

A Study on the Effect of Crease Resistant Finish Treatment on Perspiration Fastness Property of Cotton Garments

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Abstract Present day cotton garments are mostly given chemical treatments like Softening, Easy care (Wrinkle free), Antimicrobial etc. Human sweat contains chemicals and some times affects the appearances of the garments. Effect of perspiration on wrinkle free treated cotton fabric on acidic and alkaline condition has been studied during this research work. It has been observed that there is no negative effect due to perspiration at different concentrations of the wrinkle free treatment. However, at 100 gpl concentration of resin component of the finish solution, colour bleeding was resulted. Hence, garments manufacturers should be careful on the amount of chemicals used during wrinkle free treatments.

Keywords Wrinkle Free, Resin Finish, Perspiration Fastness, Colour Fastness, Gray Scale

1. Introduction

Perspiration is an important mechanism where the body uses to lose heat when its temperature starts to rise. Heat is taken from the body in order to supply the latent heat needed to evaporate the moisture from the skin. Sweat contains the chemicals or odorants 2-methylphenol (o-cresol) and 4 - methylphenol (p-cresol), as well as a small amount of urea. There are two forms of perspiration: 1- Insensible - in this form the perspiration is transported as a vapour and it passes through the air gaps between yarns in a fabric. 2- Liquid – in this form occurs at higher sweating rates and it wets the clothing which is in contact with the skin. The two forms of perspiration raise separate problems: one is the ability of water vapour to pass through the fabric, particularly the outer layer and the other is the ability of the fabric in contact with the skin of absorbing or otherwise dealing with the liquid sweat. The major concerns due to sweating in relations to human being and garment are odd looking and bad body odour.

These kinds of problems are serious when the users of the garment are supposed to be professionals in the world of entertainment or television, which must appear in public, in some cases involving important physical activity, e.g. dancers or orchestra conductors. They used to perform the work in hot spaces and under high thermal radiation

produced by the environmental conditions around them, such as lighting, the obligation to wear heavy clothes and the fact that the public or the cameras detect every detail of their aspect, make sweating a real problem that causes a discomfort for the person and may hinder their performance. The loss of aesthetic appeal caused by sweating is due to delay in evaporation of the generated sweat from the microclimate i.e. climate between the surface of the skin and inner layer of the garment. Adsorbent materials have been developed and fitted in the garments to absorb the vapor generated from the skin[1]. Researchers have observed that acidic perspiration degrades cotton cellulose and decreases the tensile strength and increases yellowing index of the cotton fabric[2]. Human perspiration also decreases clothing thermal insulation properties[3]. S. X. Wang et al had studied the effect of sweating on the moisture management functions of intimate garments and found that liquid sweat makes the wearer to feel uncomfortable by absorbing the water vapour in intimate garments[4].

In this research work an attempt has been made to study the effect of perspiration on cotton fabrics treated with non formaldehyde wrinkle free finish.

2. Materials & Methods

2.1. Materials

1. Dyed cotton handloom woven shirting fabrics having specifications of 50^S warp count, 49^S weft count, 64 ends/inch, 61 picks/inch and 1up 1down plain weave has

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Published online at <http://journal.sapub.org/textile>

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been used in the study. The procedures adopted by the weavers for dyeing of these fabrics are detailed below.

Dyeing procedure:- The fabrics are dyed by *yarn dyeing method*. Material (yarn) to liquor (water) ratio @ 1:30 is taken in a container (bath). 15 to 20 grams/liter of Na_2CO_3 and 25 to 30 grams/liter of NaCl are added to the container and stirred for 5 to 10 minutes. The temperature of the bath gradually increased up to 60°C and Reactive hot brand commercial dye stuff are then added to the bath and stirred gently for 2 to 3 minutes. Yarn in hank form then immersed in to the said dye liquor and are rotated inside the liquor with the help of steel rods for nearly one hour. Then the hank yarn are taken out from the dye bath and again dipped in to another bath containing 2 grams/liter of Na_2CO_3 and 2 grams/liter of non-ionic detergents, maintained at a temperature of 50°C , where the hank yarn are rotated for 15 minutes. Then a normal cold water wash followed by air dry is given.

