

Conventional and Single-step Pretreatment Process of Cotton Woven Fabric

Mohammad Amir HAMZAH^{1, a}, Fan LIU^{1, b}, Shu WEN^{1, c}, Shao LONG^{2, d},
Xin-Yue XIAO^{3, e}, Li-Na LIN^{1, f, *}, Ying-Jie CAI^{1, g}

¹Engineering Research Center for Clean Production of Textile Dyeing and Printing, Ministry of Education, Wuhan Textile University, Wuhan 430073, China

²Zhejiang Transfer Co., Ltd, Hangzhou 311215, China

³Huzhou Angye Digital Industry Co., Ltd, Huzhou 313008, China

^azahid.latif786@gmail.com, ^b837097057@qq.com, ^c869882975@qq.com, ^ddawuhan@163.com,
^ebettyxiao@angyetexdp.com, ^flinalin@wtu.edu.cn, ^gyingjiecai@wtu.edu.cn

*Corresponding author

Keywords: Absorbency, Tensile Strength, Dyeability, Multifunctional Scouring Agent.

Abstract. In this experiment grey fabrics (woven) were treated by using various concentrations of multifunctional scouring agent (M.F.S.A.) and H₂O₂ in case of single-step process. Also optimized required number of chemical used for whole process; here only two chemicals have been used. No additional chemicals used for water treatment and washing of treated fabric. After process only cold wash were done. After process quality of bleached fabric were tested by testing various test e.g. tensile strength and absorbency of bleached fabric. Conventional pretreatment process were also studied and compared with single step pretreatment process. Dyeability of bleached fabric also studied. Fabric pretreated by single step process have significant effect on dyeability that is comparatively better than conventional pretreatment process. Absorbency and tensile strength of bleached fabric were found significantly better in case of single-step process compared to conventional pretreatment process.

Introduction

Pretreatment of cotton based fabric mainly concerned with the removal of natural as well as added impurities from the fabric and also need to be obtained a level necessary for good absorbency and whiteness with minimum decrease of strength of fabric by utilizing lowest chemical, energy and time as well as water by using several chemical processes [1, 2]. The dye uptake during dyeing of cotton textile or absorbency of others chemical agent during finishing will be uniform or to the maximum extent possible if the fabric is pretreated well i.e. uniform in whiteness, absorbency, chemical composition and has low levels of impurities. Desizing, scouring and bleaching are the three stages of conventional pretreatments of woven cotton fabrics, whereas scouring and bleaching are the two stages of knitted cotton goods [2]. Desizing is a typical process in pretreatment by which size materials are removed from cotton woven fabrics, cotton blends and all grey synthetic materials which contain sizes. Sizing agents on the warp yarns which applied for better weaving efficiency in the weaving mills, have to be removed before further processing in textile [3-8]. Since natural impurities such as cotton wax, pectin substances and protein are associated mainly within the primary wall, the scouring process aims to remove this wall. Oils and fats are removed by saponification reaction from cotton fabric when it is heated with a solution of sodium or potassium hydroxide. They are hydrolysis into glycerol and the alkaly salt of the fatty acid [9]. Even after scouring natural fiber and fabrics still contain naturally occurring coloring matter. The progression of removing colored impurities from greige fabric as competently as possible is called bleaching and change the fabric in an entirely white state with minimum or no damage to the fabric [10]. Large amount of water and energy consumed by conventional pretreatment processes, so it is absolutely necessary to minimize the energy and water consumption. If it is possible to combine

these three processes in a single step that will be lowering the number of operations or reducing the time of reaction as well as reduction of water consumption [11]. Using multifunctional scouring agent (M.F.S.A.) seems as one of the most attractive fields in pretreatment process in textile industry. This idea has been investigated by some researchers to provide more effects in a bleached finished fabric just in a single bath. Multifunctional scouring agent RH-NB-1101H-1 is multifunctional pre-treatment chemical of complex by several chemicals. It has strong properties of washing, dispersing, emulsifying and chelating, particularly applicable to bath pre-treatment of cotton and terylene/cotton blended textiles. The present study aims at enhancing the absorb ability and dyeability of the bleached cotton cellulose in one step using multifunctional scouring agent. Besides searching for the proper conditions for attaining better absorbency along with good tensile properties.

