
2001-02	50.7	
2002-03	52.1 (P)	
2003-04	53.6 (P)	
2004-05	55.1 (E)	

Table 4. Production different woolen items in India (Quantity in millions)							
Item	1997 -89	1998 -99	1999 -00	2000 -01	2001 -02	2002 -03	2003 -04 (E)
Worsted Yarn (Kg.)	42	44	45	42	44	44	44
Woolen & Shoddy Yarn (Kg.)	63.5	58	58	60	59	58	59
Worsted wearable Fabric (Mtrs.)	66	68	68	64	65	66	66
Knitted Hosiery Goods (Kg.)	13.5	14	14	14	14	13	13
Non-worsted Fabric (Mtrs.)	17	15	16	18	18	17	17.5
E: Estimated. (Source: Indian Woolen Mills Federation, Mumbai)							

Table 5 : List of the waste streams in each textile processing			
Process	Air Emissions	Wastewater	Residual wastes
Fiber Preparation	Little or no air emissions generated	Little or no wastewater generated	Fiber waste; packaging waste; hard waste
Yarn Spinning	Little or no air emissions generated	Little or no wastewater generated	Packaging waste; sized yarn; fiber waste; cleaning and processing waste
Slashing / Sizing	VOCs	BOD; COD; metals; cleaning waste, size	Fiber lint; yarn waste; packaging waste; unused starch-based sizes
Weaving	Little or no air emissions generated	Little or no wastewater generated	Packaging waste; yarn and fabric scrapes; off-spec fabric; used oil
Knitting	Little or no air emissions generated	Little or no wastewater generated	Packaging waste; yarn and fabric scrapes; off-spec fabric
Tufting	Little or no air emissions generated	Little or no wastewater generated	Packaging waste; yarn and fabric scrapes; off-spec fabric
Desizing	VOCs from glycol ethers	BOD from water-soluble sizes; synthetic size; lubricants; biocides; anti-static compounds	Packaging waste; fiber lint; yarn waste; cleaning materials, such as wipes, rags and filters;
Scouring	VOCs from glycol ethers and scouring solvents	Disinfectants and insecticide residues; NaOH; detergents; fats; oils; pectin; wax; knitting lubricants; spin finishes; spent solvents	Little or no residual waste generated Cleaning and maintenance wastes containing solvents
Bleaching	Little or no air emissions generated	Hydrogen peroxide, sodium silicate or organic stabilizer; high pH	Little or no residual waste generated
Singeing	Small amounts of exhaust gasses from the burners	Little or no wastewater generated	Little or no residual waste generated
Mercerizing	Little or no air emissions generated	High pH; NaOH	Little or no residual waste generated
Heatsetting	Volatilization of spin finish agents	Little or no wastewater generated	Little or no residual waste generated
Dyeing	VOCs	Metals; salt; surfactants; toxics; organic processing assistance; cationic materials; colour; BOD; sulfide; acidity / alkalinity; spent solvents	Little or no residual waste generated
Printing	Solvents, acetic acid from dyeing and curing oven emissions; combustion gasses;	Suspended solids; urea; solvents; color; metals; heat; BOD; foam	Little or no residual waste generated
Finishing	VOCs; formaldehyde vapors; combustion gases;	BOD; COD; suspended solids; toxics; spent solvents	Fabric scrapes and trimmings; packaging waste
Product Fabrication	Little or no air emissions generated	Little or no wastewater generated	Fabric scrapes

Figure 1: Flowchart of textile product manufacturing

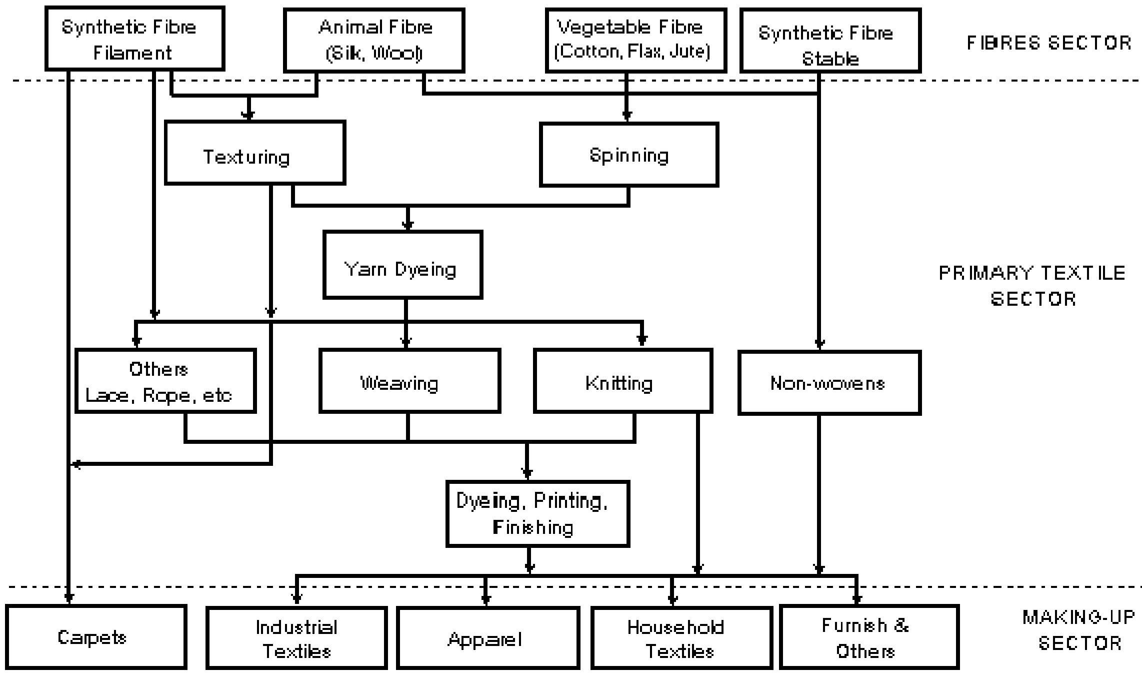

Figure 2: Flowchart of wool processing