

Coverage Of Immature Cotton Neps In Dyed Fabrics Using Chitosan Aftertreatment

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Abstract

Neps of immature cotton fibers appear as light or white specks in a dyed fabric. This is a serious problem and a major cause of fabric rejection. Since white specks due to neps of immature cotton are visible only after the value-added processes, it would be highly desirable to have a process to cover the neps in the dyed fabrics by using an aftertreatment. This paper reports on exhaust and pad batch applications of chitosan aftertreatments to cover the undyed neps of immature cotton in the fabrics which have been already dyed.

Introduction

Neps consisting of immature cotton fibers which appear as light or white specks in dyed fabrics are a major cause of fabric rejection. Previous research has shown that pretreatment of cotton fabrics with chitosan significantly improves the dye coverage of neps.¹² Therefore, this report deals with the use of chitosan as an aftertreatment for cotton fabrics that have been dyed with direct dyes.

Chitosan is a nontoxic biodegradable product prepared by deacetylation of chitin which occurs abundantly in fungi and exoskeletons of the arthropod. It may be regarded as a cellulose derivative in which the hydroxyl group on the C₂ position is replaced by acetyl or amino groups.

Procedure

Fabric used was 100% cotton; plain weave; 3.2 oz/sq. yd desized, scoured,

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and bleached. Chitosan (Chitosane KW-5) having deacetylation 91.6%; and viscosity 9.8 cps (1% in acetic acid, at 20 °C) was obtained from C.I. Specialty Chemicals, Inc. Dyes used were Direct Blue 78, Direct Black 80 Direct Blue 80, and Direct Red 83 All other chemicals used were chemically pure.

Dyeing

Standard procedure for dyeing direct dyes was used. The dye bath was set at 25 °C with 1 .0% nonionic wetting agent and required amount of predissolved dyestuff. All percentages were based on the weight of the fabric. The material to liquor ratio was 1:25. The fabric was introduced in to the dye bath and temperature was raised to 90 °C. At that time, 20% sodium sulfate (o.w.f) was added over a 10 minute period and dyeing continued for 30 minutes. The dye bath was then cooled to 60 °C and rinsed clear with water.

Chitosan aftertreatment by exhaust process

The dyed fabrics were treated for 5 minutes with 0.1% nonionic wetting. The required amount of chitosan, which was predissolved in dilute acetic acid, was slowly added to the bath. The material to liquor ratio was 1:25 The treatment was continued for 10 minutes at room temperature. The temperature was then raised to 60 °C and 10% sodium sulfate (o.w.f.) was added over a 10 minute period. The fabrics were treated at that temperature for another 30 minutes. The fabrics were then rinsed and, without drying, redyed with 0.1%-0.3% of the same dye (o.w.f).

Chitosan aftertreatment by pad batch process

The bath was set with 10 gram/liter of chitosan and 0.5 gram/liter of non-ionic wetting agent. The dyed fabrics were padded at 80% pickup, rolled, and

covered with polyethylene. After batching for 4 hours at room temperature, the fabrics were rinsed, and redyed with 0.1- 0.2% of the same dye (o.w.f).

Test methods

Nep coverage of fabrics was tested by the AATCC Subjective Rating Scale. Total color difference *E*_{CIELAB} and color strength K/S were determined by using Illuminant D65 and a viewing angle of 10° with a Macbeth Color Eye 3000 Spectrophotometer.

Colorfastness to washing was evaluated by AATCC Test Method 61-1994; IA. Colorfastness to crocking was measured with a rotary crockmeter AATCC 116-1989.

Results and Discussion

Tables I and II show the color difference values, color strength, and nep coverage rating of the dyed fabrics aftertreated with 0.6% chitosan by the exhaust process and with 0.8 % chitosan by pad-batch process, followed by redyeing 0.1-0.2 % of the same color. The optimum concentrations of chitosan in exhaust and pad-batch process were determined after several laboratory trials. Before chitosan aftertreatment, the dyed fabrics realized 1-2 nep coverage rating.

The chitosan treatment alone did not cover the neps in the dyed fabrics. However, after redyeing with 0.1-0.2 dye, the neps were more or less completely covered. The nep coverage ratings increased from 1-2 to 4-5. The chitosan aftertreatment and redyeing with a small amount of dye caused very little change in total color difference value *delta E* with the exception of Direct Blue 80 dyed fabric (Table I) and Direct Red 83 dyed fabric (Table II).