Experiment

Materials

Plain weave 100% cotton fabric was supplied by Guangzhou Senhao Clothing Co., Ltd. China. RH-NB-110-1 used as a multi-functional scouring agent that were taken from Zhejiang Runhe Organosilicone New Material Co., Ltd., Zhejiang, China. RUCOWE7 RDA used as wetting agent supplied by Rudolf Chemie Company Ltd., China. CDLAN BNE used as a sequestering agent which supplied by Runwell (G2) Textile Co. Ltd., China. PCP5 used as a detergent supplied by Run Xiang Tei Company. Reactive Red FL-2BL supplied by Color Root (Hubei) Technology Co., Ltd., China.

Methods

All process were carried by an Infrared dyeing machine. Single step pretreatment method (desizing, scouring and bleaching) were performed at single bath under the following condition: concentration of H_2O_2 and multifunctional scouring agent (M.F.S.A.) were varied from 2 g/L to 6 g/L and 2 g/L to 5 g/L respectively, process were carried out at 80°C temperature for 60 min with 1:20 liquor ratio.

In case of conventional method, desizing was carried out by oxidative method at 1:10 liquor ratio where both wetting agent and sequestering agent were used at 1 g/L, soda ash, H_2O_2 , and sodium silicate were used at 4 g/L, 5 g/L and 2 g/L respectively. Process were carried out at 75°C temperature for 25 minutes at pH 10-11. Scouring was carried out at 1:10 liquor ratio, at 95°C temperature, at 10.5 to 11 pH for 40 min by using the following components: wetting agent, detergent, sequestering agent, and caustic soda were used at 1 g/L, 2 g/L, 2 g/L and 3 g/L respectively. Bleaching was carried out at 1:20 liquor ratio, at 90°C temperature, at 10 to 11 pH for 40 min by using the following components: wetting agent, detergent, sequestering agent, stabilizer and caustic soda were used at 1 g/L, 2 g/L, 1 g/L, 0.5 g/L and 3 g/L respectively. Whereas H_2O_2 concentration were varied at 2 g/L, 3 g/L, 4 g/L, 5 g/L and 6 g/L.

Wettability of the fabrics was measured by FZ/T 01071-2008. Fabrics tensile strength were measured by GB/ T 3923-1997 method. Dyeability of the bleached fabric were determined by measuring K/S values with a Data Color 110 spectrophotometer.

Results and Discussion

Absorbency

It can be conferred from Fig.1 that absorbency height in cm of bleached fabric increased with the increased of concentration of H_2O_2 both single-step and conventional pretreatment processes. It is also observed that at 6 g/L concentration of H_2O_2 absorbency height in cm were found higher compared to others in both case. It may cause when the grey fabrics were desized, scoured, and bleached in the pretreatment solution, alkalinity of the solution reacts through saponification with the impurities and sizing materials of the fabric. This causes sizing and impurities removal, so that the water molecules can easily penetrate into the fibers and increase wettability [12].

From the result it has been also seen that fabric absorbency decreased with the increase of concentration of M.F.S.A. which is shown in Fig.1 (a). At lower concentration of multifunctional scouring agent, absorbency value found better in case of single-step bleaching process. Highest value of absorbency found at fabric treated by 3 g/L and 6 g/L concentration of M.F.S.A. and H₂O₂ respectively which is 11.2 cm in absorbency height.

