

Nonformaldehyde Crosslinking Agents For Cotton And Polyester/Cotton Blend Fabrics

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Abstract

Two commercial nonformaldehyde crosslinking agents, Natrium-NFO and Natrium-CRA were applied on millscoured and bleached cotton and 67/33 polyester/cotton blend fabrics by the pad-dry-cure (at different temperatures) technique. Wrinkle recovery angle (warp + filling) (WRA), tensile strength, tear strength, whiteness index and yellowness index of the treated and untreated fabrics were determined. Very high WRAs were obtained, especially on the blend fabric when Natrium-CRA was applied.

Introduction

The conventional cotton/viscose rayon crosslinking agents used to

produce easy-care and durable press properties in these fabrics are generally based on formaldehyde. In view of the general awareness of the hazardous nature of formaldehyde in the workplace during the application to the fabrics and of formaldehyde release from the finished fabrics at the wholesalers', retailers' and the consumers' end, it is both preferable and essential to have these properties, by using non-formaldehyde cross-linking agents. Excellent reviews¹⁻⁵ have appeared dealing with the use of various products acting as safe crosslinking agents.

The present work deals with two commercial product – Natrium-NFO

and Natrium-CRA (both of Supertex (India) Corporation, Bombay), not based on the maldehyde and applied on 100% cotton fabric and 67/33 polyester/cotton blend fabric. The treated fabrics were tested for wrinkle recovery angles (WRA) tensile strength, tear strength, whiteness index and yellowness index.

Experimental Methods

Mill desized, scoured and bleached plain weave 100% cotton fabric and 67/33 polyester/cotton blend suiting fabric were selected for the study.

Natrium-NFO and Natrium-CRA were applied on 100% cotton and 67/33 polyester/cotton blend fabrics by pad-dry-cure technique. The

crosslinking agent concentration was varied (80-150 gpl) and curing was done at 140°-170°C for 1 min. No catalyst was used in the pad liquor.

Wrinkle recovery angle (both warp and filling) of the treated fabric was determined on a Crease Recovery Tester of Hungarian make.

Tensile strength was measured on Kamal Metal Industries (Ahmedabad, India) tester and tear strength on an Elmendorf testing machine.

Whiteness index and yellowness index were determined by using Hunter's equations.

Results and Discussion

Action of Natrium-NFO on 100% cotton fabric

Natrium-NFO was applied on 100% cotton fabric by pad-dry-cure technique by varying the crosslinking agent concentration (80-150gpl) and curing at 140°-170°C for 1 min. The various properties of the treated fabric, as described, were determined and are given in Table I. Similarly, Natrium-CRA was applied on 100% cotton fabric and the corresponding results are given in Table II.

It is seen from Table I that at all curing temperatures, the WRA of the treated fabrics increased progressively as the crosslinking agent concentration increased. Further, at the same crosslinking

Table I : Properties of Natrium-NFO treated 100% cotton fabrics.

A) At 140°C for 1 minute								
Sr. No.	Sample Properties	Crease Recovery Angle			Tensile Strength		Whiteness Index	Yellowness Index
		WP	WT	Total	Tensile Weft	Tear Weft		
1	Control	73	75	148	28.8	632	82.85	12.02
2	Conc'n 80 g/l	80	80	160	28.5	760	81.49	12.76
3	Conc'n 100 g/l	85	80	165	30.6	704	81.56	12.32
4	Conc'n 120 g/l	90	80	170	30.8	684	82.49	11.71
5	Conc'n 150 g/l	95	85	180	30.0	592	81.57	12.65

B) at 150°C for 1 minute								
1	Control	75	76	151	31.4	656	79.67	13.72
2	Conc'n 80 g/l	84	82	166	28.3	704	81.20	12.86
3	Conc'n 100 g/l	87	83	170	30.8	680	80.41	13.36
4	Conc'n 120 g/l	95	85	180	29.4	640	81.66	12.50
5	Conc'n 150 g/l	98	85	183	29.0	560	79.93	13.66

C) At 160°C for 1 minute								
1	Control	78	82	160	30.1	672	81.38	12.87
2	Conc'n 80 g/l	86	86	172	26.6	680	78.36	14.41
3	Conc'n 100 g/l	92	85	177	28.8	664	81.93	12.45
4	Conc'n 120 g/l	95	95	195	29.6	604	79.37	13.66
5	Conc'n 150 g/l	100	90	190	28.6	560	79.98	13.55

D) At 170°C for 1 minute								
1	Control	82	88	170	29.7	624	79.23	14.06
2	Conc'n 80 g/l	90	90	180	30.8	704	80.07	13.45
3	Conc'n 100 g/l	96	85	181	28.0	648	75.55	15.39
4	Conc'n 120 g/l	98	95	193	29.0	604	82.02	11.91
5	Conc'n 150 g/l	100	95	195	26.8	552	80.68	13.19

agent concentration, WRA in creased with the curing temperature. It is seen that the tensile strength retention after curing is above 90% of the original. In the case of tear strength, the strength retention is between 85% and 90%. In both cases, the strength losses are higher for the higher curing temperature.

