THE COVERING OF NEPS AND IMMATURE COTTON ON KNIT AND WOVEN FABRICS BY SIMPLE CHEMICAL PRETREATMENT

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Abstract

Neps do not take up dye at the same rate as normal fabric. This dyeing technique improves the uptake of dye in neps as well as increasing the depth of the shade of dye.

Introduction

Neps are hopelessly entangled fibers. Generally, cottons that are classed as immature are more susceptible than mature fibers to the formation of neps during fiber preparation and yarn processing. Neps in cotton yarn and fabric have always posed problems to the textile dyer. Immature cotton fiber has poor cell wall development and when that fiber gets tangled it forms a nep. The neps in dyed fabric absorb less dye and appear much lighter in shade compared to the rest of the fibers in the fabric. Hence, they appear as "white" specks on the surface of the fabric. While they exist even when fabrics are dyed with lighter colors, they are particularly noticeable on fabrics dyed with dark colors such as black, navy, brown and green.

In the past, better fiber selection methods and modifications of machine settings during textile processing were practiced to avoid the formation of neps. Mercerization of yarn, a caustic soda chemical treatment, was found to be partially effective in covering neps. Some dyes have also been developed to cover neps, however they are available in only a limited range of colors. A study conducted by Mehta (1) reported a chitosan pretreatment method to successfully cover fabric neppiness prior to dyeing with direct dyes. (Chitosan is a natural cationic product made from the exoskeletons of crustaceans, a by-product of the shellfish industry). However, when the chitosan-treated fabrics were dyed with direct dyes, the wash fastness properties of these fabrics were found to be poor. It is a well established fact that the washfastness property of fabrics dyed with reactive dyes is superior to that of fabrics dyed with direct dyes. Therefore, this study evaluates the washfastness property of reactive dyed fabrics under a somewhat modified chitosan application process.

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Chitosan Application Procedures

For this study, both woven and knitted cotton fabrics were used. Fabrics used were of 100% cotton and were scoured and bleached before being treated with the chitosan. The chitosan treatment was done before the reactive dyeing procedure. Two distinct methods were used to apply the chitosan.

1. Pad-Batch Method: The bath was set with 0.5 grams/liter of non-ionic wetting agent and 15 grams/liter of chitosan. The amount of chitosan used was determined after several laboratory trials. The fabric was padded at 90% pickup, rolled and batched for four hours. After batching, the fabric was padded in a bath with 10 grams/liter of soda ash and dried. Then the chitosan-treated fabric was dyed with reactive dyes.

2. Exhaust Method: The bath was set with a goods-to-liquor ratio of 1:25, to which 0.5% of non-ionic wetting agent and 0.8% of low viscosity chitosan on the weight of the fabric were added. The temperature of the bath was raised to 60ⁱ C and 10% of sodium sulfate was added. The fabric was treated for 30 minutes and the treatment bath was drained. A fresh bath was set with 0.5% soda ash, and the fabric was treated in cold bath for 20 minutes while maintaining the pH at 6.5. After the chitosan treatment, the fabric was dyed directly with reactive dyes without rinsing.

Reactive Dyeing Procedures

For both woven and knitted fabrics four reactive dyes were used: Reactive Yellow 168 (RY168), Reactive Red 235 (RR235), Reactive Blue 235 (RB235), and Reactive Black 5 (RBL5). The chitosan treated fabrics as well as control fabrics were dyed using the following methods:

1. Pad-Batch Dyeing Method: The pad bath was prepared with 0.5 grams/liter of non-ionic wetting agent, 20 grams/liter of soda ash, and 20 grams/liter of the reactive dye. Both chitosan-treated and untreated fabrics were padded at 90% pickup, and batched for 24 hours. Then the fabrics were rinsed and boiled off at 85ⁱ C for 10 minutes, rinsed again, and dried.

2. Exhaust Dyeing Method: The dyebath was prepared with 0.5% of non-ionic wetting agent, 60 grams/liter of sodium sulfate, and 2% of the reactive dye. Both chitosan-treated and untreated fabrics were treated at 60ⁱ C for 30 minutes, and 8 grams/liter of soda ash was added. The treatment was continued for 60 more minutes. Then the fabrics were rinsed and boiled off at 85ⁱ C for 10 minutes, rinsed again, and dried.

