J. Environ. Nanotechnol.
Volume 3, No.2 pp. 173-181
ISSN (Print) : 2279-0748
ISSN (Online) : 2319-5541
doi : 10.13074/jent.2014.03.143082

# Environmental Issues in Scouring of Wool

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*Received : 17.04.2014 Accepted : 28.05.2014*

## *Abstract*

*Water is used to clean, dye, apply chemical finishes to fabrics and to rinse the treated fibres. Wool fibers are hydrophilic and can absorb moisture and water almost one-third of its own weight. Wet processing of textile materials uses large quantities of water, energy and a considerable amount of time. Almost all textile wet processes involve the use of chemicals and processing auxiliaries like phosphates, sulphates, alkalies, acids, heavy metals which result in contamination of the water used. The resultant waste water creates serious ecological effluent problems which resulted in developing bio-friendly textile processes and products. This study mainly focuses on the scouring of selected wool fibres using bio friendly cleaning agent which has no toxic chemicals or acids. The process also involves a natural basic easy method to clean wool fibres before further processing and the same was accepted by Central Sheep Wool Research Institute (CSWRI). The result focused on two ways: one which produced clean eco-friendly wool fibres without any toxic chemicals and acids. Second the effluent waters was also tested for their characteristics against the standards of effluent waters BIS IS:2490 (PART- I), PCB NORMS TESTING (BIS) PUBLIC SEWERS which produced fruitful biological results that will not affect the flora and fauna ecological balance of the earth nationally and internationally.*

***Keywords:*** *Effluent; Scouring; Testing; Wool fibre.*

## 1. INTRODUCTION

Wool is a textile fiber obtained from sheep and certain other animals, including cashmere from goats, mohair from goats, qiviut from muskoxen, angora from rabbits and other types of wool from camelids. Wool's scaling and crimp make it easier to spin the fleece by helping the individual fibers attach to each other, so they stay together. Because of the crimp, wool fabrics have greater bulk than other textiles and they hold air, which causes the fabric to retain heat. Insulation works both ways such as Bedouins and Tuaregs use wool clothes to keep heat out and protect the body.

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Wool fibers are hydrophilic, meaning they readily absorb moisture, but are not hollow. Wool can absorb moisture almost one-third of its own weight. Wool absorbs sound like many other fabrics. It is generally a creamy white color, although some breeds of sheep produce natural colors, such as black, brown, silver and random mixes.

## 2. PROCESSING OF WOOL

### 2.1 Shearing

Sheep shearing is the process by which the woollen fleece of a sheep is cut off. After shearing, the wool is separated into four main categories: fleece (which makes up the vast bulk), broken, bellies, and locks. The quality of fleeces is determined by a technique known as wool classing, whereby a qualified person called wool classer groups wools of similar gradings together to maximize the return for the farmer or sheep owner. All Merino fleece wool is objectively measured for micron, yield (including the amount of vegetable matter), staple length, staple strength and sometimes color and comfort factor.

**Fig. 1: Wool Fibre**

**2.2 Composition of Raw Wool**

Wool grease 2-25% of greasy wool weight Suint 2 - 12 % of greasy wool weight (dried perspiration) Dirt 5-45% of greasy wool weight Residues of insecticides, or insect growth regulators (IGR) used as veterinary medicines to protect sheep from ectoparasites, such as lice, mites, blowfly, etc. Fine wool from merino sheep, used apparel, typically contains 13 % wool grease, coarser wool used for carpets contains an average of about 5 % grease. Natural protein fibre obtained from hairs of sheep. Wool protein is known as Keratin. Differs from silk protein presence of sulphur in the form of cystine amino acid containing sulphur ($-CH_2S-SCH_2-$) cystine linkage. Impurities 30-70% depending on species of sheep..

Suint Dried perspiration soluble in water. Removed by washing Wool Fat or Wool wax complex mixture of esters, diesters and hydroxyesters fatty alcohol like lanoline and fatty acids. Wool fat is yellowish in colour. Soluble in organic solvents like trichloroethylene or perchloroethylene which can be easily hydrolyzed in presence of mild alkali like ammonia at moderate temperature. Wool wax can be isolated and used in preparation of good quality soap and cosmetics.