2. Non-formaldehyde crease resistance finish and silicone softener were collected from Clariant Chemicals Ltd, (Trade name and exact specifications were kept reserved due to the company's trade policy). Laboratory grade MgCl_2 and acetic acid were used during the treatment as catalyst and pH regulator respectively during the treatment with the fabrics.

2.2. Methods of Treatments

2.2.1. Finishing Treatment

The fabric sample was desized in boiling water for 45 minute (material: liquor = 1:40) and dried in room temperature. Then, fabric was treated with finish material by pad dry cure method as per the following procedure:-

Water calculated on material : water @ 1: 20 was taken in a container and heated up to a temperature of 40°C . Crease resistant finish consisting of Arkofix NZF (Resin component) = 40g/L, Dilasoft JWN (softener component)= 20 g/L, Solusoft MW conc. (softener component) = 20g/L along with MgCl_2 (catalyst)= 10g/L were added to the container & mixed well. The pH of the solution was maintained at 5.5 by adding small quantity (3 to 4 drops) of acetic acid. Cotton fabric sample was ironed properly to remove all creases, dipped slowly into it & stirred for around 20 minutes with the help of a glass rod. Then the treated fabric was padded at $1\text{kg}/\text{cm}^2$ pressure in an automatic padding mangle machine to achieve 80% expression in order to get optimum pick up of 0.8 on the weight of material.

Then the fabric was dried at 100°C for 3 minutes and cured at 150°C for 4 minutes in drying and curing chamber. Then the fabric was taken out from the curing chamber, cooled at room temperature and ironed. In the similarly method of treatment as mentioned above, the fabric sample was treated at different concentrations of Arkofix NZF (Resin component) i.e. 60 gpl, 80 gpl and 100gpl without altering the concentration of other chemicals (i.e. softener component & catalyst component).

2.2.2. Testing by Scanning Electron Microscope (SEM)

Scanning Electron Microscope (SEM) study was conducted for the treated sample in order to assess whether the above finishing chemicals were intimately bonded in to the internal structure of the fibre/fabric matrix after repeated washes. The sample cotton fabric was treated with the above crease resistant finish solution at different concentrations and then washed in a laundry-o-meter for 20 minutes washing cycle. Samples were collected after wash, dried and kept ready for study of effect of perspiration on these treated fabrics.

2.2.3. Test for Fastness to Perspiration

Colour fading can be caused by the reaction between dyes on garments and the constituents of human perspiration, such as sweat. It varies for different individuals and conditions. Methods for testing fastness levels of dyed materials against perspiration have been established by "ISO 105 – EO4 1994 (Acid and Alkaline perspiration)" standards. There are cases where more colour fading and alteration is caused depending on the conditions under which garments are worn.

Coupled with the eventual accumulation and concentration of perspiration, the reaction with sunlight is regarded as the cause for such occurrences, casting an influence on certain elements in the dye structure. To forecast such occurrences, methods for examining the components of perspiration under different conditions (acid and alkaline pH values) have been suggested by these standards.

Machinery used:- Perspirometer , Hot air oven

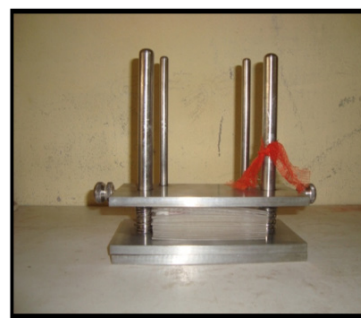


Figure 1. Perspirometer



Figure 2. Hot air oven

Testing methodology:- Standard Test Methods of "ISO 105 – EO4 1994 (Acid and Alkaline perspiration)" for measurement of colour fastness to Perspiration was used as testing methodology for the test conducted in this study.

Specimens of the textile in contact with adjacent fabrics were treated in two different solutions of acidic and alkaline and placed between two plates under a specified pressure in testing device. These specimens and the adjacent fabrics were dried separately. The change in colour of each specimen was assessed with the help of 'Gray Scale'.

- **Alkaline solutions** was prepared by taking 200ml distilled water, 0.1gram of 1-histidine monohydrochloride monohydrate, 1gram of sodium chloride, one gram of disodium hydrogen ortho phosphate dodecahydrate. This solution was maintained at a pH of 8 with 0.1 N sodium hydroxide solution.

