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AN ECOFRIENDLY APPROACH FOR WET PROCESSING OF TEXTILES

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ABSTRACT

Textile wet processes causes severe environmental pollution and health problems. It is important for the textile industry to adopt pollution preventive approach. Recycling, reusing of chemicals and dyes helps in eliminating disposal costs and reducing raw material costs. In present research, an attempt was made to study whether the units were practicing recycling techniques or not. It was found that textile wet processing units were not having awareness and proper infrastructure to implement and adopt a pollution preventive approach.

KEYWORDS*:* *Pollution, Recovery, Recycle, Reuse, Wet Processing*

I. INTRODUCTION

The textile industry is comprised of a diverse, fragmented group of establishments that produce and process textile-related products (fiber, yarn, fabric) for further processing into apparel, home furnishing and industrial goods. Textile establishments receive and prepare fibers; transform fibers into yarn, thread or webbing; convert the yarn into fabric or related products; and dye and finish the materials at various stages of production. The process of converting raw fibers into finished apparel and non-apparel textile products is complex one. Little overlap occurs between knitting and weaving or among production of manmade, cotton and wool fabrics. Textiles generally go through three to four stages of production that may include, yarn formation, fabric formation, wet processing, textile fabrication. The general steps in which fibers are processed to manufacturing of textile goods (DPPEA, n.d.). The textile wet processing industries are those units, which take gray fabrics as raw materials and process it to obtain finished fabrics (Kharat et al., 2000). These various wet processes are shown in Table 1 (Gupta et al., 2000).

The Indian textile industry has its importance in the national economy, but at the same time it is responsible for disastrous environmental impacts (Bunning et al., 1993). These impacts start with the use of pesticides during the cultivation of plants, from which natural fibers are obtained and with the erosion caused by sheep farming or with the emissions during the production of synthetic fibers. From that moment, a number of processes are applied using thousands of chemicals to process the fibers and to reach the final stage of textile end product. The industry in India including mill sector, handloom, powerloom, process houses and khadi village industries are using harmful substances either for enhancing aesthetic appeal or for imparting certain desirable characteristics to the textiles. These toxic materials are being used in several textile-wet processes as listed in Table 2 (Subramanian et al., 1998).

TABLE 1 – PROCESSES INVOLVED IN THE WET PROCESSING OF TEXTILES

Process step	Description
1. Desizing	Chemical treatment to remove the size.
2. Scouring	Remove fabric impurities
3. Bleaching	Enhance whiteness of the textiles
4. Mercerizing	Chemical treatment for enhancing textile appearance.
5. Dyeing and finishing	Colouring effect Physical and chemical finishing to furnish the textile's quality.

Source: (Gupta et al., 2000)

TABLE 2 – LIST OF TOXIC AND HARMFUL SUBSTANCES USED BY TEXTILE INDUSTRY

Textile processes	Toxic substances used
1. Cotton growing	Banned pesticides such as DDT, Dieldrin, Aldrin, etc.
2. Wool storing	Banned insecticides e.g. Dieldrin.
3. Sizing	Pentachlorophenol as a preservative.
4. Scouring	Chlorinated products
5. Bleaching	Hypochlorite (Chlorine Bleaching)
6. Dyeing & Printing	Azo dyes containing aromatic amines, dyes containing traces of heavy metals and formaldehyde as a mordant.
7. Finishing	Formaldehyde as a cross-linking finish, urea formaldehyde as F.R. finishes.

Source: (Subramanian et al., 1998)

The textile industry has caused severe water pollution problems. Consequently, this area is beginning to receive serious and widespread attention within the industry and from other agencies. Several cases of pollution from textile industry have been reported in the recent past. The supreme court of India had to intervene and there have been cases where a number of units have been shut down or relocated due to the pollution problem (Kathuria, 2001). In India, there are four measures to solve any problem i.e. reformative, preventive, curative and punishable. While closure of the textile units is not a solution to the problem of pollution but a punishment for the industry. Therefore, it is important that our approach should be preventive to control a problem. There is a need to use the Eco-friendly chemicals and process technology that is energy efficient, which produces less waste, requires fewer resources such as chemicals and water and lastly they should be easy to operate.

Barclay et al., 2000, stated that the implementation of measures to prevent the generation of waste in the first place. It applies to both product and process changes, and includes all inputs and waste outputs. There are two aspects of waste minimisation –

- **Source reduction and**
- **Recycling**

Source reduction is any activity that reduces or eliminates the generation of industrial waste at the source, usually within a process. **Recycling** is the retrieval of materials or products either for reuse in their original form, or for reprocessing into products of similar composition. Source reduction is always a more desirable environmental option than recycling. Within any process, there are five aspects that should be taken into account, when considering the implementation of waste minimisation (Barclay et al., 2000).