Dirt is held by adhesive action of suint and wool fat which is removed during scouring and washing operation. Burrs Vegetable fragments consisting of dried grass, straw, sticks etc. are collected on the body of sheep during grazing and scraching the body against bush or tree to relieve itching.

**2.3 Wet Processing**

Wet processing is the segment of the textile production that involves cleaning, bleaching, dyeing and finishing of textile fibres and yarns in aqueous solutions. Most fabrics regardless of their end use go through one or all of these wet processing steps. Water is used to clean, dye, apply chemical finishes to fabrics and to rinse the treated fibres or fabrics state Davila *et al.* (2000), Moore and Ausley (2004). Wet processing of textile materials uses large quantities of water, energy and a considerable amount of time elucidate Moses and Jaganathan (1996), Bhattacharya and Iyanger (2001), Adrion (2006), Lal (2003), Muthukumar *et al.* (2001) and Joshi *et al*.(2006). Almost all textile wet processes involve the use of chemicals and processing auxillaries like phosphates, sulphates, alkalies, acids, heavy metals which result in contamination of the water used. According to Teli *et al.* (2000), Moghe and Nabar (2006) the resultant waste water creates serious ecological effluent problems. Nileshkanoonga and Adivarekar (2009), Mondal (2006) and Teli *et al.* (2004) further state that this has expanded hands to develop bio-friendly textile products.

## 2.4 Preparatory Processes for Wool

### *2.4.1 Wool Scouring*

Wool straight off a sheep, known as “greasy wool” or “wool in the grease”, contains a high level of valuable lanolin, as well as dirt, dead skin, sweat residue, pesticides and vegetable matter. Before the wool can be used for commercial purposes, it must be scoured, a process of cleaning the greasy wool. Scouring may be as simple as a bath in warm water or as complicated as an industrial process using detergent and alkali and specialized equipment. In North West England special Potash pits were constructed to produce Potash used in the manufacture of a soft soap for scouring locally produced white wool.

In commercial wool, vegetable matter is often removed by chemical carbonization. In less-processed wools, vegetable matter may be removed by hand and some of the lanolin left intact through the use of gentler detergents. This semi grease wool can be worked into yarn and knitted into particularly water-resistant mittens or sweaters, such as those of the Aran Island fishermen. Lanolin removed from wool is widely used in cosmetic products such as hand creams.

Scouring is a process by which all natural and additive impurities such as oil, wax, fat, hand dust etc., are removed to produce hydrophilic and clean textile material. It is one of the vital processes of wet processing. Scouring of wool differs from cotton scouring. Wax content of wool is higher than that of cotton. Cotton can withstand strong alkaline conditions at high temperature. Wool is sensitive to alkali. Sodium hydroxide is never used for wool scouring. Wool wax can be hydrolyzed by mild alkali like sodium carbonate or ammonia.

Wool Scouring is done in many ways such as Emulsion scouring, Solvent scouring, Freezing scouring and Chemical scouring where chemicals are used which affects the ecological natural balance in the soil.

## 2.5 Environmental Factors involved in Wool Scouring

Wool grease is insoluble in water, but soluble in non-polar solvents such as dichloromethane or hexane. Refined wool grease is a valuable by-product. Suint is the secretion of the sweat glands in the skin. Suint is soluble in polar solvent such as water and alcohol. Dirt can include a variety of materials such as mineral dirt, sands, clay, dust and organic materials. Ectoparasiticides environmentally hazardous for Discharge of raw wool scouring effluent disposal of the sludge generated by the treatment of the effluent. Ectoparasiticides present in raw wool Cyromazine Dicyclanil Difilibenzliron Triflumuron Insect growth regulators (IGRs), Cypermethrin Deltamethrin Fenvalerate Flumethrin Cyhalothrin Synthetic pyrethroids insecticides (SPs Diazinon Propetamphos Chlorfenvinphos Chlorpyriphos Dichlorfenthion, Organophosphorous insecticides (OPs) yHexachlorocyclohexane (Imdane), Dieldrin DDT, Organochlorine insecticides (OCs) well-studied substances. Endocrine (Blood secreting glands) disrupting capacity Lindane and DDT most toxic (also the most active as pesticide), Hexachlorocyclohexane (also called lindane) hazardous due to their persistence and bioaccumulity. Likely to have long-range effects organochlorines (Ocs) have lower aquatic toxicity than synthetic pyrethroids and are less persistent than organochlorines. Nevertheless they have high human toxicity Organophosphates (Ops) show high aquatic toxicity the synthetic pyrethroid insecticides (SPs)

