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Research Paper

Colourfastness properties of digital printed cotton fabric

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■ **ABSTRACT :** Colourfastness is the most significant parameters of the quality of printed fabrics in the textile industry. The aim of this study was to assess the colourfastness properties of digital printed cotton fabric. In order to accomplish this experiment, commercially available pre-treated cotton fabric was digital printed with selected five different colours (black, blue, green, red and yellow). All the printed fabrics were treated with superheated steam at 110° C for 5 min for colour fixation. Steamed fabric samples were finally washed in 10 g/l non-ionic detergent (Ahurachem) until all the unreacted dyes and chemicals were removed from the fabric surface. The fastness properties of the printed cotton samples were evaluated and the results revealed that number of washes did affect the colour strength (K/S) of the printed samples. Irrespective of colours, wet rubbing, sunlight, alkali media perspiration and damp sublimastation attained greater percentage of colour strength loss than control samples.

■ **KEY WORDS:** Colour strength, Digital printing, Fastness, Pre-treatment, Post-treatment

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In recent years, numerous innovations have been introduced in the techniques of digitally printed textiles. At present, the most dominant printing technique for textiles is screen printing, although digital ink jet printing is rapidly expanding in the textile markets. The efficacy of ink jet printing as a flexible ink transfer method is primarily based on its cost and time saving for small print runs (Novakovic *et al*., 2010). What more, this printing technique enables achieving better visual effects, far more flexible formats, besides with the repeated printing process better reproducibility and consistent quality is achieved (Owen, 2003). Ink is also one of the influential factors in behaviour of the prints in usage. It is disputable which dye colour type is the most stable in relation to fastness properties.

Fastness properties can be defined as mechanical, physical and chemical resistance of dye on a textile surface to external factors. Fastness properties of a dyed or printed textile material determine the period of its durability and usability.

Colour is the most important component of the fabric and garment, one of the means to make the fabrics and garments more attractive, appealing and promote in adding colour to them, the consumers except retention of the original rather than initial hue, during wear and tear. Change in colour definitely means reduction in K/S values, as commonly expressed in three dimensions of colour hue, value and intensity. Several times, the garment in-spite of being good in strength, durability, comfort ability, breathability and other favorable features, it is discarded because of the remarkable change in colour may be dyed or printed, appears to be dull, fade and

unpleasant. Therefore, the main aim of this paper was to study the colour fastness properties of digital printed cotton fabrics.

■ RESEARCH METHODS

Materials :

Cotton and other cellulosic fibres are commonly printed using reactive water based inks. Hence in the present study Commercially available pretreated cotton fabric with plain weave (67 ends / inch x 35 picks / inch, fabric weight 140.40 g/m^2) structured sample was procured from Jaysinth, Mumbai.

Printing procedure :

Machine :

The model of ink-jet printer used was Mimaki QualiJet HS^{B}T with a piezoelectric drop on demand print head and all the print outs were obtained with the resolution 720dpi, the CMYK system, standard head transition 4.A PC system with RIP master software.

Printing :

Five pantone colours were selected to print the cotton fabric samples namely Red (Red pantone DS 74-1c), Green (Green pantone DS 276-1c), Yellow (Yellow pantone DS Process cyan), Blue (Blue pantone DS 188-1C), Black (Black pantone DS process).

Fabric post-treatment :

The fabrics were air dried at room temperature for 24 hours and then put into a steamer. All the printed fabrics were treated with superheated steam at 110° C for 5 min for colour fixation. The steamed fabric samples were finally washed in 10 g/l non-ionic detergent (Ahurachem) until all the unreacted dyes and chemicals were removed from the fabric surface.

Colour fastness tests :

The colour fastness of the printed fabrics were assessed by the IS Test Method 3361-1979 (colour fastness to washing), IS Test Method 61-2001 (colour fastness to rubbing) and IS Test Method 786-1985(colour fastness to sunlight), IS Test Method 971-7-1983 (colour fastness to perspiration) and IS Test Method 689 (colour fastness to sublimation).

Evaluation of colorfastness property :

Colourfastness properties of all the digital printed samples were evaluated by using Minolta spectrophotometer before and after subjecting to colour fastness testes.

■ RESEARCH FINDINGS AND DISCUSSION

It is observed from Table 1 that increasing the number of washes decreases the colour strength. the blue attained highest percentage of colour loss over control with 15th wash (28.14%) which may be attributed to the hydroxyl groups of the water molecules react with dye molecule to produce dye molecules with poor substanstibility for the fibre. Green colour showed least colour strength loss (2.72%) this is attributed the very stable covalent bond exist between the dye molecule and the fibre polymer (Zhang *et al.*, 2008).

It is seen from Table 2 that irrespective of fibre content and colours, wet rubbing fastness attained greater percentage of colour strength loss (blue -30.90%, black-17.69%, red 16.31%, green-12.21% and yellow-6.00%) than dry rubbing this may be due to the moisture content in the wet rubbing sample helps to migrate unreacted or unfixed dye molecule from the coloured specimen to adjacent white fabric which may leads to poor fastness to wet rubbing.

From the result presented in the Table 3 reveals that greater percentage of colour loss was observed for

Table 1 : