African Journal of Biotechnology Vol. 7 (6), pp. 821-823, 18 March, 2008
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB07.532
ISSN 1684–5315 © 2008 Academic Journals

Short Communication

Study of chemical and physical behavior cotton fabrics treated by corona discharge after several laundering

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Accepted 26 September, 2007

Cotton fabric because of finishing process has shrinkage behavior after laundering and for improving this problem, chemical agents utilize for anti-shrinkage. This temporary finishing can reduce shrinkage but has many environmental problems. Corona discharge treatment has been used for cotton fabric, other fibers and polymers. This treatment can reduce costs and environmental impacts. In this study, cotton fabric was treated by corona discharge instrument at 2 - 40 passages and fabrics were washed with laundering method. After four times laundering, shrinkage behavior of corona discharge treated fabric as compared with un-treated fabric decrease. After 10 passages of corona discharge treatment, water, dye absorption and shrinkage are modified but after 14 passages, despite of shrinkage improvement, dyeing properties decrease.

Key words: Corona discharge, cotton fabrics, laundering.

INTRODUCTION

Corona treatment consists on the application of an electrical discharge of high voltage (around 10.000 V) through air between two electrodes, using frequencies around 40 kHz, at normal atmospheric temperature and pressure, on dry cotton fabric (Ward et al., 1979). Physical and chemical surface changes in the cotton's structure are noticed after Corona discharge (Pavlath and Slater, 1971). Corona discharge has been proved to be a useful method for improving the polymer surface hydrophilic property, especially in the composite material strength improvement (Riccobono and Rolden, 1973; Stone and Barrett, 1962; Jung et al., 1977; Ward et al., 1978), the treatment can improve the surface affinity and the sticking strength with some hydrophilic polymers, because the treatment can lead to the increasing of the high reactive free radical oxygen in the polymer surface.

Corona discharge was also applied in the chemical graft copolymerization (Shishoo, 1996; Lieberman and Lichtenberg, 1994), this is also based on that after the irradiation, new active group is produced and the monomer can be successfully grafted onto those active groups in the irradiated material. Some other researchers have introduced the corona discharge treatment into the textile surface treatment to improving the wool fabric printability (Rakowski et al., 1982) or the wool fabric shrinks resistance properties (Marsh, 1987; Venugopalan, 1971). Corona discharge technology is also widely used in the printing of some polymer films (Venugopalan, 1971; Benerito et al., 1981). The treatment has been confirmed to be simpler and more practical than any other chemical and physical methods because the samples can be quickly treated under atmosphere pressure (Ward et al., 1978).

MATERIALS AND METHODS

Materials

A plain weave, resized, scoured and bleached cotton fabric with the following specifications was used in all the experiments. 25 ends 21 picks per cm and 122 g/cm^2 weight per unit area (conditioned 65% R.H., 21°C). The laundry detergent used in this work was SHOMA of TOLYPERS Limited and Corona instrument made by Azad Electrical Industry (Figure 1).The laundering machine used was SDL.

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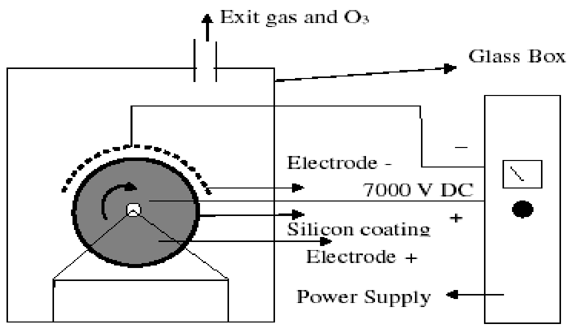

Figure 1. Main components of corona reactor.

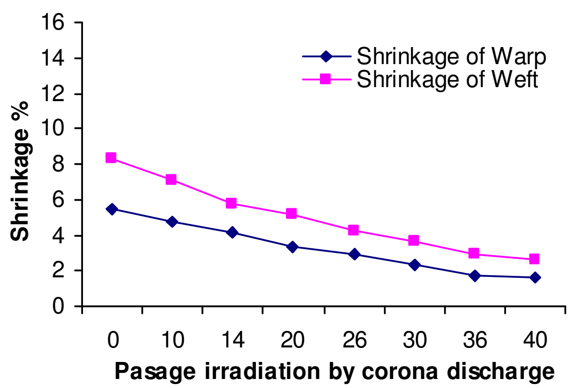

Figure 2. The shrinkage amount of warp and weft fibers after the first washing.

