“Impact of Bioscouring Pretreatment on the Quality of Cotton and Polyester/Cotton Blended Fabrics”

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Introduction

Grey fabric as it comes out of loom is quite unattractive and contains natural and added impurities. These give undesirable properties to the fabric and the dyeing and printing process cannot be carried out successfully on the fabric. Hence, grey fabric is given some pretreatment before they are sent for the dyeing / printing and finishing. Unless the fabric is dyed or printed it cannot become attractive and in turn saleable in the market. Therefore, pretreatment is carried out in certain sequence and all the fabrics have to be passed through the following sequences. The sequences are: Desizing, Scouring, Bleaching and Mercerization.

Above mentioned preprocessing steps at each stage has its individual objectives. Among these **"Scouring"** plays an important and critical part for the subsequent treatments. After desizing, the cloth still contains fats and waxes (both natural and added). The non-cellulosic components present in mature cotton fibers are found in the cuticle and the primary cell wall, the outer most layer of the concentric layered structure that make up the cotton fibre. The layers interfere with further aqueous chemical processing such as dyeing and finishing and need to be removed before such aqueous processing. **Boiling in Sodium Hydroxide (NaOH) is the conventional scouring process used by the textile industry to improve the wetting and the penetration of aqueous dyeing and finishing solution**. The scouring process involves large quantities of water and energy and requires special handling of the sodium hydroxide effluents.

Scouring consists of the hot alkaline liquor containing a detergent through a regularly packed column of desized cloth usually under pressure for a prolonged period of normally up to 4 hours to 6 hours at 130°-140°C. At room temperature the material has to kept up to 24 hours. This is done in a boiler, also called a Kier. Efficient boiling is essentially for good bleaching in accordance with saying that **"Well boiled half Bleached."** The temperature of the kier liquor, the pressure in the kier, the

composition of the kier liquor, the duration of the boiling liquor etc. depends on the nature of the goods being scoured.

Now days, conventional textile process in industries is substituted by biotechnology. **“Biotechnology can be defined as the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services”.**

Presently, the traditional scouring process is adopted by biotechnology through **“Enzyme Processing”.** Enzymes have been used on a large scale for many years. Firstly by the leather industry and later by the textile industry in various processes, both in pretreatment of fabric and in garment wash.

The **“history of Enzyme Technology”** really began as easily as **late 1700’s and early 1800’s**. In **1876, William Kuhne** proposed that the name **“Enzyme”** be used as the new term to denote phenomena previously known as unorganized ferments that is ferments isolated from the viable organisms in which they were found. **The word itself means “in yeast” and is derived from the Greek “En” meaning “in” and “zyme” meaning “yeast” or “leaven”.**

Enzymes are large protein molecules, and like other proteins, they are made up of long chain of amino acids. They are naturally occurring high molecular weight proteins capable of catalyzing the chemical reaction of biological process and hence are known as “bio-catalysts”. Enzymes can be isolated from the animals, plants and microbial origin where they play an important role in the function of cells and can be considered as living catalyst. Depending upon the medium used for preparation, enzymes can be referred to as Pancreatic, Malt or Bacterial extract. Pancreatic enzymes are prepared from slaughter house waste such as pancreas, clotted blood, liver etc; whereas Malt extracts are made from germinated Barley. “Bacterial Enzymes” are produced by growing cultures of certain micro-organisms in sterilized wort, providing an excellent supply of enzymes.

Due to selective in their action, they are used only on specific substrate. Enzymes can be classified by the types of substrate they work on. **Proteases work on proteins, Carbohydrases (amylases) work on carbohydrates, Cellulases work on cellulose and lipases work on lipids.** Enzymes can bring about hydrolysis, oxidation, reduction, coagulation, decomposition, although the most common reaction of enzyme is the hydrolysis. **Ease of handling, storage and disposal makes enzymes a choice catalyst for any processing industry.**

The **use of biotechnology in textile processing has been known for many centuries**. The first application known is the retting of bast fibre with the use of micro-organisms. Since 1990, the use of enzyme technology has increased substantially, especially in the processing of natural fibres.

The application of biotechnology in textile industry can be divided into three major areas**- Production (Biopolymer), Processing (Enzymology) and Waste management (Bioremediation).**

Textile industries use various chemical agents in their different processes like desizing, cotton softening, denim washing, silk degumming etc., these chemicals after their use, increase the load in the effluents and some of them are corrosive which could damage equipment and the fabric itself. However, with the introduction of the “enzymatic process in textiles”, the scenario has changed in recent times ensuring eco-friendly production and are successfully used in various textile processes like pretreatment, dyeing and finishing. The stringent environment and industrial safety conditions have ensured environment friendly production and increased the potential for the use of enzymes in textile processing. Enzymes being natural products are completely biodegradable and accomplish their work quietly and efficiently without leaving any pollutant behind. Also, the process would operate at relatively low temperature and atmospheric pressure with little by-product formation.