Wool from the majority of grower nations contains residual sheep treatment medicines which are used legally to control infestations of lice, ticks and mites. The presence of these materials on wool is variable and depends on the permitted legal use pattern in each country. All major grower countries have banned the use of organochlorine pesticides for sheep treatment, there is evidence that wool from some former Soviet Union States and South America contain lindane at detectable concentrations.

Wool scouring Environment issues Potential for pollution of water. The removal of contaminants present on the raw fibre leads to the discharge of an effluent main polluting contributors are: highly concentrated organic material in suspension and in solution, dirt in suspension micro-pollutants resulting from the veterinary medicines applied to protect sheep from external parasites detergents view Chavan (2013). These high levels of oxygen-depleting substances must be removed from the effluent before it can be discharged to the environment without potential for harmful effects. Ectoparasiticides when they enter the scouring process, a distinction has to be made between Lipophilic (Hydrophobic) and hydrophylic compounds lipophilic compounds - OCs, OPs and SPs - associate strongly with the wool grease removed with it during scouring (although a fraction -up to 4 %-is retained by the fibre and will be released in the subsequent wet processes). This behaviour applies also to diflubenzuron (IGR).

Environmental issues associated with wool scouring (with organic solvent) trichloroethylene used solvent. Trichlorethylene is a non-biodegradable. Unaccounted losses of this solvent arising from spills, residues on the fibre, if not adequately treated to destroy the solvent, may lead to diffuse emissions resulting in serious problems of soil and groundwater pollution. Wool preparation before colouring Carbinsing Scouring, Drycleaning Fulling Bleaching.

Environmental issues in Wool pretreatment gives rise mainly to water emissions, although there are also specific operations (e.g. carbonising and dry cleaning) where halogenated organic solvents can produce not only emissions to air, but also contamination of soil and groundwater if their handling and storage is not done using the necessary precautions. The pollutants that can be found in the waste water, originate in part from the impurities that are already present on the fibre when it enters the process sequence and in part from the chemicals and auxiliaries used in the process.

Pollution originating from impurities present on the raw material residues of pesticides used to prevent the sheep becoming infested with external parasites can still be found on scoured wool in amounts, which depend on the efficiency of the scouring process. These are mainly organophosphates (OPs) and synthetic pyrethroid (SPs) insecticides and insect growth regulators (IGRs), detectable residues of organochlorine pesticides (OCs) can be observed. They partition between the fibre and the water according to their stronger or weaker lipophylic character and, as a consequence, traces of these compounds are released in the waste water.

Spinning lubricants, knitting oils and other preparation agents also represent an important issue in wool pretreatment. These substances are removed during the scouring process, contributing to the COD load and aquatic toxicity in the final effluent. The main concerns are about: • poorly refined mineral oils (content of aromatic hydrocarbons) • APEO (non-biodegradable and giving rise to toxic metabolites) • silicones (non-biodegradable and difficult to remove without scouring assistants) • biocides (toxic to aquatic life).

Pollution originating from chemicals and auxiliaries used in the process in considerable amounts of surfactants are used in pretreatment as detergents, wetting agents, etc. Surfactants with good biodegradability with acceptable performance are now available the use of alkylphenol ethoxylates (APEO) is still common in some companies due to their low cost Alkylphenol ethoxylates (APEOs) and in particular nonylphenol ethoxylates (NPEOs) are under pressure due to the reported negative effects of their metabolites (chemical reaction in living organisms) on the reproduction system of aquatic species.

Other pollutants of concern that may be found in water effluent from pretreatment activities are: reducing agents from bleaching treatments and chemical setting of carpet wool yarn (sodium metabisulphite): they contribute to oxygen demand in the waste water ; poorly bio-eliminable complexing agents (e.g. EDTA, DTPA, phosphonates) from hydrogen peroxide stabilisers, etc. insect-resist agents in wool carpet yarn production. Dyeing and Printing Main pollutants are Colour Dyeing auxiliaries, Heavy metals mainly chromium Printing thickeners. These pollutants are mainly discharged to water. Finishing Apparel: Softening agents (amino silicones) Fluoro-chemicals (Stain repellents) Carpet back coating residues, Moth proofing agents.