- **Similarly Acidic solution** was prepared by taking 200ml distilled water, 0.1gram of 1 - histidine monohydrochloride monohydrate, 1gram of sodium chloride, 0.44 gram of sodium dihydrogen orthophosphate dehydrates. This solution was maintained at a pH of 5.5 with 0.1 N acetic acid solutions.

Procedure of Testing:

White cotton fabrics were used to measure the colour staining due to perspiration on it. The white cotton fabrics were sewed on the sample. Then the composite specimens (white fabric along with the untreated / treated fabric specimen) was wet thoroughly in alkaline solution in liquor ratio 50:1 and allowed to remain in the solution at room temperature for 15 to 30 minutes, pressed and moved it from time to time to ensure good and uniform penetration of the liquor. Then, the solution was poured and wiped the excess of liquor from the specimen. The said composite specimen was placed between the two acrylic plates and all the plates (21 plates) were placed into the machine units (fig.-1) regardless of number of specimens. Then the upper steel plate was placed over it and dead weight of 5kg was kept on the top of the plates and locked the pressure plate in position by turning the thumbscrews. The unit was left for 24 hours in the testing room at normal atmosphere. Next day, the weight was removed from the unit and the total unit as such was placed in hot air oven (Fig.-2) for 4 hours at 42degree+/-1 degree Celsius. Then, the composite specimen was opened out by breaking the stitching on all side except one of the stitched side and dried by hanging it in air at temperature not exceeding 60°C with 3 parts in contact only at the remaining line of stitching. Assessment of fading of colour on white fabric was done using grey scale (Fig-3 & Table-1).

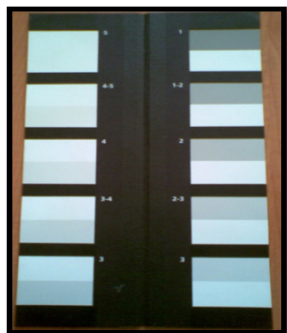


Figure 3. Gray scale

Table 1.

Gery scale Rating	Interpretation for change/staining
5	No change /No staining
4	Slight Change/Slight Staining
3	Moderate Change/Moderate Staining
2	Severe Change/Heavy Staining
1	Very Severe Change/Very Heavy Staining

2.2.4. Effect of Human Perspiration on Treated Samples

Effect of human perspiration on treated sample was also studied by sewing the treated samples on garments and evaluation was done in the same procedure as mentioned above. White cotton fabrics were sewed on treated specimen samples in order to measure the colour staining due to perspiration on it. Then the composites i.e. (stitched white fabric along with the treated fabric specimen) was attached to the garment in such a way that the specimen were in contact to the human body part where maximum sweating occurs (Fig.-4).



Figure 4. Perspiration sample attached to garment

The garments were then put on for 18 hours during the sunny day time. After that the specimen and the white cotton fabric was removed from the garment. Then these composite specimens were wet thoroughly in alkaline solution and in acidic solution separately and the change in colour of each specimen were assessed by the same method as mentioned above.

3. Results and Discussion

3.1. Washing Fastness Property

The garments are subjected to repeated washes. If any finishing treatment on the fabrics do not last for a good number of washes, then this type of finishes are not of much use for garments. Hence, before proceeding for study on Perspiration properties of garments due to finishing treatment, a S.E.M. study was conducted in order to be confirmed whether after some washes, the applied finishing substrates were intimately bound in to the internal structure of the fibres or not.

