NOTE

Improving Soil-Release Properties of Easy-Care Cotton via Chemical Modification

Chemical modification of cotton with the aim of making it better than in its natural state so as to counter the intensive competition of synthetic fibers has been extensively studied. This subject has been recently reviewed.[1] However, to our knowledge, not much work has yet been published on making use of chemical modification of cotton prior to durable-press finishing so as to deal with one of the most serious problems associated with such type of finishing, namely the greater susceptibility of easy-care cottons to soiling and their lower levels of soil removal.[2,3]

The present work was undertaken with a view of studying the effect of introducing carboxymethyl, cyanoethyl, and cyanoethyl together with carboxyethyl groups in cotton cellulose prior to durable-press finishing on the soil-release properties of easy-care cotton.

Partially carboxymethylated cotton (PCMC) was prepared[4] by padding the cotton fabric (bleached poplin) in an aqueous solution of monochloroacetic acid (4*N*), followed by padding with sodium hydroxide solution (10*N*), and then storing in a polyethylene cover at ambient conditions for 16 hr. At the end of this procedure, the fabric was thoroughly washed, neutralized with HCl (1%), washed again, and finally dried at room temperature. A control sample was prepared under similar conditions, but treatment with monochloroacetic acid was omitted.

Cyanoethylated cotton (CEC) was prepared according to a method described elsewhere[5] by impregnating the fabric in an aqueous solution of sodium hydroxide (5%, w/v) for 15 min followed by squeezing to ca. 100% wet pickup. After being batched for 10 min the alkali-treated fabric was treated with acrylonitrile and stored in a polyethylene cover for 18 hr. The fabric was then washed and dried as above. A control sample for this modified cotton was prepared under similar conditions, except that no treatment with acrylonitrile was carried out.

Cotton bearing cyanoethyl along with carboxyethyl groups (HCEC) was obtained by partial hydrolysis of cyanoethylated cotton. The latter was padded with aqueous sodium hydroxide (10%) to a wet pickup of ca. 100%, followed by storing at room temperature for 8 hr. The fabric was then washed and dried as usual.

Easy-care finishing was performed by padding the fabric in a solution containing 120 g/l. dimethyloldihydroxyethylene urea (DMDEU) and 18 g/l. magnesium chloride hexahydrate to a wet pickup of ca. 80%. The fabric was then dried at 100°C for 5 min, cured at 160°C for 3 min, thoroughly washed, and finally dried at ambient conditions.

The carboxyl content of the said modified cottons was determined according to a reported method,[6] nitrogen content by the Kjeldahl method, and moisture regain by a standard method. Evaluation of soil-release properties (the release of oily soil) was carried out as per Kissa's method.[7] Conditioned crease recovery was monitored using Wrinkle Recovery Tester, T. J. Edwards Inc., Boston, and tensile strength on an automatic tensile strength testing machine, type FMGW 500 (VEB Thüringer-Industriwerk Rauenstein), at 25°C and 65% relative humidity.

Table I shows the soil-release properties, as well as some of the textile properties of the modified, alkali-treated and unmodified cotton fabrics after treatment with DMDEU. It will be seen that partial carboxymethylation of cotton prior to the finishing treatment imparts soil-release properties to easy-care cotton. The same holds good for partially hydrolyzed cyanoethylated cotton. Efficiencies of soil removal of 95 and 82% are obtained with these two substrates, respectively. This contrasts with a soil-removal efficiency of 72% for easy-care cotton obtained from unmodified cotton. On the other hand, cyanoethylated cotton as well as alkali-treated cottons (controls) show slight improvement in soil-removal efficiency, indicating that cyanoethylation or alkali treatment of cotton prior to easy-care finishing did not exert a significant effect on soil-release properties.

The significant enhancement in the efficiency of soil removal observed with partially carboxymethylated cotton and partially hydrolyzed cyanoethylated cotton could be associated with the hydrophilicity of these substrates, as evidenced by their greater moisture regain as compared with other substrates studied (Table I). Previous reports[8] emphasized that in hydrophilic fabrics, water penetrates into crevices and intrayarn and interyarn spaces to wash away trapped soil particles.

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TABLE I
Effect of Chemical Modification of Cotton on Soil-Release and Textile Properties of Easy-Care Cotton

Property	Substrate Crosslinked with DMDEU					
	Cotton	Cotton treated with 10*N* NaOH	Cotton treated with 5% NaOH	Partially carboxymethylated cotton	Cyanoethylated cotton	Partially hydrolyzed cyanoethylated cotton
M.E.-COOH/100 g cellulose[a]	—	3.42	—	41.05	0.30	5.53
Nitrogen content, %	—	—	—	—	3.14	1.60
Soil release, %	72	77	76	95	74	82
Moisture regain, %	5.02	6.03	5.73	11.53	4.33	6.80
Crease recovery, warp + weft, deg	275	290	270	295	270	275
Tensile strength (warp), kg	30.5	26.7	35.8	26.9	40.5	36.5
Elongation at break (warp), %	5.5	10.0	9.5	13.0	5.0	8.0

[a] M.E. = milliequivalent.

Besides this, the charge developed on the modified cotton is greatly reduced, thereby minimizing attraction of oppositely charged soil.

As far as the textile properties are concerned (Table I), crosslinked cyanoethylated cotton showed the highest tensile strength, whereas crosslinked partially carboxymethylated cotton showed the lowest. The strength of the crosslinked substrates follows the following order: cyanoethylated cotton > partially hydrolyzed cyanoethylated cotton ≥ cotton treated with 5% NaOH > unmodified cotton > cotton treated with 10*N* NaOH ≥ partially carboxymethylated cotton. The elongation at break follows the opposite order, wherein crosslinked partially carboxymethylated cotton, acquired the highest elongation at break and crosslinked cyanoethylated cotton the lowest.

The lower strength observed with partially carboxymethylated cotton and its control could be associated with (1) the relatively high crease recovery; (2) increased accessibility of the substrate owing to the high concentration of caustic soda used in the treatment, (3) decreased orientation, since the modification treatment was carried out tensionless; and (4) the relatively high susceptibility of the accessible portion to degradation by the crosslinking catalyst, particularly during curing.

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