Re-using and recycling is accomplished either by using the waste generated directly or after treatment. It helps in eliminating disposal costs and reducing raw material costs (Barclay et al., 2000). Many materials put to beneficial through use and reuse, involves the return of a waste material either to the originating process or to another process as an input material. These include reuse of certain process water, reuse of wash water from bleaching operations, reuse of scouring rinses for desizing or for cleaning printing equipment, reuse of mercerising wash water to prepare baths for scouring, bleaching etc (Hagler, 1995).

Kharat et al., (2000), stated that management strategies must focus on recycle, reuse, and recovery. Recovery systems are used to extract various components of waste streams. Some of commercial systems used are:

1.1 Size Recovery

Starch degradation during desizing eliminates the possibility of its recovery. Starch also exerts a high BOD load on the receiving stream (Kharat et al., 2000). The problem can be mitigated by using enzymes that degrade starch into ethanol rather into anhydroglucose. The ethanol can be recovered by distillation for use as a solvent or fuel, thereby, reducing the BOD load. Alternatively, an oxidative system like H_2O_2 can be used to fully degrade starch to CO_2 and H_2O. Synthetic sizing formulations based on polyvinyl acrylic (PVA) and acrylic resins, instead of starch, are expensive. Considering the cost of effluent treatment, the cost of synthetic sizing formulations is negligible (Babu et al., 2007).

1.2 Caustic Recovery

The recovery of caustic from mercerising operations is also practical. Mercerisation is the process of treating cotton fabrics and certain blends with concentrated (approx. 15% or more) sodium hydroxide solution. Waste streams from this process are extremely alkaline. Because mercerisation is always a continuous process, these waste streams are fairly easily handled. Recovery systems can reclaim up to 98% of the caustic used. One system that avoids the use of caustic (and also water) in the mercerisation process is the use of liquid ammonia. This produces the same effect as mercerisation without the highly alkaline wastewater stream. Of course, the ammonia gas is recovered and reused (Hagler, 1995). Use of $ZnCl_2$ as an alternative method leads to an increase in the weight of fabric and in dye uptake, and allows easy recovery of NaOH. Moreover, the process is ecologically friendly and does not require neutralisation by acetic or formic acid (Karim et al., 2006).

1.3 Reuse of Dye bath / Print Paste

Kharat et al., (2000) disscussed that textile dyeing can be performed using either continuous dyeing ranges or batch dye machines. Batch machines are relatively expensive but more efficient than continuous dyeing ranges in their usage of water, chemicals and energy. Batch dyeing offers flexibility, short-run capability and ease of control. Reconstituting and reusing the dye bath instead of discharging it, after one dyeing, can obtain reduction in quantity of wastewater and discharge of pollutants.

A study was conducted on the reuse of the spent dye bath in polyester dyeing. Result indicated that 5-7% saving on dye and 65-75% saving on auxiliaries was found by re-use of the spent dye bath, along with a substantial decrease in the discharge of pollutants. The dye bath re-use was attempted in mill trials with good success. No adverse effect was seen on spinning performance of the fibres dyed in reuse dye bath (Shenai, 2003).

"Adams-Mill Company", reused dyebath for dyeing nylon pantyhose in rotary drum dyeing machines. Water use decreased by 35% with a cost savings of $0.02 per pound of production. The mill also reduced energy use by 57 % (EPA, 1997). Other company "Amital", saved a large amount of money by reusing dyebaths and noncontact cooling water. The facility reduced its water consumption from 320,000 gallons per day to 102,000 gallons per day and simultaneously increased production from 12 to 20 batches per day. Additionally, energy consumption for heating dyebath decreased substantially. The investment saved the company about $13,000 a month and paid for itself 30 days after implementation (EPA, 1997).

Janakiraman (1998) reported that print paste, after a particular design order, had to be discarded. The value of dyes, chemicals, and auxiliaries was high and hence was reformulated for the next darker shade using computer colour matching equipment. The benefits were saving in dyes, chemicals and the environment.

Recently, screen-free printing methods, such as ink-jet printing and electrostatic printing, had been developed that made use of an electronic control of color distribution on fabric. Screen-free printing methods were attractive for pollution mitigation (Babu et al., 2007).

Bochner (1994) discussed that recycle or re-use empty containers were the largest source of solid waste. Lal (1998) reported that recycling is eco friendly e.g. recycling of wool and recycling of woven garments to regenerate fibres, then yarn, and lastly recycled fabric. Recycling conserves water, energy, dyes and chemicals.