The whiteness index of all the treated fabrics is comparable, irrespective of the crosslinking agent concentration and the curing temperature. There is practically no increase in the yellowness index of the treated fabric when the crosslinking agent and the temperature of curing are varied.

The results given in Table II indicate that similar trend is seen as in Table I. However, the improvement in WRA after treating with Natrium-CRA is much more than that in the case of Natrium-NFO, at all crosslinking agent concentrations and curing temperatures studied. On the other hand, the tensile strength losses of around 20% are observed.

In general, the improvements in WRA are realized at the cost of tensile and tear strength. However, these losses are within the limits prescribed for durable press treatments using, for example, the conventional DMDHEU, which is based on formaldehyde.

The whiteness index of all the treated fabrics indicate that there is a significant change in the W.I. as the curing temperature increases. With the increase in concentration of the crosslinking agent at a lower temperature there is not much change. However, at higher temperatures, with an increase in concentration of the crosslinking agent there is a substantial change in the whiteness

Table II : Properties of Natrium-CRA treated 100% cotton fabrics.

A) At 140°C for 1 minute								
Sr. No.	Sample Properties	Crease Recovery Angle			Tensile Strength		Whiteness Index	Yellowness Index
		WP	WT	Total	Tensile Weft	Tear Weft		
6	Control	75	78	153	28.7	544	87.99	9.68
7	Conc'n 80 g/l	80	75	155	30.7	720	85.45	10.91
8	Conc'n 100 g/l	92	88	180	26.0	656	78.89	13.71
9	Conc'n 120 g/l	102	98	200	24.1	560	81.23	12.73
10	Conc'n 150 g/l	115	112	227	22.8	560	82.88	12.08

B) at 150°C for 1 minute								
6	Control	80	85	165	30.3	576	87.71	9.99
7	Conc'n 80 g/l	85	83	168	29.5	704	83.49	11.96
8	Conc'n 100 g/l	92	86	178	26.2	640	82.79	12.39
9	Conc'n 120 g/l	103	97	200	26.0	496	82.29	12.36
10	Conc'n 150 g/l	115	114	229	22.8	496	82.04	11.71

C) At 160°C for 1 minute								
6	Control	78	82	160	29.8	568	86.62	10.58
7	Conc'n 80 g/l	88	83	171	28.7	720	76.07	15.82
8	Conc'n 100 g/l	95	90	185	26.0	608	73.34	17.20
9	Conc'n 120 g/l	108	97	205	26.1	480	72.49	17.50
10	Conc'n 150 g/l	118	120	238	24.0	480	70.18	17.80

D) At 170°C for 1 minute								
6	Control	76	86	164	28.0	608	81.16	12.90
7	Conc'n 80 g/l	90	80	170	26.6	672	77.60	15.30
8	Conc'n 100 g/l	95	95	190	26.4	592	72.70	16.20
9	Conc'n 120 g/l	104	96	200	25.5	488	72.46	17.65
10	Conc'n 150 g/l	120	120	240	24.4	480	71.82	16.54

index. The yellowness index exhibits a similar pattern indicated by the white-ness index.

The results for Natrium-CRA when compared with Natrium-NFO show that on application to 100% cotton fabric Natrium-CRA gives much higher wrinkle recovery angle with tolerable loss in tensile strength. The whiteness index and yellowness index are better only at lower temperatures of curing. Particularly, at 150°C and 150 gms/liter concentration, the wrinkle recovery is 229°, which is reasonable, and there is a tolerable change in tensile strength, tear strength, whiteness index and the yellowness index, thereby indicating that the lower the temperature of curing the lesser the yellowing and with an increase in the temperature the wrinkle recovery is higher and the yellowing is higher as well.

Action of Natrium-NFO on 67/33 Polyester/Cotton Suitings

Natrium-NFO was applied on 67/33 polyester/cotton fabric by pad-dry-cure technique by varying the crosslinking agent concentration (80-150 gms/liter) and curing at 140° to 170°C for 1 minute. The various properties of the treated fabric such as wrinkle recovery are given in Table III. Similarly, Natrium-CRA was applied on polyester/cotton fabric and the corresponding results are given in Table IV.

