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To Study and Analysis of Improving Wrinkle Resistance of Cotton Fabrics Using Resin Finishing and Their Cheracteristics

Eshetu Solomon, Abreha Bayrau and K. A. Thakore
Federal Tvet Institute Department of Textile Technology Addis Ababa, Ethiopia

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ABSTRACT; Cotton is one of the most commonly used fibers for textiles, as most apparels are made of cotton. However, cotton fabric normally has shrinkage and wrinkling problems, degrading its aesthetic value. Resin finish is applied to improve the wrinkle problem of cotton fabric. Conventionally, cotton is dyed first, then finished with a cross linking agent (or finished after bleaching to be sold in white) to obtain the desired color and crease recovery properties. If the two steps could be merged, significant savings in energy, water, labor, and machine occupation time would be achieved. Since the 1950s, many researchers have attempted to combine dyeing and resin finishing processes into one step. However, a commercially viable combined dyeing and resin finishing process has not been reported. The main challenge has been producing treated fabrics that have deep shades, good fastness properties, and excellent crease recovery performance simultaneously. In the present research, combined dyeing and resin finishing of cotton fabric was conducted using monochlorotriazine reactive dyes and citric acid as cross-linking agent by pad-dry-cure method. To investigate the dye concentration, citric acid, alkali, catalyst concentration and curing temperature were varied. The method afforded medium shades (K/S ≈6). The strength retention and pilling resistance of the combined treated fabric compared to only dyed fabric does not show significant difference. Fastness to washing and crocking was as good as that from a conventional reactive dyeing method and fabric crease recovery properties show better improvement compared to only dye and bleached (untreated) fabrics.

KEY WORDS: cotton, dyeing, resin finishing and reactive dyes.

I. INTRODUCTION:

Cotton is nearly pure cellulose, which is the most abundant organic polymer with the formula $(C_6H_{10}O_5)_n$ on earth and it is a polysaccharide consisting of a linear chain of several hundred to over ten thousand $\beta(1\rightarrow4)$ linked D-glucose units. In textile industry, cotton is still one of the most preferred fibers because of its own natural and distinctive properties while rising sale of synthetic fibers, but have serious disadvantages such as tendency to crease formation and poor crease recovery. Crease resistance is imparted to cellulosic fibers by restricting the slippage of molecular chains through cross linking. Crease resistant finishing resins include: synthetic resins, melamine, epoxy, urea, formaldehyde, vinyl, oxidized starches, thermoplastic resins, linear reactants, and chloral-alkyl compound. The same finding was obtained by L. K.Yam, Eunice (2012). Amino formaldehyde resins such as dimethylol dihydroxyethylene urea (DMDHEU) have long been used for the crease resistant finishing of cotton, but they have one major disadvantage: formaldehyde release, which has an impact on human health and the environment [20]. However, there are some short comings of the treatment, such as stiffening the fabric, reducing tensile and tear strength, reducing absorbency qualities, abrasion resistance, and elongation factors of the fabric, producing non-removable creases when altering fabric.

Each one of the commercially important species contains many different varieties developed through breeding programs to produce cottons with continually improving properties (e.g., faster maturing, increased yields, and improved insect and disease resistance) and fibers with greater length, strength, and uniformity. The same results were studied by M. Lewin (2007). Cotton fiber is hydrophilic that easily absorb water, resulting hydrogen bonds breakages and shrinkage. That's why 100% cotton tends to has more wrinkle and shrinkage, especially after laundering the same finding was obtained by L. K.Yam.

Cotton is a cellulosic fiber which is the most important textile fiber because it has fairly good strength, softness, moisture absorbency, and pliability the same research was done by N. Ristić, I. Ristić, (*2012*),The structure of cotton fiber can be viewed in two directions: longitudinal and cross-sectional. The longitudinal view reveals that the fiber has a ribbon-like structure with twists, called convolutions, at irregular intervals along the fiber. The primary wall is tough and contains wax, protein, and pertinacious substances as well as cellulose. It acts as a protective layer, forming the shell of the fiber during its early days of growth inside the boll. The secondary wall is almost pure cellulose and represents about 90 percent of the total fiber weight the relevant research was done by S. Gordon and Y-L. Hsieh (2007), Cellulose in the cotton fiber's secondary all is arranged in fibrils that are packed alongside each other. The secondary wall provides flexibility. The lumen provides liquid nutrients and protoplasm while the plant is growing. Cotton fiber is almost 100 percent cellulose. Fiber strength depends on structural organization of the cellulose chains while fiber's physical properties depend on molecular weight of the polymer. Moreover, molecular weight distribution predicts the polymer performance. The higher the molecular weight and the narrowness of molecular weight distribution, higher is the strength of the polymer the same finding was obtained S. Gordon and Y-L. Hsieh (2007),

