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EFFECT OF DIFFERENT WOOL SCOURING TECHNIQUES ON PHYSICAL PROPERTIES OF WOOL FIBER

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Abstract— The first process of preparing wool is termed scouring; wool scouring is the process of washing wool in hot water and detergent to remove the non-wool contaminants and then drying it. A growing concern for the environment has led to increased demands on the scouring process as reduction in pollution has become increasingly important as the pollution load associated with conventional emulsion scouring of greasy wool is extremely high. The work done by using Cow Urine (Gomutra) as natural ecofriendly scouring agent, has changed the concept of scouring from chemical and pollution oriented one, to a chemical free, eco friendly process with other advantages. In this research cow urine was used as alkali medium with an optimized value of 150 gpl along with natural detergent SapindusSaponaria (Reetha) of 20 gpl, in five bowl system with the help of ultra sound technology for process intensification. An attempt is made of wool scouring of raw greasy wool in dry state at very low temperature in an eco-friendly manner. The dry scouring process, unlike aqueous scouring, doesn't adversely affect the intrinsic properties of wool fibers like strength, elongation, colour, moisture regain, etc. On the contrary, the whiteness index of dry scoured wool fibers was found to be better than convention detergent and alkali based aqueous scouring process.
It was observed that using this optimized recipe effluent load was reduced by 40%, without hampering the other desired mechanical properties of Wool. Also this process doesn't hamper the dyeing property of wool.
Keywords— cow urine, eco-friendly, ritha, wool scouring, ultra sound, dry scouring

I. INTRODUCTION

Raw wool, after being removed from sheep, is called "greasy wool" or "fleece wool" and it contains large amounts of dirt, vegetable matter, suint salts and wool wax. Hence very the first process of preparing wool involves the removal of these contaminants and this process is termed scouring.Wool scouring is the process of washing wool in hot water and detergent to remove the non-wool contaminants and then drying it. It has always been an important step in the wool processing. A growing concern for the environment has led to increased demand on the scouring process as reduction in pollution has become increasingly important as the pollution load associated with conventional emulsion scouring of greasy wool is extremely high[1,2].

The Emulsification of grease on the surface of fiber during aqueous scouring is the most important step of scouring action to remove contaminants from wool. Aqueous scouring is usually carried out under conditions of high temperature 55± 3^0C and high detergent concentrations [3, 4].

The use of high amount of chemicals and detergents in the conventional methods of wool scouring is seriously objectionable both for the environment and the industry during effluent treatment and its disposal. Moreover, conventional mechanical scouring can result in poor whiteness and a higher level of residual dirt [5, 6].

1.1 Cow Urine and ritha solution

Cow urine mainly contains urea and enzyme as a major chemical composition besides water content, while natural extract of Ritha (Sapindus Saponaria) has been used as a detergent since ancient time. With the combination of these two natural sources wool scouring trials were conducted with varying combinations. The results shows that natural Cow urine and ritha combination works

as a scouring media and has the potential to save water and energy, improve product quality and reduces the time and use of chemicals. In this study, Cow urine works as an alkaline medium for wool scouring while the Ritha work as detergent. The Urea [7,8] being the main constituent of cow urine, help the wool fiber to swell and the ammonia present in the urine help to maintain the pH of 8-9, along with the enzyme present in the urine helping to break the bonding between the wool fiber surface and grease. Ritha work as detergent and take out the loosen grease along with it in this work the effect of cow urine and ritha solution was studied in terms of scouring efficiency along with the ultra sound.

1.2 Ultrasount wave

It has been postulated that Ultrasound waves with frequencies above 16 – 20 KHz are known to accelerate chemical processes. Ultrasound also can help in speeding-up the process of contaminant removal and can also help to reduce the chemical consumption in combination of natural items like Cow urine and ritha solution. Moreover, several studies have shown that ultrasonic irradiation can be used to reduce the time as well as processing temperature in various sono-chemical processes. The present work takes advantage of these facts to make the conventional scouring process more efficient and environment friendly.