### 2.6 Objectives of Scouring

- To make the fabric more hydrophilic
- To remove impurities such as oils, waxes, gum, husks as nearly as possible
- To improve absorbency of fabric or textile materials without physical and chemical damage
- To produce a clean material by adding alkali
- To make the fabric ready for next process

Keeping the above points in view about the different chemical methods adopted for Scouring of wool, its environmental factors and its objectives, the investigator has planned to undertake a study on using bio friendly cleaning agent for scouring of selected varieties of wool and its characteristics of effluents being produced.

## 3. METHODOLOGY

The methodology comprises of the following steps:

### 3.1 Selection of Wool Fibre

Sandyno wool fibres and Coimbatore Kurumba wool fibres were procured and selected for the study.

### 3.2 Processing of Wool Fibre

#### *3.2.1 Scouring of Wool Fibre*

Scouring, the first step in wool processing removes oily and greasy impurities from the fibre and also improves the absorbency and dyeability of the fibres explain Dixit *et al.* (1991), Shukla (2005), Neetu and Shahnaz (2003).

A special non-ionic detergent was selected for the study. It is a biologically degradable wetting agent with emulsifying and dispersing action for the scouring and removal of mineral oil contamination from textiles. Required quantity of wool fibre was treated with this non-ionic detergent keeping M:L ratio as 1:40 and 52 ± 2°C temperature. The selected wool fibres were immersed and washed subsequently in the three bowls, rinsed in cool soft water and dried.

### *3.3 Objective Testing Evaluation*

The Characteristics of wool Scouring Liquor effluent is done by Objective method. The environment problems associated with the scouring effluents discharged by textile processing are typically related to pollution caused by the discharge of untreated effluents. Textile effluents are generally grey (in pre-treatment processes) or coloured (colouration processes) and have a high BOD (Biological -Oxygen Demand), COD (Chemical Oxygen Demand), high solids and have high temperature in some cases. The constituents of the liquors with respect to pH, TSS, Colour, Turbidity, Alkanity, COD, BOD, Oil and Grease and TDS can be analysed. The scouring effluents was collected as a sample from each variety of Sandyno and Coimbatore Kurumba wool fibres and were analyzed chemically as suggested by NIIR Board (2005) and Wasif *et al.* (1996) for their pH, Total Suspended Solids, Colour, Turbidity, Total Alkanity, Chemical Oxygen Demand, Biological Oxygen Demand, Oil and Grease and Total Dissolved Solids.

#### *3.3.1 Potential Hydrogen (pH)*

pH is a measure of hydrogen ion concentration in water. pH is the most important parameter, as it indicates instantaneously the acidic or alkaline conditions of an effluent water views Rao (1992). The pH value which is determined according to ISO 3071 is restricted to the range of 4.0 to 7.5 because it corresponds to the natural conditions of undamaged human skin. According to Manivasakam (1995), waters with pH below 7 are acidic and pH above 7 is alkaline. After measurement of pH, the electrodes should be thoroughly washed with distilled water.

### *3.3.2 Temperature*

Temperature measurements are usually made with mercury filled centigrade thermometer. The reading should be made by dipping the thermometer in the sample (water or waste water). The temperature should be expressed to the nearest centigrade.

### *3.3.3 Total Suspended Solids (TSS)*

The undissolved matter present in the effluent water is usually referred to as suspended solid. The calculation for TSS is as given below: TSS = [Weight of residue (mg) / Volume of effluent (ml)] x 1000 (ppm).

### *3.3.4 Colour*

Colour is a common constitute of many natural waters. Standard colour solution was prepared to test the scouring effluents and compared with the colour of the sample with that of the working colour standards by looking vertically downwards against a pure white surface placed at such an angle that light is reflected upwards through the columns of liquid. If the colour exceeds 70 units, dilute the centrifuged sample with distilled water such that the colour is within the range.

### *3.3.5 Turbidity*

Turbidity is caused by the final particles present in suspension. It is to be mentioned that waters having the same turbidity may posses different types of solids in different quantities and their effects may vary. Manivasakam (1995) says that normally ground waters from deep wells and brine holes are clear. However, they may also become turbid or attain colour on standing.