This was also true with the color strength (K/S) values. Direct Blue 80 dyed fabric (Table I) showed 15% increase in K/S values and Direct Red 80

dyed fabric (Table I) gained 12% in K/S value. Small changes in E and K/S values occurred in the fabrics dyed with most of the other dyes by chitosan after treatment and redyeing. This confirms the hypothesis of Rippon² that the chitosan is preferentially sorbed by the immature cotton fibers. A small amount of dye which dyed the chitosan treated neps increased the color value of the dyed neps to the level for the base dyed fabric.

Table III shows the nep coverage, delta E Values and K/S of the dyed fabrics aftertreated with 0.8% chitosan and redyed in the same dye bath using the remaining dye. The chitosan aftertreated dyed fabric picked up the remaining dye from the exhausted dye bath and realized substantially higher color strength and color difference values than those redyed with 0.1-0.2 % of new dye. The neps were dyed and nep coverage ratings increased from 1-2 to 5.

The washfastness data given in Table IV show that the colorfastness to washing, and wet cracking were adversely affected by chitosan aftertreatment and redyeing. The ratings are either the same as dyed fabrics before the aftertreatment or lowered by one unit after the aftertreatment and redyeing.

Summary

White specks of immature cotton in dyed fabrics were dyed after the chitosan aftertreatment and redyeing with a small amount of dye. Application of chitosan can be made by an exhaust or a pad-batch method.

After several preliminary trials, it appeared that 0.6% chitosan (o.w.f.) appeared to be the optimum concentration in the exhaust method and 0.8% chitosan in the pad-batch process.

Redyeing with a new dye can be performed after rinsing without drying. The same unused dye in the dye bath after dyeing can also be utilized in redyeing the chitosan aftertreated fabrics.

Colorfastness of the dyed fabrics was affected by the specific dye used. Nep coverage improved the quality of the dyed fabrics.

Acknowledgments

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References

(1) Mehta, R.D. and Combs, R.N., American Dyestuff Reporter, Vol. 80, Sept. 1991, p. 274

(2) Rippon, J.S., Journal of the Society of Dyers and Colourists, Vol. 101, Oct. 1984, p. 298.

Table I: Color Difference, Color Strength, and GNP Coverage of the Direct Dyes Dyed Fabrics aftertreated with 0.6% chitosan by the exhaust method and redyed with 0.1-0.2% of the same dye.

Dye	After-treatment	ΔE	Color Strength K/s	Nep Coverage Rating
1% Dir. Black 80	No Aft		9.9	1-2
1% Dir. Black 80	Aft	1.2	10.9	5
1% Dir. Blue 80	No Aft		6.0	2
1% Dir. Blue 80	Aft	2.21	6.9	5
1% Dir. Blue 78	No Aft		3.58	1-2
1% Dir. Blue 78*	Aft	0.37	3.62	4
2% Dir. Red 83	No Aft		7.81	1
2% Dir. Red 83*	Aft	1.23	7.88	4

Table II: Color Difference, Color Strength, and Nep Coverage Using Chitosan by Pad-Batch Process and Redyeing with 0.1- 0.2 % of New Dye.

Dye	After-treatment	ΔE	Color Strength K/s	Nep Coverage Rating
1% Dir. Blue 80	No Aft		5.02	1-2
1% Dir. Blue 80	Aft	0.61	5.24	5
2% Dir. Blue 78	No Aft		5.91	1-2
2% Dir. Blue 78	Aft	0.50	6.21	5
2% Dir. Black 80	No Aft		10.01	1
2% Dir. Black 80	Aft	0.85	10.78	5
2% Dir. Red 83	No Aft		5.09	1
2% Dir. Red 83	Aft	2.36	5.63	5

Table III: Color Difference, Color Strength and Nep Coverage Using Chitosan by Pad-Batch Process and Redyeing in the Exhausted Dye Bath of the Same Dye.

Dye	Chitosan	ΔE	Color Strength K/s	Nep Coverage Rating
1% Dir. Blue 80	No AFT		5.02	1
1% Dir. Blue 80	0.80%	2.2	5.23	5
2% Dir. Blue 78	No AFT		5.91	2
2% Dir. Blue 78	0.80%	3.17	6.21	5
2% Dir. Black 80	No AFT		10.01	1
2% Dir. Black 80	0.80%	4.29	13.09	5
2% Dir. Red 83	No AFT		5.09	1
2% Dir. Red 83	0.80%	5.31	7.34	5

Table IV: Color Fastness.