Alkaline scouring using caustic soda is popular all over the world. The conventional process of scouring not only removes the impurities but also attack the cellulose, leading to a reduction in strength and loss of weight of the fabric. Furthermore the

resulting waste water has a high COD (chemical oxygen demand), BOD (biochemical oxygen demand) and salt content. **Developing environmentally safer methods for processing textile can be done with biological system, rather than conventional chemical methods.** In the last decade, enzyme system has been developed for scouring. Bioscouring is an effective way to scour cotton and cotton blended fabrics for a natural look or to prepare fabric for dyeing. The process is known as “bio-preparation” or “bioscouring”. The process can be applied on various types of equipments such as jigger, jets, pad-batch and pad steam range.

Bioscouring process can be categorized into Aerobic scouring and Anaerobic scouring. **“Aerobic scouring” process** is the process where the microbial enzymes are activated in the presence of atmospheric oxygen. Whereas, the **“Anaerobic scouring”** process is carried out by employing consortium of micro-organisms producing enzymes in an aqueous system. Aerobic methods require pure cultures and become expensive on large scale. Whereas, anaerobic systems can be used in scale up trials at a cheaper rate.Apart from this, the treatments have to be carried out at a particular pH and temperature. Alternatively, **the in-situ production of a cocktail enzymes by a consortium of micro-organism at room temperature under anaerobic conditions standardized by Vahadarajan, P. V., Balasubramanya, R. H.,Nachane, N. D., and Mahangade, R.R., “ Biochemical Scouring Technique for cotton goods” (patent granted in 2009), appear to be cost effective process.** The consortium contains hydrolytic, acidogenic, methanogenic and sulphate reducing organisms. Yarn or fabric can be subjected to anaerobic treatment for 4-6 hours followed by boiling in 1% alkali at 100°C for 30 min. The results have indicated that such anaerobically treated yarns and fabric followed by bleaching and dyeing indicated deep shades than their conventional dyed counter parts. This indicates that quantity of dyes required may be slightly less which could bring out the cost of the finished fabrics.

Advantages of bioscouring are:

1. Uniform wax removal and better wettability
2. Bioscoured fabrics require less dyes and gives (heavier) darker shades than traditional scoured fabrics.

3. Dyeing saving and hence reduced level of dyes in effluents
4. Low caustic required and hence low chemical load in effluents. Requires very low concentrations of alkali (0.1% w/w).
5. Weight loss of the fabric is very minimal.
6. Technology is suitable for 100% cotton and blended textiles.
7. Commercial enzymes can also be used but appears expensive on scale-up trials as compared to the Anaerobic microbial Bioscouring process.
8. A great potential for commercial exploitation.

The present study reports the impact of bioscouring anaerobic techniques on cotton and blended woven fabric in comparison with the conventional kiering process. In this study the grey 100% Cotton fabric and Polyester/cotton blended woven fabric were desized followed by Conventional scouring and Bioscouring treatment which include commercially available enzyme treatment and anaerobic treatment with various time duration (6h, 10h, 12h, 18h, 24h and 48h) and the fabrics were assessed for their physical properties. All the fabrics were further bleached followed by dyeing process and the fabrics were again assessed for their colourfastness properties and dye uptake. The optimum time duration of the anaerobic treatment were selected and further carried out for the semi-bulk trial and the techno-economic feasibility were studied. The effluent profile of conventional scouring and bioscouring were also studied.

Significance of the study

1. It is expected that bioscouring anaerobic technique will score over the conventional chemical method which is energy intensive and polluting.
2. Bioscouring is an environment friendly process.

Aims and Objectives

1. To standardize the method of anaerobic bioscouring technique for optimum scouring of cotton and blended (polyester/cotton) woven fabrics
2. To undertake semi-bulk trial of bioscouring on the optimized condition to selective woven fabrics
3. To compare and evaluate the quality parameters of both conventional and bioscoured fabrics
4. To compare the efficiency of the new bioscoured technique with the conventional kiering process
5. To undertake dyeing trials and comfort properties of the conventional and bioscoured fabrics
6. To find out the effluent profile of the conventional and bioscoured process

Scope of the study

1. The study will give an insight about the anaerobic bioscouring technique which leads to reducing of sources (chemicals) during wet processing.
2. Process being ecofriendly, environment will be safe and clean.
3. The standardized method will result in an optimum scouring process.
4. This study will also focus on the comfort characteristics of fabrics.