### *3.3.6 Alkalinity*

Alkalinity in water is not a specific substance but rather a combined effect of several substances and conditions. Manivasakam (1995) explains alkalinity is caused by the presence of bicarbonates, carbonates, hydroxides and to a certain extent by borates, silicates, phosphates and organic substances.

### *3.3.7 Chemical Oxygen Demand (COD)*

COD is the oxygen required by the organic substances in water to oxidize them by a strong chemical oxidant, Menzes (2001). The COD may be taken as a measure of the extent to which an effluent will deoxygenate a water course, the organic material is oxidized chemically rather than biologically suggest Atkinson and Lowe (1979). The COD was thus calculated as: COD = [(B –A) x Nor. of FAS x 8 x 1000 x dilution factor] / Volume of the sample taken.

### *3.3.8 Biological Oxygen Demand (BOD)*

BOD is defined as the amount of oxygen required to carry out the biological decomposition of dissolved solids in effluent under aerobic conditions at standard temperature state Rao (1992), Benefield (1980) and Mairal *et al.* (2003). The BOD test measures the oxygen consumed by bacteria during the process of oxidizing organic matter under aerobic conditions. In dilution requirements, often the BOD concentration in waste / effluent water will be more than the DO. BOD is calculated as: BOD (mg / lit.) = (A – B) x Dilution factor.

### *3.3.9 Total Dissolved Solids (TDS)*

The determination of dissolved solids helps in the estimation of dissolved mineral matter content of the effluent suggests Vankar (2002). The difference in weight is the weight of TDS and calculated as follows: TDS = (Weight of residue (mg) / (Volume of effluent (ml) x 1000 (ppm).

*3.3.10 Oil and Grease*

Oils, fats, soaps and greasy substances gain access into water through the discharge of industrial effluents. These contaminants coat the materials with which they get contact. Oil and Grease mg/l = {(mg. residue distilling flask) / mg. sample taken for determination)} x 1000

The wool scoured effluents of Sandyno (S) and Coimbatore Kurumba (K) wool fibres were analysed for the above mentioned parameters for the study.

## 4. RESULTS & DISCUSSION

The results and discussion for the selected wool fibres is shown below:

### 4.1. Results of the Characteristics of Wool Scouring Effluent:

The results of the characteristics of wool scouring effluents of Sandyno (S) and Coimbatore Kurumba (K) is shown in Table I

**Table 1. Characteristics of Wool Scouring Effluent**

| S.No | PARAMETERS | WOOL SCOURINGEFFLUENT | |
|---|---|---|---|
| | | S | K |
| 1 | pH at 30°C | 7.75 | 8.33 |
| 2 | TSS mg/l | 546.5 | 330.5 |
| 3 | Colour Hazen | 400 | 210 |
| 4 | Turbidity NTU | 695 | 290 |
| 5 | Total Alkalinity as $CaCo_3$ mg/l | 100 | 115 |
| 6 | COD mg/l | 1122 | 384 |
| 7 | BOD 27°C mg/l 3 days | 106 | 12 |
| 8 | BOD 20°C mg/l 5 days | 120 | 15 |
| 9 | Oil & grease mg/l | 74.5 | 19 |
| 10 | TDS mg/l (Evaporation Method) | 488 | 464 |

The above results were checked along with the standards of effluent waters BIS IS:2490 (PART- I), PCB NORMS TESTING (BIS) PUBLIC SEWERS and the same was approved by the Tamil Nadu Water Board, Coimbatore. However on the whole, the scoured effluent of the selected varieties proved to be lesser than BIS sewage norms. Further, it also proved that by using this non-ionic detergent, the effluent when left in the sewage will cause no harm to the environment.

## 5. CONCLUSION

True eco-textiles are those which are produced by using natural bio-degradable fibres or materials and in the production of which no hazardous or toxic substances are used. Increasing concern internationally for ecological preservation has also led to the quest for resources that are safe, bio-degradable and re-cyclable. Strohle (2009) views National and International awareness about milieu and ecology has increased the use of eco-friendly fibres, natural dyes, eco-processing and finishing all over the orb.

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