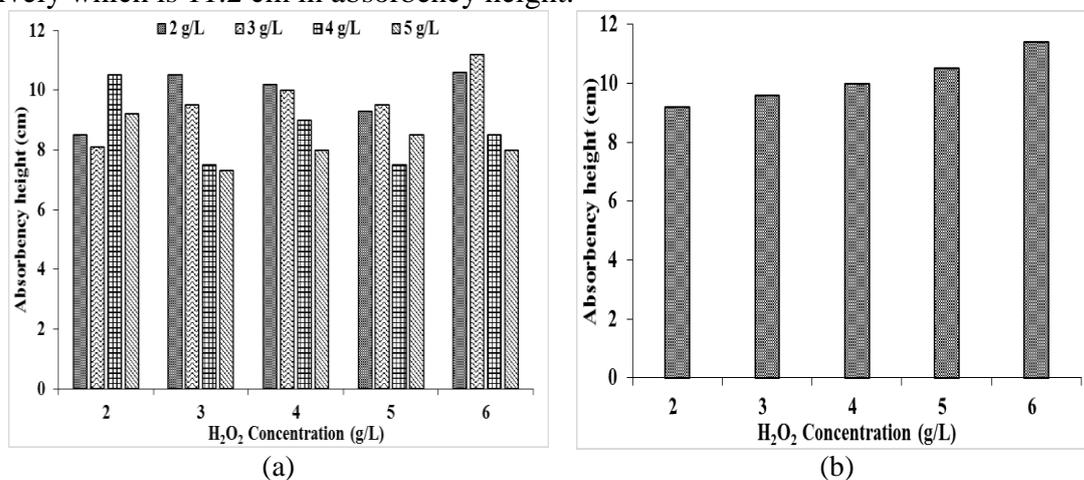


Fig.1 Absorbency of bleached fabric (a) single-step process, (b) conventional process

Tensile Strength

It can be conferred from Fig.2 that fabric treated by single step process showed comparatively higher strength than conventional process. In case of conventional method of bleaching process, with the increasing of H₂O₂ concentration decrease the strength of fabric which is shown in Fig.1 (b). It may be because of peroxide not only react with the color but also with the fibre. Also when fibre is oxidized consequently strength is lowered [12]. Sodium hydroxide may also cause for fibre damage. With the increasing of the both H₂O₂ and M.F.S.A. concentration decreased the strength of the fabric which is shown by Fig.2 (a). It may cause higher concentration of M.F.S.A. generate higher pH of the medium which cause break the material at lower stress and strain. Also at high concentration of H₂O₂ fibre may started damage.

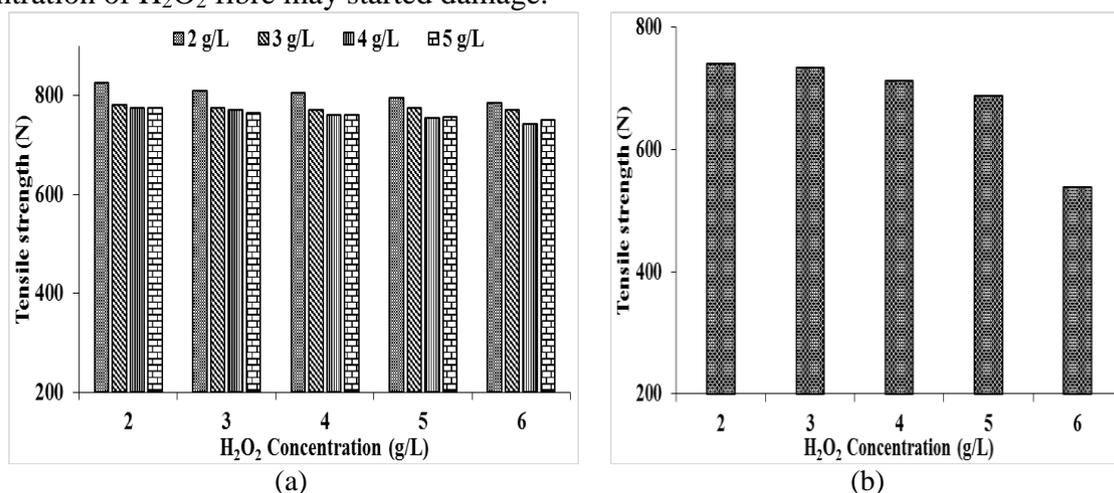


Fig.2 Tensile strength of bleached fabric (a) single-step and (b) conventional process