Methodology

Selection of Fabrics:

The fabrics used in the study were 100% Cotton grey woven fabric and (61:39) Polyester/ Cotton blended grey woven fabric. The fabrics were procured from M/s. Praffulchandra M. Shah, Dadar, Mumbai. The anaerobic treatment was carried out in a sealed tank employing microbial consortium developed and maintained at CIRCOT. Commercial grade chemicals and dyes available were utilized for the study.

Objective: 1 –

1. 100% Cotton and (61:39) Polyester/Cotton blended grey woven fabric were desized by soaking in water prior to anaerobic bioscouring treatment
2. Anaerobic bioscouring treatment on 100% Cotton and (61:39) Polyester/Cotton blended grey woven fabric was performed in various time duration, *viz;* 6h, 10h, 12h, 18h, 24h and 48h.
3. After anaerobic bioscouring all the fabrics (100% Cotton as well as Polyester/Cotton blended grey woven fabric) were treated with 0.1% NaOH for 15min at 100°C.
4. Weight loss of the fabric was identified to assess the optimum result of the anaerobic bioscouring treatment.

Objective: 2 –

1. The semi-bulk trial of anaerobic bioscouring was carried out with the selected optimized condition on the woven fabrics.
2. The semi-bulk fabric was further bleached and dyed as per the pilot study.
3. The techno-economic feasibility was assessed.

Objective: 3 –

1. Fabric count, Yarn count, GSM, Crimp percentage, Shrinkage percentage, Breaking strength & Elongation percentage and Tearing strength was performed to understand the physical parameters of the fabrics.
2. The control parameters of 100% Cotton and (61:39) Polyester /Cotton blended grey woven fabrics were studied.
3. The physical parameters were studied on the Conventional scour fabric as well as on Bioscour fabric (viz; commercial enzyme & anaerobic treatment)
4. With the obtained data the quality parameters of both Conventional scour and Bioscour fabrics were studied.

Objective: 4 –

1. Conventional scouring was carried out to 100% Cotton as well as to (61:39) Polyester/Cotton blends grey woven fabric in 1%NaOH on o.w.f for 4h at 121°C till the pressure reached to 15lb/inch^2.
2. Bioscouring was categorized in to Commercial enzyme scouring treatment and Anaerobic scouring treatment.
3. The commercial enzyme treatment was applied to 100% Cotton as well as (61:39) Polyester/Cotton blends grey woven fabric were dipped in the solution (weighing 20 times the mass of the specimen), containing 5 g of Diastase and 10g of Sodium Chloride per litre, at 50° C and at pH of 6.5 – 7.7. Both the fabrics were allowed to remain in the solution for 1½ h.
4. The required quantity of fabric (approx. 2m for each treatment) was subjected to anaerobic treatment for 6h, 10h, 12h, 18h, 24h and 48h respectively. The anaerobic treatment was carried out in a sealed tank employing microbial consortium developed and maintained at CIRCOT. The treatment was carried out at room temperature. At the end of the treatment period, the samples were boiled in 0.1% NaOH solution (o.w.f) for ½ h, washed and air dried.

5. After completion of all the scouring treatment the efficiency of the new bioscouring technique with the conventional kiering process was analyzed.

Objective: 5 –

1. The 100% Cotton and (61:39) Polyester/Cotton blends grey woven fabrics treated with Conventional scouring as well as Bioscouring were further passed through the Bleaching treatment. The bleaching process was carried out with bleaching agent, Hydrogen Peroxide (H_2O_2) - 3g/l, along with alkali stabilizer Sodium Silicate – 1.5g/l and to remove the remaining kitties from the fabric. The total time duration for the bleaching treatment was 1h at 90°C at 9.5 – 11pH.
2. Both the quality of fabrics was assessed for their comfort properties through Kawabata Evaluation System - Fabric (KES-FB) for handling & feel, Drop test for absorbency and whiteness index.
3. All the treated fabrics were further carried to the dyeing process. The 100% Cotton grey woven fabric was dyed with Reactive dye in Launderometer and (61:39) Polyester/Cotton blends grey woven fabric was dyed with Disperse+Reactive dyes in HTHP machine.
4. After dyeing, fabrics were washed in soap solution (2g/l) at 60°C.
5. The fastness properties like the rubbing fastness, washing fastness, perspiration fastness and light fastness of all the dyed fabrics were analyzed as per the relevant standards.
6. The colour strength of all the dyed samples was determined.

Objective: 6 –

1. The effluent of the conventional scouring process and the bioscouring process was analyzed to understand the COD, BOD and TSS level.

The physical tests were performed under Indian standards and some of the test procedure was also followed as per the methods detailed in Hand Book of Test Methods (CIRCOT). The tests were carried out under standard atmospheric condition of 65% ± 2% Relative Humidity and 27°C ± 2°C Temperature.