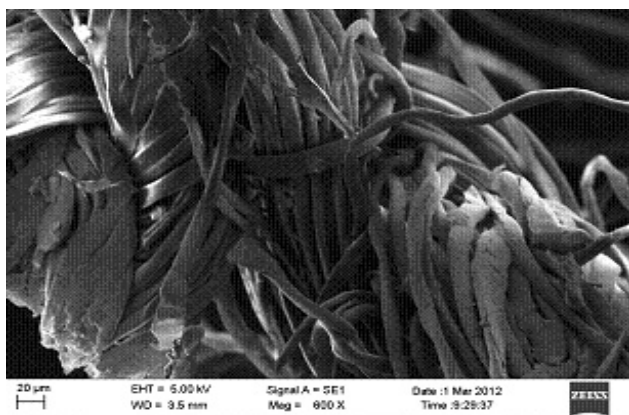


Figure 5. Un treated sample

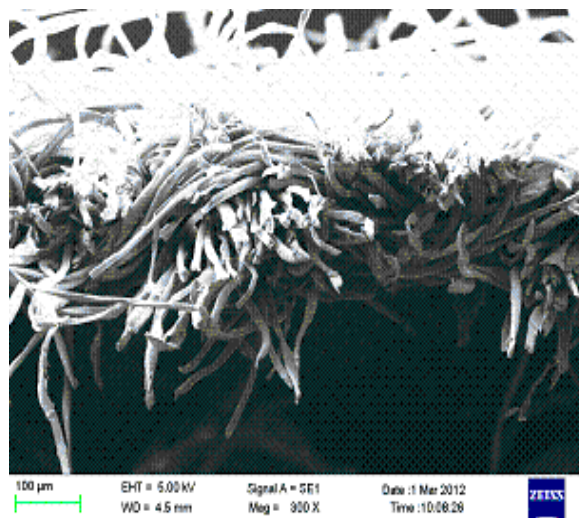


Figure 6. After wash of treated sample

It was noticed from the above SEM study (Fig: 5 & 6), that the applied finish material i.e. resin compound were strongly adhered to the substrates in the fiber matrix after a severe washing cycle of 20 minutes. Hence treatment with the above said type of finish on the garments for getting crease resistant effect may be considered as quite reasonable and justified.

3.1.1. Fastness to Perspiration Property

Untreated sample:

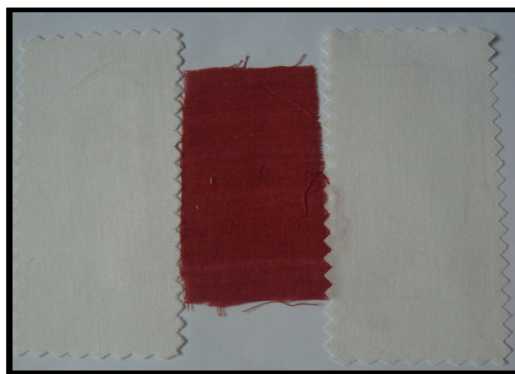


Figure 7(a). Gray scale rating (acidic) - 5

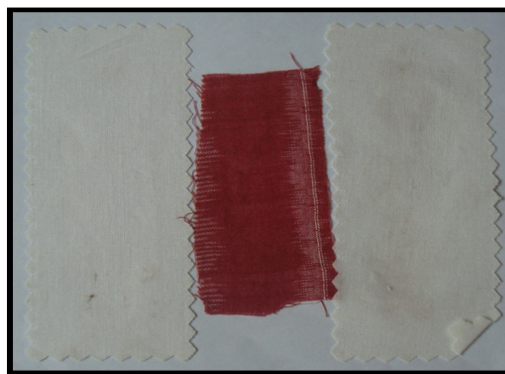


Figure 7(b). Gray scale rating (alkaline) - 5

Treated with 40 gpl Resin :