Dyeability

To investigate the dyeability of bleached fabric for both single step and conventional pretreatment process, fabrics were dyed by Reactive Red FL-2BL at three different dye o.w.f. (0.5%, 2% and 4%) variation and observed the K/S value. In Tab.1, sample 1, 2, 3 and 4, 5, 6 represent fabric treated by 2g/L, 4 g/L and 6 g/L concentration of H₂O₂ respectively during bleaching process for both single step and conventional pretreatment process.

Tab.1 K/S value for different dye o.w.f. variation

Single step process				Conventional process			
Sample no	0.5%	2%	4%	Sample no	0.5%	2%	4%
Sample 1	1.75	5.88	15.28	Sample 4	1.45	6.15	13.13
Sample 2	2.17	8.88	10.93	Sample 5	1.27	5.82	12.89
Sample 3	2.06	8.38	17.26	Sample 6	1.49	5.74	12.8

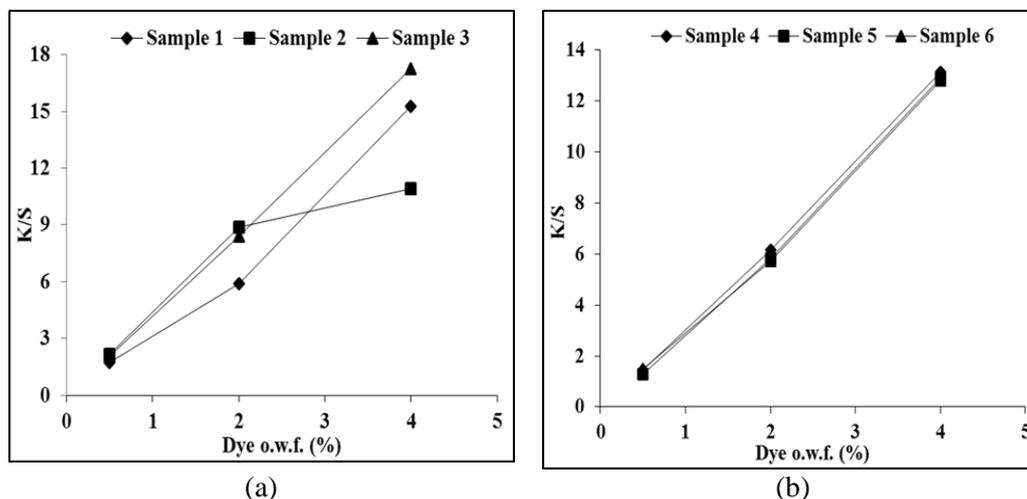


Fig.3 K/S value of dyed fabric (a) for single-step and (b) conventional pretreatment process

Also all percentage value showed in the table represent dye % considered as on the weight of fabric (o.w.f.). It was found that fabric treated by single step processed absorbed more dyes than those treated conventionally, irrespective of the dye % o.w.f. which is shown in Tab.1 and also Fig.1 (a) and (b). If it is considered sample 1 and 4 then it can be seen that at dye o.w.f (0.5 %) dyeing process 17 % more dye uptake by fabric which treated by single step compared than conventional pretreatment process which shown in Tab.1.

