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Evaluation on the Effect of Crease Resistant Finish on Cotton Fabric Treated with Citric Acid

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Abstract: *In this research, an attempt is carried out to obtain the crease resistant property of cotton fabric by finishing with citric acid as crosslinking agent, sodium hypo-phosphite as a catalyst, polyethylene emulsion as a softener, acrylic emulsion as an additive and non-ionic wetting agent. Four different concentrations of crease resistant finishing solutions are prepared and applied on cotton fabric samples using pad-dry-cure process. And then, the crease recovery angle and other related properties of treated fabric samples are analysed and compared with untreated fabric sample. The results show that the crease recovery angles of the treated fabric samples increase due to the crosslinking reaction. Among them, the fabric sample treated with 6% concentration of citric acid gives the highest crease recovery angle in both warp and filling directions. According to the results, the fabric weight and fabric stiffness increase, the fabric thickness is not obviously different and the fabric breaking strength decreases due to the acidity of citric acid.*

Key Words: *cotton fabric, crease resistant property, citric acid, crease recovery angel, crosslinking reaction*

1. INTRODUCTION:

Cotton, the most well-known and one of the oldest fabrics can be found in ancient Egypt and prehistoric mexico. The drawback of this fabric is that it can be easily creased and lower in strength in wetting condition. Attempts had been processed and formaldehyde-based resin to reduce this condition. But it is found that long-term exposure to formaldehyde caused irritation to human skin, respiratory problems and they are even carcinogenics. So low-formaldehyde materials and formaldehyde free materials such as Polycarboxylic acids are used as substituents for crosslinking agents.

2. MATERIALS AND METHODS:

2.1 Fabric Specification

The cotton fabric is purchased from local market in Yangon. The construction properties of the cotton fabric include the followings: warp count 35 Tex, weft count 32 Tex, ends per cm 22, picks per cm 17 and the weight 127.65 g/m^2.

2.2 Conditioning of Fabric Samples

All tests are carried out in the standard atmospheric condition and relative humidity at (20$\pm$ 2˚C, 65$\pm$ 2%RH) in the laboratory of Textile Testing and Quality Control of the Department of Textile Engineering, Yangon Technological University.

2.3 Preparation of Sample Fabrics for Wrinkle Resistant Finishing Treatment

The sample fabrics (33.02 cm×38.10 cm) are prepared for the crease resistant treatments. The padder mangle is used for one-dip-one-nip padding process and Auto mini tenter is used for drying and curing the fabric samples.

2.4 Preparation of Wrinkle Resistant Finishing Treatment Solution

In the crease resistant solution, four different concentrations of Citric acid (4%, 5%, 6%, 7%) are prepared respectively with 3% of Sodium Hypophosphite (catalyst), 5% of Polyethylene solution (softener), 3% acrylic emulsion (additive) and 1% wetting agent. The material to liquor ratio of 1:15 is used for this research and the conditions for crease resistant finishing and the samples are denoted as in Table 1.

Table 1. Designation of Samples

Sample code	**Citric acid (CA)**	**Sodium Hypo -phos**	**Poly-ethylene**	**Acrylic**	**Non-ionic wetting agent**	**Drying**		**Curing**	
						Temp (˚C)	Time (min)	Temp (˚C)	Time (min)

		-phite (SHP)							
C_0	Untreated fabric								
C_1	4%	3%	5%	3%	1%	80	5	140	3
C_2	5%	3%	5%	3%	1%	80	5	140	3
C_3	6%	3%	5%	3%	1%	80	5	140	3
C_4	7%	3%	5%	3%	1%	80	5	140	3

2.5 Crease Resistant Finishing on Cotton Fabric

First of all, the sample fabrics are immersed separately in the different concentrations of crease resistant solution which contain Citric acid, Sodium hypophosphite, Polyethylene, Acrylic emulsion and Non-ionic wetting agent. Then, the sample fabrics are passed through the padding roller to give wet pick-up of 80% on the weight of the fabric. And then, the treated samples are dried at the temperature of 80˚C for 5 minutes and cured at the temperature of 140˚C for 3 minutes. Then, the treated samples are washed in sodium carbonate, rinsed in cold water and dried at room temperature. All of the samples are examined under standard condition to investigate the effect of wrinkle resistant finish on physical properties the treated fabric.

3. RESULTS AND DISCUSSIONS:

3.1 Evaluation of the Effect of Crease Resistant Finish on Cotton Fabric

All tests are carried out according to the respective AATCC and ASTM standard test methods. The test results of untreated and treated fabric are shown in Table 2.