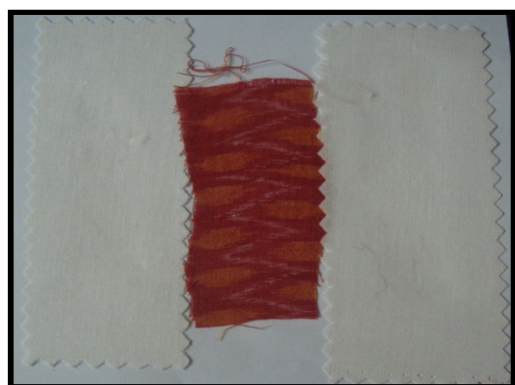


Figure 8(a). Gray scale rating (acidic) - 5

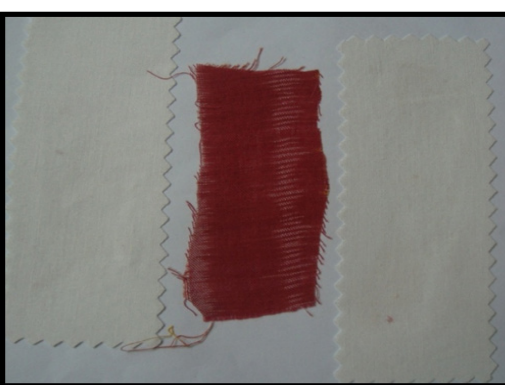
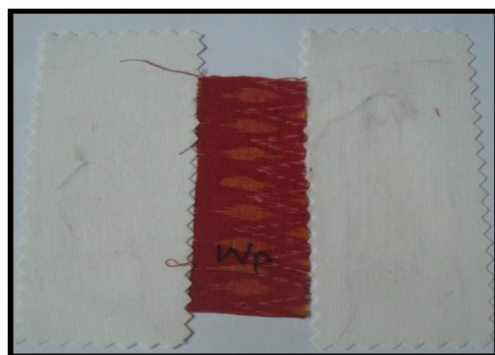
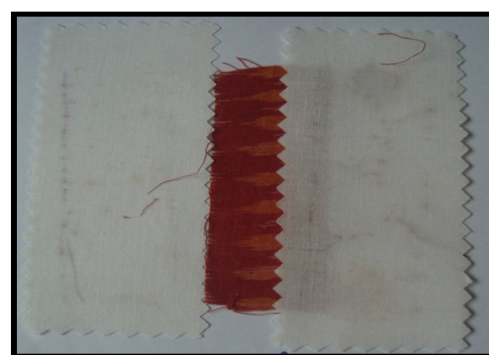


Figure 8(b). Gray scale rating (alkaline) - 5

Treated with 60gpl resin:**Figure 9(a).** Gray scale rating (acidic) - 5**Figure 9(b).** Gray scale rating(alkaline) – 5**Treated with 80gpl resin:****Figure 10(a).** Gray scale rating (acidic) - 5**Figure 10(b).** Gray scale rating(alkaline) – 5**Treated with 100 gpl Resin:****Figure 11(a).** Gray scale rating (acidic) - 5**Figure 11(b).** Gray scale rating (alkaline) - 4-5

It was observed from the above (Fig.-7 to 11) that, colour fastness due to perspiration as measured by the help of grey scale rating showed excellent value both in case of parent and treated samples. For all the samples treated at different concentrations, grey scale rating of 5 was found matching in both in acidic and alkaline treated solution. There was no considerable staining noticed except the treated sample at 100 gpl showed slight fading in colour in alkaline medium only.

3.1.2. Colour Fastness to Human Perspiration

The effect of human perspiration on the wrinkle free finish treated fabrics under acid and alkaline conditions were also studied by stitching the treated fabrics in the garments and allowed to worn by students for 18 hours. Then in the similar

way as done above, with the help of grey scale rating the assessment was done. The fading of colour was compared with grey scale by a panel of five judges and placed in Table-2.

Table 2. Fastness to perspiration (acidic and alkaline condition): Grey scale Rating

	treated resin finish 40gpl	treated resin finish 60gpl	treated resin finish 80gpl	treated resin finish 100gpl
Acidic condition	5	5	5	5
Alkaline condition	5	5	5	4-5

The fading of colour due to human perspiration on crease resistant finished fabric in both acidic and alkaline medium

showed a similar favourable result i.e. no colour fading was observed. Here also, a slight colour fading in alkaline medium was noticed by the panel of judges with the fabric treated with 100 gpl concentration of the finishing chemicals. It may be due to some degradation occurred in amorphous /crystalline region causing loosening of the micro fibrils, thus making colour bleeding when come in contact with alkaline medium. So, it is quite risky to treat the cotton fabrics with 100 grams/litre of resin components even though we may get better crease resistant property.

4. Conclusions

Presently cotton garments are mostly treated with wrinkle free finishes in order to improve feel, lusture and to avoid frequent hot pressing problems. But, these type of finishes have some adverse effect on tensile strength and air permeability, thermal insulation properties of the cotton fabric because of the resin component used during such treatment. However, from the above study it may be concluded that these type of finishes have no negative impact due to human perspiration on cotton garments.

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