Also at dye o.w.f. (4 %) dyeing process 14 % more dye uptake by fabric which treated by single step pretreatment process compared to conventional process which also shown by Tab.1. May reason is that more wettability of bleached fabric treated by single step process than conventional process at 2 g/L H₂O₂ concentration which is shown in Fig.1. In case of sample 2 and 5 at dye o.w.f (0.5 %) dyeing process 41% more dye uptake by fabric which treated by single step compared than conventional pretreatment process. Also at dye o.w.f. (2%) dyeing process 34 % more dye uptake by fabric which is treated by single step pretreatment compared than conventional process. In case of sample 3 and 6 at dye o.w.f. 0.5 % shade dyeing process 27 % more dye uptake by fabric which treated by single step compared than conventional pretreatment process. Also at dye o.w.f. (2 %) dyeing process 31 % more dye uptake by fabric which treated by single step compared than conventional pretreatment process. Also at dye o.w.f. (4 %) shade dyeing process 25 % more dye uptake by fabric which treated by single step compared than conventional pretreatment process. A probable answer can be while treating cotton multifunctional scouring agent might have reduced crystallinity and increased the amorphous region; as a result the fabric absorbed more dyes in case of single step process [13]. It can be also conferred that dye uptake increased regularly with the increasing of dye o.w.f. (%) in case of sample of 1 and 3 for single step pretreatment process which is shown in Figure 3. But in Fig.3 (b) showed that better regularity in dye uptake for all sample in conventional pretreatment process.

Conclusion

Single-step bleaching process has better result effect compared to conventional process. Best results of absorbency of bleached fabric were found at 2 g/L and 6 g/L concentration of M.F.S.A.

and H₂O₂ respectively. Tensile strength of bleached fabric lies between 825 N to 750 N in case of single step bleaching process at all concentration of H₂O₂ which is better than conventional pretreatment process. Fabric pretreated by 3 g/L concentration of H₂O₂ has better dyeability about at all dye o.w.f., in case of single step bleaching pretreatment process which is also better than conventional pretreatment process.

Acknowledgement

This work was supported by the China National Textile and Apparel Council (2013 “Textile Vision” Applied Basic Research) and a grant from Hubei Province Science and Technology Support Program (Project 2013BAA043).

References

- [1]S.R. Karmakar, Chemical technology in the pre-treatment processes of textiles, first ed., Elsevier, New York, 1999.
- [2]L. Segal, P.J. Wakelyn, Fibre chemistry, in: M. Lewin and E. Pearce (Eds.), Cotton fibres, Marcel Dekker, New York 1988, pp. 846.
- [3]H. Schönberger, T. Schäfer, Best available techniques in textile industry, Berlin: 2003.
- [4]D. Shao-Wei, L. Da-Nian, Kinetics of the thermal inactivation of bacillus subtilis α -amylase and its application on the desizing of cotton fabrics, Journal of Applied Polymer Science. 109 (2008) 3733-3738.
- [5]M.M. Hashem, An approach towards a single pre-treatment recipe for different types of cotton, Fibres and Textiles in Eastern Europe. 15 (2007) 85.
- [6]H. Feitkenhauer, D. Fischer, D. Föh, Microbial desizing using starch as model compound: Enzyme properties and desizing efficiency, Biotechnology progress. 19 (2003) 874-879.
- [7]B. Diderichsen, A new desizing enzyme shows the changing nature of enzyme production, Journal of Biotechnology. 38 (1995) 196-197.
- [8]A. Cavaco-Paulo, G. Gubitz, Textile processing with enzymes, first ed., CRC, Boca Raton, 2003.
- [9]E.R. Trotman, Textile scouring and bleaching, first ed., Griffin, London, 1968.
- [10]V.A. Shenai, Technology of bleaching and mercerizing, first ed., Sevak, New Delhi, 1991.
- [11]V.A. Dehabadi, Novel possibilities in chemical pretreatment and finishing of cotton fabrics, Ph.D thesis, Universität Duisburg, Essen, 2013.
- [12]K.S. Huang, E.P. Jan, L.A. Lu, A new process for the desizing, scouring and bleaching of cotton/nylon fabrics with tetraacetythylenediamine, Cellulose Chemistry and Technology. 41 (2007) 43-50.
- [13]M.S. Hossain, M.K. Uddin, Comparative analysis between conventional pre-treatment and bio-preparation, International Journal of Engineering & Technology. 11 (2011) 14-19.