Discussions

Objective: 1 –

Based on repeated trials, 18h Bioscouring treatment was found to be optimum with regard to wax and other non-cellulosic matter removal, weight loss and strength retention of the fabric.

Objective: 2 –

Semi-bulk trial (5 metre size) also indicated that the properties of the bioscoured cotton and blended fabrics were on par with the trials on smaller size of the fabric.

Objective: 3 –

The physical attributes of the bioscoured fabrics were slightly better than the conventional chemical processed fabrics.

Objective: 4 –

The adopted Bioscouring technique has been found to be ideal and economical as compared to the conventional chemical process.

Objective: 5 –

Uptake of bioscoured fabrics was found to be higher than the conventional process.

Objective: 6 –

Release of chemicals and dyes from the bioscoured fabrics was significantly less and hence load on the effluents is minimal.

Bibliography

Journals:

1. Adivarekar R. V., and Kanoongo N., (2008) *"Textile wet processing scenario in India",* The Indian Textile Journal, January, pgs: 47-55.
2. Akin D. E. and Hardin I. R. (2004) *"Recent research on biotechnology in textiles",* Colourage, Vol: 51, Annual, pgs: 55 – 60.
3. Anonymous (1999) *"Bioscouring",* Textile Asia, May, pgs: 134.
4. Karmakar S. R., (1998) *"Application of Biotechnology in the pretreatment processes of textiles",* Colourage Annual, pgs: 75-86.
5. Mahapatra, (2007) *"Use of Enzymes in Textile Wet Processing",* Colourage, Vol: 54, No: 6, June, pgs: 64 – 66.
6. Manickam M. M. and Prasad J. G. (2004) *"Bio-technology in textiles – its application",* Textile Magazine, Vol: 45, No: 12, pgs: 73 – 79.
7. Moghe V. V. and Nabar P.S., (2006) *"Bioscouring: An ecological way of scouring",* Colourage, Vol: 53, No: 2, February, pgs: 95 – 96.
8. Murthy K.S., (2004) *"Role of Enzymes in textile processing",* Colourage, Vol: 51, No: 6, pgs: 55-58.
9. Muthu-Manickam M. and Ganesh-Prasad J. (2005) *"Application of bio-technology in textiles",* Colourage, Vol: 52, No: 10, pgs: 41 – 48
10. Nikhil and Nishkam A. (2003) *"Enzymes in wet processing",* Indian Textile Journal, February.
11. Parthiban M., and Manjula S., (2007) *"Biotechnology & new millennium fibres",* The Indian Textile Journal, April, pgs: 19-23.
12. Patra A. K., (1998) *"Applications of Enzymes",* Textile Asia, Vol: 29, No: 8, pgs: 46 – 48.
13. Patra A. K., (2003) *"Enzymes for wet processing pretreatment",* Textile Asia, Vol: 34, No: 9, pgs: 46 – 51.
14. Shanmugasundaram O. L., and Kumaravel S., (2006) *"Application of Biotech in Textile industries",* The Indian textile Journal, January, pgs: 21-27

15. Sharma M., (1993) *"Application of Enzymes in Textile Industry",* Colourage, January, pgs: 13-17.
16. Shukla S. R., Sharma U., & Kulkarni K.S., (2000) *"Enzymes and their uses in Textile Processes",* Colourage, February, pgs: 19-24.
17. Shukla S. R., (2006) *"Importance of pre-treatment",* Colourage, Vol: 53, No: 4, April, pgs: 66 – 69.
18. Varadarajan P. V., Balasubramanya R. H., Nachane N. D. and Mahangade R. R. (2008) *" A new bio-chemical scouring technique for cotton hand processing units",* Indian Journal of Fibre & Textile Research, Vol: 33, March, pgs: 88 – 92.ss

Books:

1. Aehle W. *"Enzymes in Industry – Production and Application",* Wiley – VCH Verlag GmbH & Co., Second, Completely Revised Edition.
2. Cavaco – Paulo A. and Gubitz G. M. (2003) *"Textile Processing with Enzyme",* Woodhead Publishing Limited, Cambridge
3. Guebitz G. M., Cavaco-Paulo A. and Kozlowski R. (2006) *"Biotechnology in Textile processing",* Food Products Press.
4. Sundaram V., Iyer K. R. K. and Sreenivasan S. (2008) *"Hand book of methods of test for cotton fibres, yarns and fabrics – Chemical test",* Part – 3, CIRCOT, ICAR.
5. Sundaram V., Iyer K. R. K. and Sreenivasan S. (2008) *"Hand book of methods of test for cotton fibres, yarns and fabrics – Mechanical processing, Yarn test and fabric test",* Part – 2, CIRCOT, ICAR.

Websites:

1. www.google.com
2. www.fibre2fabric.com