Table 2. Test Results of Untreated and Treated Cotton Fabric

Sample code	Fabric weight (g/m^2)	Fabric thickness (mm)	Crease recovery angle (˚)		Overall Flexural Rigidity (mg-cm)	Fabric breaking strength (kgf)	
			Warp	Filling		Warp	Filling
C_0	127.65	0.33	79.00	85.60	20.97	66.30	45.20
C_1	135.78	0.36	80.00	84.00	23.19	61.00	44.60
C_2	149.00	0.36	92.30	94.10	24.20	56.90	43.90
C_3	143.47	0.36	98.90	100.20	24.12	55.00	38.30
C_4	149.48	0.34	81.30	86.10	24.00	48.90	38.20

(i)Fabric Weight

The weight of a fabric is dependent on threads per inch, yarn number and finish. The greater the yarn number and fabric count, the heavier the weight. According to the Figure 1, the weight of the treated fabric samples is greater than that of the untreated fabric as the increase of concentration of CA in the padding liquor. The weight of the sample C_4 is greater weight than the other treated samples. The reason is that crosslink affects the degree of swelling, so lower degree of swelling makes the fabric more compact, which leads to increase in weight of the fabric. And also to t-test results shown that the weight of all treated samples are significantly different with the untreated sample.

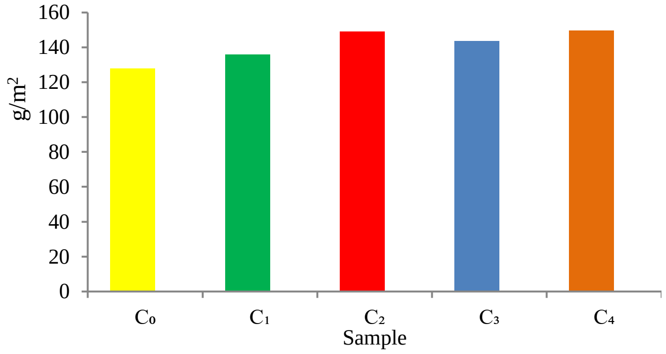


Fig.1 Fabric Weight Test Results

(ii) Fabric Thickness

The thickness of a fabric depends on the mass per unit area, the type of yarns used, the weave structure and the finish. The effect of crease resistant finish on the thickness of untreated and treated fabrics is shown in Figure 2.

By observing Figure 2, the thickness of all treated samples are slightly increased as compared to untreated sample. The increase in thickness may be due to the formation of a layer on the surface of the fabric and stress relaxation of the fabric after treatment. According to significant test, sample C_1, C_2 and C_3 are significantly different with the untreated sample at 95% confident level whereas sample C_4 is not.

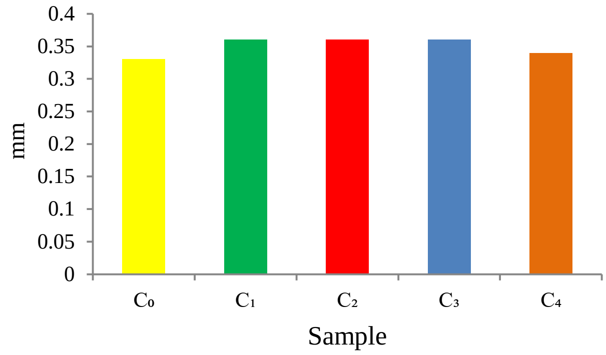


Fig.2 Fabric Thickness Test Results

(iii) Crease Recovery Angle

In figure 3 (a) and (b), it is found that the crease recovery angles of treated fabric samples increase up to 6% concentration of CA and the crease recovery angle decreases again when 7% concentration of CA is used in treatment.

According to significant test results, there are no real differences among the samples (C_0, C_1 and C_4) but the crease recovery angles of the samples (C_2 and C_3) significantly increases. It may be due to the fact that crosslinking agent, citric acid, has formed the desired crosslinked structure with the free hydroxyl groups of cellulose chains, and thus, it is quite stable to creasing.

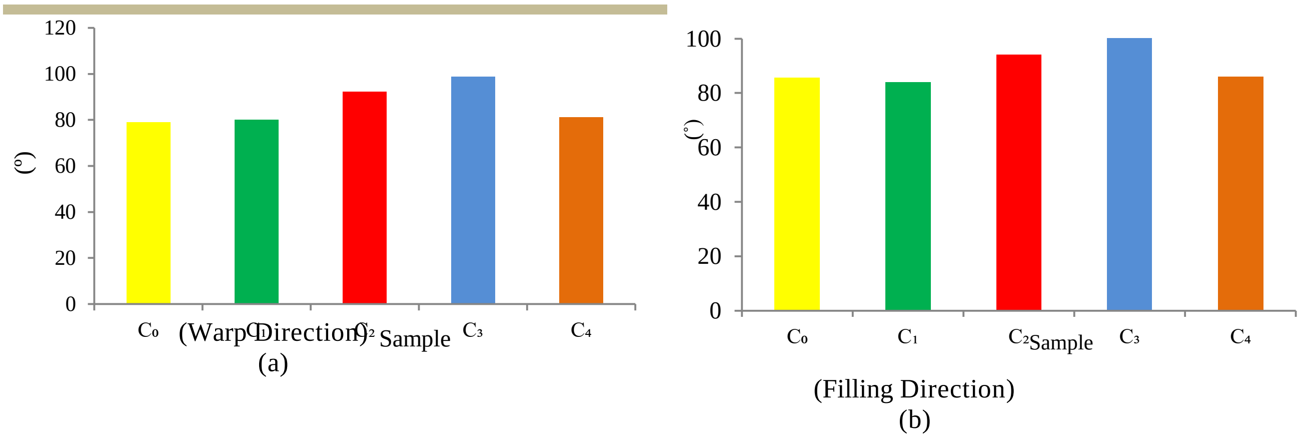


Fig.3 (a), (b) Crease Recovery Test Results

(iv) Fabric Stiffness

Fabric stiffness is defined as its resistance to bending. The degree of fabric stiffness depends on the properties such as types of fibre and yarn, fabric structure and finishing treatments. The results of the overall flexural rigidity of untreated and treated fabric samples are shown in Figure 4.