II. METHODOLOGY

Research was conducted in and around Delhi (Delhi/NCR). In total 51 units were studied for the present research which included 27 cotton processing units (processing only cotton) and 24 cotton & manmade (processing both). An interview Schedule was prepared to study whether the recycling techniques were being practiced or not. The results are tabulated in Table 3.

II. RESULTS AND DISCUSSION

Reuse of scouring bath reduces alkali requirement and pollution load (Saxena et al., 1998). It was found that in the present study only **(3.92%)** of the total units were **reusing scour wash water**.

Caustic from mercerising can be recovered for reuse by membrane separation technology or by most commonly used evaporation method. The membrane separation technology is relatively much costlier than the evaporation technique and such expenditure may not be justified for the small or medium scale textile industries (Kharat et al., 2000). Only **(8%) units**, of the total sample units were **recycling the sodium hydroxide solution** from mercerising. Further, comparison of finding between the two categories of units indicated that none of the cotton processing units was involved in such recycling but on the other hand, (16.67%) cotton & manmade processing units were recycling sodium hydroxide from mercerising.

Reuse of neutralisation (after scouring and washing) bath reduces acid consumption, water consumption and pollution load (Saxena et al., 1998). Analysis indicated that **none of the units were reusing the neutralisation bath** for dyeing or any other purposes. It may be due to lack of awareness and proper infrastructure in the processing unit.

Effluents from various textile-processing units contain various classes of dyes and chemicals such as acids, alkalis, surfactants, salts etc. These need special treatment, before they are let in the drain. In order to reduce the problem of effluent treatments, the baths can be suitably treated and re-used. Most of the researches reported that reusing the dyebaths for dyeing a second or third batch with the same dye replenishing the spent dye (Shenai, 2003). Results of the present study had shown a different picture. **Not even a single unit was found reusing the dye bath** and further, **none of them were extracting the dye or chemicals** from the dye bath. It may be due to lack of awareness and poor infrastructure in the processing unit.

Recycling of blanket wash water can reduce fresh water consumption and pollution load (Saxena et al., 1998). Print paste recovery from the blanket carryover by a doctor's knife and it can be used for dark shades preparation. It reduces pollution load and water requirement for washing (Saxena et al., 1998). It was observed that none of the units was found practicing such kind of recycling.

Recycle of treated wastewater can also reduce fresh water consumption and pollution load (Saxena et al., 1998). The analysis of data had revealed that **(12.5%) cotton & man-made processing units** were **reusing the treated wastewater for cleaning, gardening** and **boiler**. On the other hand, none of the cotton processing units was found reusing the treated wastewater.

III. CONCLUSIONS

Above discussion highlighted that implementing recycling, recovery and reusing of dyes and chemicals can control pollution, conserve energy, water and other resources. Therefore, it is important of textile wet processing units to adopt ecofriendly pollution preventive approach for their sustainability.

TABLE 3 - POLLUTION PREVENTIVE APPROACH – RECYCLE/REUSE/RECOVERY

S.NO	RECYCLE/REUSE/RECOVERY	COTTON UNITS (C) N = 27	COTTON & MANMADE UNITS (CM) N = 24	TOTAL UNITS N = 51
1.	**Reusing of scour bath** Yes No	 1 (3.70) 26 (96.30)	 1 (4.17) 23 (95.83)	 2 (3.92) 49 (96.08)
2.	**Recycling of sodium hydroxide solution from mercerizing** Yes No	 0 (0.00) 27 (100.00)	 4 (16.67) 20 (83.33)	 4 (7.84) 47 (92.16)
3.	**Reusing neutralization bath for dyeing batches** Yes No	 0 (0.00) 27 (100.00)	 0 (0.00) 24 (100.00)	 0 (0.00) 51 (100.00)
4.	**Reusing the dye bath** Yes No	 0 (0.00) 27 (100.00)	 0 (0.00) 24 (100.00)	 0 (0.00) 51 (100.00)
5.	**Extracting dye from the dye bath** Yes No	 0 (0.00) 27 (100.00)	 0 (0.00) 24 (100.00)	 0 (0.00) 51 (100.00)
6.	**Recovering & reusing the chemicals in the dye bath** Yes No	 0 (0.00) 27 (100.00)	 0 (0.00) 24 (100.00)	 0 (0.00) 51 (100.00)
7.	**Reusing the treated waste water** Yes No	 0 (0.00) 27 (100.00)	 3 (12.50) 21 (87.50)	 3 (5.88) 48 (94.12)

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