1.3 Dry Scouring

Though avoiding harsh chemicals above process there is use of water and there is a problem of diminishing water and disposing of the waste water without unduly contaminating the environment. The problem of disposal involves further expenses adhering to stricter environmental emission normsof prior to release of effluent into the environment. The proposed study is aimed at developing a method for scouring wool in a dry medium using fine powders of grease adsorbing materials that involves an efficient means of producing clean wool in a very eco-friendly manner with low or no water.

It is known that some forms of clay such as Fullers' Earth can absorb vegetable oils and greases very well. It is expected that when such clay is sprayed and mixed with raw greasy wool, and subjected to heat, the grease or wool wax will melt. Along with grease and suint other impurities will also get removed and get adsorbed over the fine powder of clay. The grease loaded clay can then be removed by simple mechanical processes such as shaking, dusting, and carding or by rinsing with small amount of water in presence of ultrasound Thus there is a scope to develop a new method of wool scouring which utilizes very little or no water, which is more efficient and eco-friendly and which doesn't damage the fibre properties.

II. MATERIAL AND METHODS

Merino wool of Australian origins were selected for major part of the scouring experiments, because they contain a high amount of contaminants such as wool wax, dirt, dust and suint and therefore are difficult to be scoured. These wools were tested for different parameters such as wool fibre diameter, Residual grease content, clean wool content, wool base and vegetable matter content, staple strength and staple length, etc. using standard method (IWTO, ISO, IS).

Different set of combination has been used to study the effect of Cow urine and ritha solution combined. In case of ultra sound the sound energy was kept constant and the process parameters like temperature, chemicals concentrations, number of baths for wool scouring have been varied and the effect has been studied.

To study the effect of fuller earth in the wool scouring, the dry scouring was carried out by layer wise mixing of wool and different particulate materials at optimized process parameters, i.e. 10 gm of raw wool was mixed with 5gm of particulate matter and heated at 50˚C for 10 min after proper opening or mixing and separating the wool and particulate matter.

Residual Grease Content Analysis The grease content of wool and residual grease content of scoured wool were analyzed as per the standard method IWTO-19-03. The soxhlet extractor of

capacity 250 ml assembled with ground glass joints to 250 ml distillation flask and reflux condenser was used for accurate measurement of residual grease content.

Whiteness & yellowness Measurement The ASTM whiteness Index (WI) and yellowness Index (YI)-E313 of samples, before and after scouring were determined by using spectrophotometer colour I –Match (version 7) according to IWTO- 35-03 standard test method. The Improvement in whiteness and reduction in yellowness are expressed as the percentage change relatively to the original whiteness and yellowness respectively.

Moisture Content Measurement The entire samples were preconditioned in a stability chamber for 24hr at 65 ± 2 % RH and 27 ± 2^0 C. The moisture content was determined after obtaining the weight of wool dried at 105^0C for 3 hr. The oven dry mass was determined according to standard IWTO-34-85-E method.

Single Fiber Strength Test The single fiber strength of raw and sample scoured wool was measured on Shimadzu tensile strength tester according to ASTM D 3822 standard test method. The instrument was based on constant rate of elongation (CRE) principle. The distance between jaws was 10mm and the travel rate was 6 mm/min.

Fiber Mean Diameter Test Fiber diameter measurement was carried out using OFDA 100 as per the standard IWTO-47-2011. The fiber samples were cut into 2 mm snippets and spread on a 70mm square glass slide. The whole slide was scanned with a minimum of 6000 fibers measurement in each measurement. For each sample, three measurements were taken. The mean diameter and standard deviation of the sample were then calculated.

COD Measurement Chemical oxygen demand (COD) was tested using standard test method ISO-15705: 2002, also called as sealed tube method. Total coliform count was tested using standards method IS1622: 1981, RA 2009

III. RESULTS AND DISCUSSION

Measurement of Residual Grease content

For easy processing on the worsted system the residual grease content of wool fiber need to be below 1%. The residual grease content (RGC) obtained by different scouring methods is shown in table 2. In case of commercial scouring process the addition of chemical help in removal of grease from wool fiber. In case of Gomutra and Ritha solution RGC is comparable with conventional process. It shows that desired RGC can be obtained by using natural chemicals. This is due to swell of wool fiber and loosening out the bond between wool and grease by enzyme and ritha, where ritha act as a detergent and take out the grease. When, we use the ultra sound technology for wool scouring the micro bubbles created by ultra sound help in removal of grease with fewer amounts of chemicals. While in case of dry scouring fine particles absorb the grease. Hence no addition of grease is required, and desired RGC is achieved.