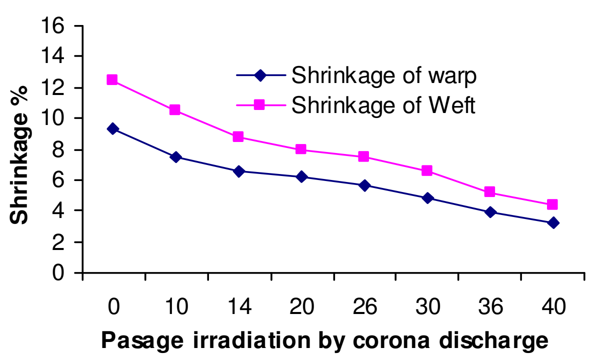

Figure 3. The shrinkage amount in warp and weft fibers in 4 washing cycle.

Corona treatment

In this research, the samples were placed on silicon roller and treated in 2 - 40 passages in 7000 V (DC).

Fabric weight loss

Bone dry untreated cotton fabric samples were weighed on an electronic balance, subjected to air plasma corona treatment, reweighed, and then washed at 60°C for 60 min in distilled water at a liquor ratio of 40:1. Then they were bone dried and reweighed. The weight loss was calculated due to percentage of the bone dry cotton Fabric weight.

Carbonyl group identification

2, 4-Dinitrophenyl Hydrazine Test: This method immediately identifies carbonyl groups (both aldehyde and ketone groups) on cotton fibres. 2,4-Dinitrophenyl hydrazine in presence of carbonyl compounds (including many quinones) gives sparingly soluble dinitrophenyl hydrazones (Benerito et al., 1981). In this test, 0.1 g of the cotton sample was added to 3 mL of the 2, 4-dinitrophenyl hydrazine solution in a glass test tube and shaken for 10 min.

Color measurement

The color changes of fabrics were evaluated by CIE Lab system with light source D65.

Washing and shrinkage measuring

All procedures such as samples preparation, washing and shrinkage measurement used by ASTM D 1905 method. Treated and untreated samples were marked by waterproof marker in warp and weft Sections and then washed with SHOMA laundry detergent for 4 times at 65°C in 30 min. After each time of washing, all samples were rinsed and dried in a same condition and then measured for dimensions.

RESULTS AND DISCUSSION

Cotton Fabrics that treated with corona discharge have less shrinkage level exposed to washing process than untreated. Shrinkage in weft section is higher than warp (Figure 1). With respect to same structural characteristics of warp and weft yarns, above difference referred to conditions in weaving processes and finally synthesis. By increasing of irradiation (passage round), the shrinkage decreased after washing.

One kind of prediction methods about fabric shrinkage amount during washing is increasing the washing times in the laboratory conditions. Increasing in washing cycle showed the notable and important results then in this study the treated and untreated samples washed in standard condition ASTM D 1905 from 1 to 4 cycles. The amount of shrinkage of warp and weft in treated and untreated samples showed the decrease of irradiation cycle rounds (Figure 2). This result showed the effect of corona treatment in discharge or reduction of effective forces in fabric.

The percentage of exhausting increased with increasing cycle round in corona treatment (see Figure 3) up to the 14 passages but the exhausting reduced with increasing in cycle round (after 20 passages) (Table 1).The results obtained from measurement of carboxyl group showed the reduction of carboxyl group with increasing in corona treatment after 14 passages (Table 1).

Table 1. The effect of change in passages time after being treated on the carboxyl group contents and the damage caused by the corona treatment on cotton samples (dyed in distilled water, L: R ≈ 40:1, at 60℃, and for 60 min).

Corona treatment	Carboxyl group contents (meq. / 100 g)	Weight loss (%)	Dye exhaustion (%)
Untreated	1.85	-	13.6
4	2.17	10.1	14.8
10	2.49	15.6	18.5
14	3.93	15.1	20.7
20	2.89	18.4	18.3
25	2.71	20.4	14.8
30	2.53	26.5	13.3
40	1.64	35.2	12.3

Conclusion

According to results, increasing in corona passage number to usual level (14 passages) can increase exhaustion and carboxyl groups. The results showed that increasing corona passage number reduced shrinkage behavior and this behavior related to internal forces in fabric.

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