Dye	Washfastness Alteration	Staining	Crocking Test	
			Dry	Wet
Dir. Blue 80	3	34	5	4
Dir. Blue80 *	2-3	2-3	5	2-3
Dir Blue 78	3	3	5	3
Dir. Blue78*	3	2-3	4	3
Dir. Black80	3	2-3	5	4
Dir. Black 80*	2	1	5	4
Dir. Red 83	34	2-3	5	4
Dir. Red 83*	2	2-3	5	3

*0.6% Chitosan Aftertreatment and Redyeing with 0.1 - 0.2% Dye

Kinetics...

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From the plotting of the bound nitrogen versus real curing time (curing time—the time needed to raise the temperature of the fabric in the oven), we can obtain a second order reaction function with no constant item. From which we further found that the crosslinking reaction is a zero order reaction and the inverse crosslinking reaction is a first order reaction (which depends on the bound nitrogen of crosslinking reaction at different curing time.).

This study also determined that the reaction and inverse reaction rate constants for different mixed catalysts are ranked as aluminum sulfate/citric acid>aluminum sulfate/tartaric>aluminum sulfate/acetic acid (almost) at a same curing temperature. However, the rank of the activation energy of the reaction and inverse reaction is aluminum sulfate/citric acid< aluminum sulfate/tartaric<aluminum sulfate/acetic acid.

Additionally, the reaction and inverse reaction rate constants of the various metal compound catalysts are ranked as follows: aluminum sulfate>aluminum chloride>zinc nitrate (almost) at a same level of curing temperature. However, the rank of the activation energy of the reaction and inverse reaction is aluminum sulfate<aluminum chloride<zinc nitrate. The difference between the activation energy of the reaction (ΔE_{a0}) and the activation energy of the inverse reaction (ΔE_{a1}) for mixed catalysts is lower than that for the metal compound catalysts. □ □

References

- (1) R. J. Berni, R. R. Benerito, E. E. Coll, and E. J., Textile Res. J. vol.44, 47-55(1974).
- (2) R. J. Berni, R. M. Reinhardt, and R. R. Benerito, Textile Res. J. vol.38, 1072-1073 (1968).
- (3) C. C. Chen, Textile Res. J. vol.59, 337-342(1989).
- (4) C. C. Chen, Textile Res. J. vol.60, 669-672(1990).
- (5) E. J. Gonzales, R. R. Benerito, and R. J. Berni, Textile Res. J. vol.36, 565-571(1966).
- (6) E. J. Gonzales, R. R. Benerito, and R. J. Berni, Textile Res. J. vol.36, 571-578(1966).
- (7) A. G. Jr. Pierce, R. M. Reinhardt, and R. M. H. Kullman, Textile Res. J. vol.45, 420-428(1976).
- (8) T. H. Sheen, S. M. Li, J. H. Wu, and C. C. Chen, Textile Res. J. vol.63, 357-361 (1993).
- (9) S. Wolfram, "Mathematics-A System or Doing Mathematics by Computer," (2nd Edition) Addison-Wesley Publishing Company, New York, 1991.
- (10) H. M. Ziifle, R. J. Benerito, E. J. Gonzale, and R. J. Berni, Textile R. J. vol.38, 925-930(1968).
- (11) H. M. Ziifle, R. J. Berni, and R. R. Benerito, J. Appl. Ploym. Sci. vol.7, 1014-1062(1963).

News

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home the point that *real* jeans are made only of US cotton.

The "Get Real" jeans promotion is being conducted by Cotton Council International (CCI), the export promotion division of the Memphis-based National Cotton Council of America.

Several of Asia's biggest music superstars-Leon Lai. Gary V., Kana and Da Bubblegum Bros-are making promotional appearances and being featured in advertising this spring and summer.

Integrated advertising, public relations and cross-merchandising tie-ins at retail with Epic/SONY in Japan and Polygram Records elsewhere in Asia are enabling CCI to increase media exposure for the project and tap into high-visibility communications channels such as record store displays, karaoke lounges and CD and cassette tape packaging.

A total of 31 Cotton USA-licensed

jeanswear brands are participating in the promotion, including market leaders such as Lee, Wrangler, Pepe, EDWIN, Big John, Bobson and Apple/Texwood. The promotion extends to 2,360 chain stores, jeans boutiques and department store counters in the major metropolitan cities across the five countries.

"This promotion alone is expected to generate sales of two million pairs of jeans," said Allen Rerhaar, CCI's executive director, Washington, DC. "That's the equivalent of 8,300 bales of US cotton because roughly two pounds of cotton is used to make a pair of jeans. US cotton producers need that kind of consumption overseas because they are having to rely more and more on the world marketplace to remain profitable."

CCI promotes US raw cotton and value-added cotton apparel and other products. The Washington, DC-based organization conducts market-building activities in more than 50 countries worldwide, including the Far East, Europe and South America.