Cotton fiber length ranges from 1to 6centimeters, but normally is 2.2to 3.3cm. The tensile strength and dimensional stability is good but resiliency is low. Raw cotton fiber has high moisture regain up to 8.5% and resistance alkali. However, the resistance to acids, sunlight, mildew and insects is poor; hence the fibers get damaged easily. It is flammable and can be burned easily the same results were studied by D. Schindler and P. J. Hauser (2004).The bonding allows molecules to draw close to each other so as to increase fiber strength. Besides, it influences in moisture absorption to responsible for comfort. Glucose units of hydroxyl group responsible for chemical reactivity such as moisture, dyes and many finishes. Chemicals attack the oxygen atom between or within the two ring units breaking the molecule chain of the cellulose. the same finding was obtained by F. Asim, N. Kausar, M. Mahmood (2013),

The most useful dyes are found to be those that can adopt an elongated and coplanar configuration in which the number of hydrogen bonds is maximized and the cellulose crystal structure is not disrupted. Reactive dyes are the most popular application class used to dye cellulose fibers. It forms covalent bond with cellulose. Due to the strong primary bonding between dyes and fibers, it possesses high level of fastness the same finding was obtained by F. Asim, N. Kausar, M. Mahmood (2013).The Resin finishing can be defined as those chemicals used to improve the properties and performance of washable fabrics. Apparel fabrics, from a historically perspective were made from natural fibers, namely wool, silk and cotton. After they have been washed and dried, they must be ironed otherwise they will look very rumpled the outcome of the results done by C. Tomasino(1992), Resin finished fabrics exhibit a significant strength loss, tear strength and fabric pilling along with a wrinkle recovery angle increase. The loss of fabric strength after resin finishing is caused by cross linking cellulose chains, which restricts molecular mobility in response to forces (stress). The strength of finished fabric improved when the crosslink's were removed. The same finding was obtained by Khatri , M. H. Peerzada , R. A. Jhatial (2011), Besides cross linking, the acidic conditions of resin finishing may contribute to fabric strength loss, especially in the case of Polycarboxylic acid finishing process.

II. METHODOLOGY AND EXPERIMENTS

2.1 Materials

Fabric

A bleached woven 100% cotton fabric was used in this study. The fabric of 150 gram/m^2 weight having plain weave of 68 epi × 52 ppi (warp × weft) construction was used. The weft yarn was cotton count of32 and the warp yarn cotton count of 32.

Dyes and Chemicals Used

The reactive dye used in this study was monochlorotriazine (MCT). This is because literatures show MCT dyes give better result during combined process (7) and we checked also in our pilot experiment MCT dyes give better result compared to ramazol and direct dyes. Tricarboxylic acid (citric acid) was used as a cross linking (crease resistant) agent. sodium hydrogen carbonate ($NaHCO_3$) was used as alkalis for dye fixation and sodium di-hydrogen phosphate (NaH_2PO_4) was used to catalyze the esterification of citric acid and hydroxyl groups of adjacent cellulose molecules in cotton fiber for cross-linking process.

Equipment

Padder

A horizontal padder from Mathis-Switzerland was used for applying dyes and finishes to cotton fabric. The air pressure of the padder was set at approximately 5.5 atmospheres for controlling fabric wet pick up at 80%. The padding fabric speed was set for 3.0 m/min. Tricarboxylic acid (citric acid) was used as a cross linking (crease resistant) agent. sodium hydrogen

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carbonate ($NaHCO_3$) was used as alkalis for dye fixation and sodium di-hydrogen phosphate (NaH_2PO_4) was used to catalyze the esterification of citric acid and hydroxyl groups of adjacent cellulose molecules in cotton fiber for cross-linking process.

Mini-Drier

A mini-drier was used for drying and curing the fabric after padding. The temperature for drying was 80°C for 3 min; the curing temperature was varied from 150 to 200 ^{O}C in order to study the fixation of cross-linking agent and therefore resultant effect on crease recovery and the physical properties of treated fabric.

Recipes and Formulations

The formulations used were prepared by systematic and randomly selecting the concentration of dye and chemicals.