Tests

Tests performed included the following:
CIE (Commission International de l'Eclairage) Lab color difference at equal apparent strength of the dyed fabrics - determined by using Illuminant D 65 and a viewing angle of 10° with a Macbeth Color-Eye 3000 Spectro photometer.

Colorfastness to washing - evaluated by AATCC Test Method 61-1993; Wash Method 2A was used for reactive dyes.

Colorfastness to dry and wet crocking - measured with a rotary crockmeter using AATCC 116-1989 test method.

Lightfastness - measured at 20 and 40 hours of exposure according to AATCC Test Method 61-1989 using an Atlas Sunchex air-cooled Xenon-Arc Lamp; for calibration, used blue wool lightfastness standard L-4 for 20 AATCC fading unit equivalents.

Results

Results of the color difference values obtained on the chitosan pretreated and reactive dyed fabrics for the above tests is summarized in tables 1 and 2 . Reactive dyed fabrics without the chitosan pretreatment were used as control fabrics. Table 1 shows the color difference results of fabrics dyed with Pad-Bath Method and Table 2 shows the color difference results of fabrics dyed using Exhaust Method. From these tables, the DE value, which gives the total color difference, indicates that in all cases the chitosan treatment increased the shade of the dyed fabric. The Macbeth Spectrophotometer ratings also supported the DE values, which indicated about 4 to 69% increase in the strength.

The colorfastness properties to washing, crocking and light are shown in tables 3 and 4. Table 3 shows the results of fabrics dyed with Pad-Bath Method and table 4 shows the results of fabrics dyed using Exhaust Method. From these results it is evident that the chitosan pretreated fabrics demonstrated excellent colorfastness properties to washing, crocking, and light.

Conclusions

It has been demonstrated that, for the dyes used in this study, the chitosan pretreatment had:
1. Significant and desirable effects on the color properties.
2. Noticeable change in nep coverage.
3. Improved fabric appearance.

It is evident from these results that a full range of medium to dark shades may be produced on cotton fabrics containing neps. Thus, it is possible to simultaneously improve the colorfastness properties, as well as cover the neps.

Reference

(1) Mehta, R.D., “An Improved Process for Nep Coverage in Dyeing Cotton”. American Dyestuff Reporter, Sept., 1991.

Table 1: Color Difference Values and Color Strength

	DL	DA	DB	DE	Strength
RY168	-1.79	3.53	0.10	3.96	13.5%
RR235	-6.15	0.56	4.84	7.85	69.0%
RB235	-3.26	1.77	1.60	4.04	20.0%
RBL5	-2.05	2.47	2.49	4.06	11.0%

Table 2: Color Difference Values and Color Strength

	DL	DA	DB	DE	Strength
RY168	-2.24	3.29	-1.33	4.20	11.0%
RR235	-5.60	1.68	3.04	6.59	64.0%
RB235	-1.19	1.14	1.20	2.04	04.0%
RBL5	-3.17	2.86	2.48	494	20.0%

Table 3: Dye Performance of Fabrics

	Washfastness	Crocking		Lightfastness
	Alteration	Dry	Wet	20 Hours
RY168 Untreated	5	5	4.5	4.5
RY168 Treated	5	4.5	4	4.5
RR235 Untreated	4	4	3.5	4
RR235 Treated	5	5	3	4.5
RB235 Untreated	4.5	3.5	3.5	5
RB235 Treated	5	4	3	5
RBL5 Untreated	5	5	4	4
RBL5 Treated	5	4	2.5	3

Table 4: Dye Performance of Fabrics

	Washfastness	Crocking		Lightfastness
	Alteration	Dry	Wet	20 Hours
RY168 Untreated	5	4	4	5
RY168 Treated	5	3.5	3.5	5
RR235 Untreated	5	4	3.5	4.5
RR235 Treated	5	3	3	4
RB235 Untreated	5	3.5	3.5	5
RB235 Treated	5	3	3	5
RBL5 Untreated	5	3.5	4	4.5
RBL5 Treated	5	5	3	3.5