As seen in Figure 4, all treated fabric samples have higher overall flexural rigidity values than the untreated fabric sample. The significant test results also show that the values of overall flexural rigidity of all treated samples significantly increase when compared to untreated sample. Additionally, there are no significant differences among the treated samples. The reason of increasing overall flexural rigidity may be due to the effect of crosslinking with citric acid and cellulosic fabric. The higher the values of overall flexural rigidity, the stiffer the fabric is.

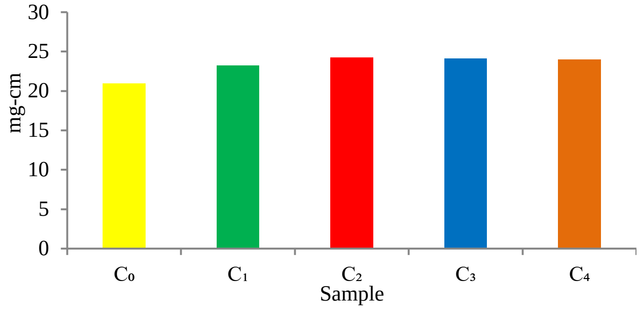
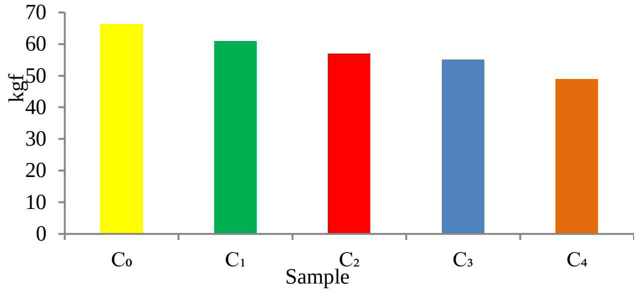


Fig.4 Fabric Stiffness Test Results

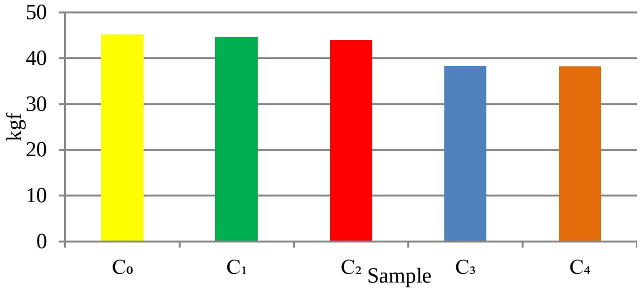
(v) Breaking Strength

Fabric breaking strength is a measure of the resistance of the fabric to a tensile load or stress in either warp or filling direction. The test results of the fabric breaking strength in both warp and filling directions are shown in Figure 5 (a) and (b). By observing the figures, the breaking strength of all treated fabrics is decreased as compared to untreated sample.

According to the significant test results, it can be observed that the breaking strength of all treated samples significantly decrease in warp direction but that of samples C_1 and C_2 does not significantly decrease in filling direction. The reason of decreasing breaking strength may be due to the fact that the cotton fibres are weakened by acidic condition of crease resistant finish solution. As the concentration of citric acid increases, the loss of breaking strength also increases. The crease resistant finish also limits the movement of fibre elements. Limiting fibre movement will reduce the breaking strength of fibre.



(Warp Direction)
(a)



(Filling Direction)
(b)

Fig.5 (a), (b) Fabric Stiffness Test Results

4. CONCLUSIONS:

From this study, crease resistant cotton fabric can be achieved by applying citric acid, crosslinking agent, with sodium hypophosphite as a catalyst with selective additives. It can be found that crease recovery performance of treated fabric sample reaches the maximum in both warp and filling directions when 6% concentration of citric acid is used. Although the weight, thickness, crease recovery angle and overall flexural rigidity of the treated samples increase, the breaking strength decreases in when compared with untreated sample. The increase in crease recovery angle is due to the inter macromolecular crosslinking in fibres, whereas the strength loss is mainly due to acidity of the treated solutions. This treated cotton fabric can be used for casual wear and blouses.

5. RECOMMENDATIONS

It is recommended that concentration of citric acid should not be exceeded than 7% because the breaking strength of cellulosic fabric can be reduced. The pH value of liquor should be adjusted to the range from 4 to 5 in order to obtain the preferable crease resistant performance. As for future work, air porosity and wash fastness tests should be done to know whether the crease resistant effect on the treated fabric will be permanent or not.

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