It is seen from Table III that at all curing temperatures, the wrinkle recovery angle of the treated fabric increased progressively as the concentration of the crosslinking agent increased. It is also observed that with the increase in the temperatures of curing, there is no significant change in the wrinkle recovery angle. The wrinkle recovery angle at 150°C with 150 gms/liter is practically similar to the wrinkle recovery angle at 170°C and 150 gms/liter, indicating that there is a plateau on the wrinkle recovery angle which does not increase with the increase in temperature. The whiteness index of the treated fabric is comparable irrespective of the crosslinking agent concentration and the curing temperature, thereby indicating that there is no significant yellowing taking place because of an increase in the concentration of crosslinking agent. Similarly, there is a marginal change in the yellowing of the treated fabric when the crosslinking agent concentration and the temperature of curing are increased.

The results given in Table IV indicate that a similar trend can be

Table III : Properties of Natrium-NFO treated 67/33 Polyester/Cotton blend fabric.

A) At 140°C for 1 minute						
Sr. No.	Sample Properties	Crease *Recovery Angle			Whiteness Index	Yellowness Index
		Warp	Weft	Total		
1	Control	120	111	231	79.46	13.15
2	Conc'n 80 g/l	132	120	252	77.59	14.15
3	Conc'n 100 g/l	130	124	254	78.00	13.68
4	Conc'n 120 g/l	135	122	257	79.47	13.01
5	Conc'n 150 g/l	138	125	263	79.42	12.90

B) At 150°C for minute						
1	Control	122	110	232	77.85	14.20
2	Conc'n 80 g/l	134	120	254	78.16	13.86
3	Conc'n 100 g/l	134	123	257	78.66	13.58
4	Conc'n 120 g/l	137	123	260	79.37	13.18
5	Conc'n 150 g/l	140	127	267	78.79	13.49

C) At 160°C for minute						
1	Control	125	110	235	78.11	13.88
2	Conc'n 80 g/l	134	122	256	76.83	14.44
3	Conc'n 100 g/l	135	124	259	78.08	13.82
4	Conc'n 120 g/l	138	128	266	78.70	13.63
5	Conc'n 150 g/l	142	128	270	77.12	14.38

D) At 170°C for 1 minute						
1	Control	124	112	236	77.52	14.21
2	Conc'n 80 g/l	134	123	257	76.02	14.87
3	Conc'n 100 g/l	137	125	262	77.32	14.37
4	Conc'n 120 g/l	136	127	263	78.80	13.30
5	Conc'n 150 g/l	140	130	270	78.51	13.58

Table IV : Properties of Natrium-CRA treated 67/33 Polyester/Cotton blend fabrics.

A) At 140°C for 1 minute						
Sr. No.	Sample Properties	Crease Recovery Angle			Whiteness Index	Yellowness Index
		Warp	Weft	Total		
6	Control	122	108	230	80.58	12.62
7	Conc'n 80 g/l	118	105	223	77.89	13.64
8	Conc'n 100 g/l	119	120	239	77.08	14.45
9	Conc'n 120 g/l	130	122	252	79.11	13.49
10	Conc'n 150 g/l	140	128	268	77.36	13.97

B) At 150°C for 1 minute						
6	Control	124	110	234	79.60	13.17
7	Conc'n 80 g/l	125	109	234	76.17	14.63
8	Conc'n 100 g/l	130	118	238	75.88	15.00
9	Conc'n 120 g/l	133	124	257	76.57	14.79
10	Conc'n 150 g/l	142	127	269	73.77	15.81

C) At 160°C for 1 minute						
6	Control	123	108	231	78.80	13.58
7	Conc'n 80 g/l	127	110	237	73.61	16.02
8	Conc'n 100 g/l	121	118	239	75.35	15.37
9	Conc'n 120 g/l	135	125	260	76.94	14.60
10	Conc'n 150 g/l	138	125	263	74.31	15.73

D) At 170°C for 1 minute						
6	Control	120	110	230	76.41	14.26
7	Conc'n 80 g/l	128	110	238	73.62	16.13
8	Conc'n 100 g/l	122	116	238	75.73	15.31
9	Conc'n 120 g/l	135	120	255	71.82	17.24
10	Conc'n 150 g/l	140	128	268	74.00	15.84

seen as in Table III. There is not much difference in the wrinkle recovery angle obtained on treatment with Natrium-CRA as compared to Natrium-NFO at all the crosslinking agent concentrations and curing temperatures studied, unlike the observation of 100% cotton (Table I & II). On the contrary, in the case of Natrium-CRA the whiteness index and yellowness index show a significant change as compared to Natrium-NFO. However, these changes in the whiteness index and yellowness index are by themselves within the tolerable limits.

Summary

Excellent results (very high WRAs with tolerable strength losses and with minimum yellowing) are obtained when Natrium-CRA (150 gpl) was applied and cured at 150°C for 1 min, especially on the polyester/cotton blend fabrics. □ □ □

References

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