III. RESULTS AND DISCUSSIONS

Dyeing By Pad-Dry-Cure Method

In order to combine the finish application to impart wrinkle resistance property to cotton fabric with coloration, the fabric was treated with a mixture of dye and cross linking chemicals and fixed by using the conventional method of pad-dry-cure using a suitable catalyst. Initial investigations on selection of the class of dyes suggested that MCT dyes are more suitable for combined application than among Di-cholorotriazine, vinyl sulphone based reactive dyes and direct dyes. For comparison, the fabric was only dyed using a conventional pad dyeing process. The table shows the properties of fabric dyed only. This sample was used as *control* for the evaluation of physical and mechanical properties combined dyed and resin finished fabrics samples obtained by varying different variables. The physical and mechanical properties of combined dyed and resin finished fabric were tested according to the standard test methods as mentioned above are reported in the tables below (4.3 to 4.7). The tables show the test results of treated fabrics such as color strength (K/S), dry crease recovery angle (DCRA), tensile strength, tears strength, pilling effect and fastness (wash fastness and crock fastness) by varying the dye bath variables one by one. The same results were obtained by W. D. Schindler and P. J. Hauser (2004),

Table 4.1: Bleached cotton fabric properties

Crease Recovery Angle (^{0})	*Tensile strength (N)*		*Tear Strength (N)*	
	Warp	Weft	Warp	Weft
107	138	87	15.85	15.53

Table 4.2: Properties of fabric dyed only with MCT

K/S	*Tensile (N)*		*Tear (N)*		*Pilling*	*DCRA(^{0})*	*Fastness Properties(rating scale)*					
							Wash		Crock			
									Dry		**Wet**	
	Warp	Weft	Warp	Weft			Color change	stain	Color change	Stain	Color change	Stain
7.9249	133	82	14.76	14.03	4-5	125	4-5	4-5	4-5	4-5	4	4

N = newton, DCRA = dry crease recovery angle

Table shows properties for fabrics dyed with varying dye concentration while the others were maintained constant as indicated in above. The test results show that the color yield (K/S) increased with increasing dye concentration in bath from 9 to 18 g/L. The percentage retention of the color yield of combined dyed and resin finished fabric by varying dye concentration was determined by comparing with the fabric dyed only resulted in 27.19%, 56.1%, 66.56% and 67.72% respectively for the dye concentration increases from 9 , 12, 15 and 18g/L. These data suggest that more than 15g/L dye concentration does not increase the color yield significantly under the conditions used. The same findings was obtained by C. Q.Yaug (2012),

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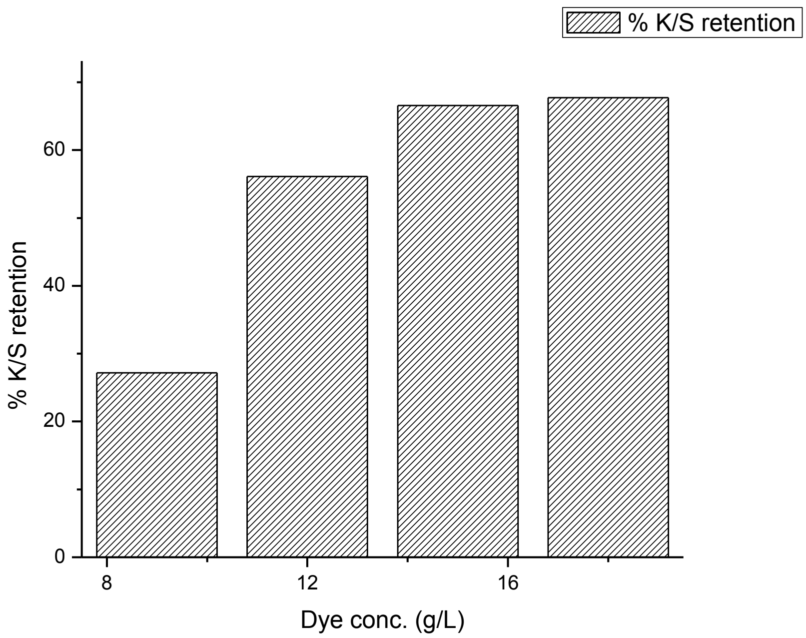

Figure 4.1: %K/S retention as a function of dye concentration

The percent K/Sretention of the fabrics dyed by combined dyeing and resin finishing by varying the citric acid concentration while the other variables were maintained constant in relative to the only dyed fabric was 80.86%, 66.56%, 17.56%, 11.16% respectively for the citric acid concentration in the dye bath i15, 25, 35 and 45 g/L. These data shows that as citric acid concentration above 25 g/L in the bath K/S value of the fabric badly affected. The same research was conducted by and the results were obtained by C. Berry (2013),