Table-2 Residual Grease Content and COD, BOD Values

Sample details	Residual grease content (%)	COD, (ppm)	BOD (ppm)
Commercial Way	0.98	5170	1551
Gomutra + Ritha solution scouring	1.01	3145	1038
Ultra sound scouring	0.98	3248	1104
Dry scouring	0.92	2950	930

Effect on COD &BOD

It was observed that the use of cow urine and Ritha reduces the COD value of effluent. This newly developed natural eco friendly scouring process is not using the any addition chemical like conventional scouring process. So, COD load was reduced. This load was reduced up to 40% of original value; it can be seen from the Table 2. Also with ultrasound technology the use of chemical

is 30% less and hence the COD values are less. While no chemical was added in dry scouring still getting the values due the wool grease removed.

Effect on Whiteness and yellowness

The whiteness and yellowness indices of wool are shown in Table 3. The improvement in whiteness percentage after scouring. Increase in Gomutra and Ritha solution scouring it was found to increase yellowness; this is because of presence of ammonia. In case of Ultra sound scouring the whiteness is increased due to the fiber become cleaner. The height whiteness Index was achieved in case of dry scouring this may be more remove of the grease and less damage to fibers

Table-3 Whiteness and yellowness

Sample details	Whiteness Index*	Yellowness Index
Commercial Way	4.801	24.464
Gomutra + Ritha solution	5.706	23.361
Ultrasound	5.998	21.540
Dry Scouring	7.128	29.098

**Measured using American Standards test method E313.*

Effect on Physical properties

The mechanical properties of wool fibers have no significant effect due to different type of wool scouring. Little difference in the tenacity and elongation of wool fibers is attributing of high degree of variability in fiber dimension and non uniformity in wool.

It has also been found that there is no difference in fiber diameter of all the samples as shown in Table 4. The fiber diameter ranges is in between 21-22.5 micron.

Table-4 Physical Properties

Sample details	Strength (gf)	Strain%	Diameter Micron (μ)	MR%
Commercial Way	3.80 (1.27*)	44.70 (12.16)	21.32	11.25
Gomutra + Ritha solution	4.30 (0.82)	51.00 (10.25)	22.05	11.49
Ultrasound	4.15 (1.29)	49.50 (13.57)	21.06	11.80
Dry Scouring	4.30 (1.56)	52.30 (8.65)	21.69	11.42

** values in brackets standard deviations*

Effect on dyeing of wool

From Table Number 5, it is clear that the depth of shade on wool fiber is higher when they were scoured with dry scouring method. This may be due to less damage to the wool fibers during the process and more whiteness of wool fibers.. Other variations in the K/s values are due to the high degree of variability in fiber dimension and non-uniformity of wool fibers. The trend is almost same for the all dye molecules.

Table 5: Evaluation of dyeing behavior of wool fiber after scouring by different technique

Sr No	Sample	K/S Values	
		Orange 1%	Navy Blue 2%
1	Commercial	11.67	6.31
2	Ultrasound	13.35	6.41
3	Dry scouring	16.22	6.74
4	Cow urine	14.48	6.17

IV. CONCLUSION

With the use of natural resources like Cow Urine & Ritha scouring efficiency was found to be increased. The desired residual grease content can be achieved without using any synthetic chemicals. The mechanical energy of ultrasound accelerates the cleaning action of chemicals like detergent and alkali, accelerating the scouring process. The study revealed the efficacy of using ultrasound in the scouring process to accelerate the process of removal of contaminants from the raw wool and suggests ultrasound assisted scouring can be done at much lower temperature, utilizing lesser amount of chemicals and with substantial saving in time. The new method of scouring of raw greasy utilizing fine powders and nano particles of grease adsorbing materials is proved to be an efficient and eco-friendly scouring method. It was observed that the effect of the different type of scouring methods attempted do not affect the dyeing behavior of wool confirming usefulness of methods.

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