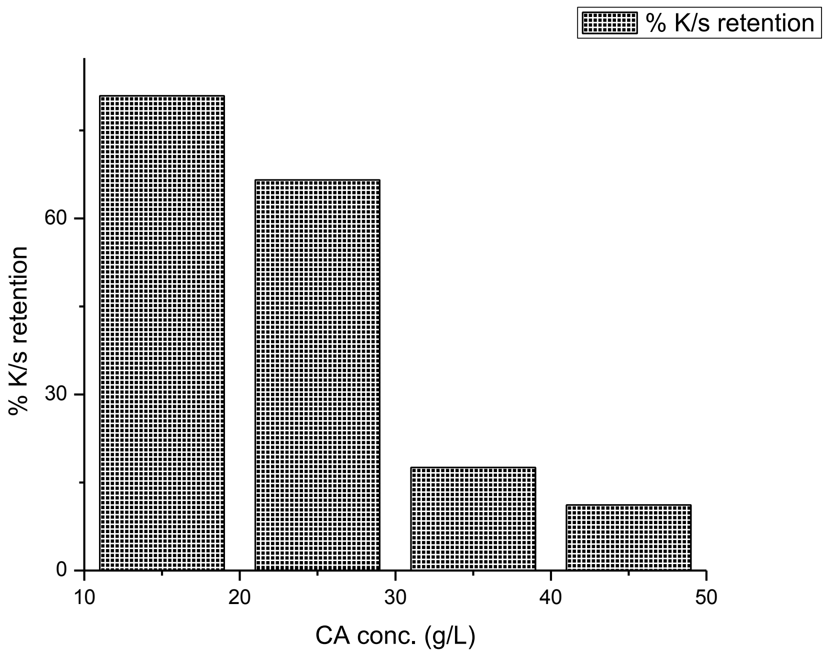

Figure 4.2: %K/S retention as function of citric acid concentration

20g/L and 30g/L, K/S value of the fabric was 1.17 and 2.66 respectively for these two concentrations resulting in very light shade and lower K/S retention as when compared with only dyed(control)fabric. However, the color yield increase significantly as the alkali concentration was increased beyond 30g/L to 40 and 50g/L. A comparison with control fabric showed percent retention of shade depth compared to only dyed fabric were 14.75%, 33.62%, 66.56%, 72.88% respectively as the alkali concentration was increased from 20 g/L to 50 g/L in the treatment bath as the other variables maintained constant. the same finding was measured by DP Chattopadhyay, DN Sharma(1999),

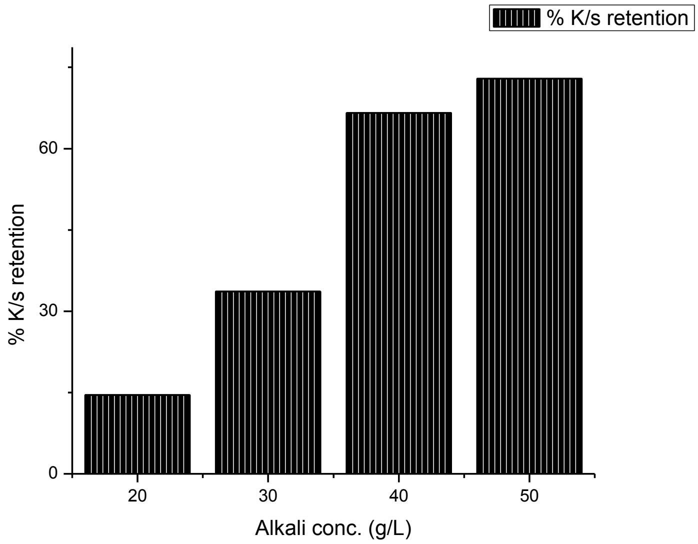

Figure 4.3: %K/S retention as a function of alkali concentration

IV. CONCLUSION

In the present study two processes namely dyeing and resin finishing of cotton fabric were combined and carried out in single stage in order to conserve energy, process time and to gain other associated benefits. It becomes essential that the color yield and dyeing properties such as fastness to various agencies are not compromised while achieving the objective of an acceptable wrinkle resistance finish. As the dye concentration in the bath increases the color yield (K/S value) increases and show better strength retention, but the crease recovery angle decreases .Maintaining the other variables constant and increasing cross-linking agent (citric acid) concentration in the dye bath, crease recovery increases, but the color yield and mechanical properties decreases. As the alkali concentration increases both the color yield and crease recovery increases, but at alkali concentrations greater than 50 g/l the crease recovery does not show slight decline. Alkali concentration does not have significant effect on mechanical properties of combined dyed and finished fabrics. the same conclusion derived by Ming Lu(2010) and, M. Orhan (2013).

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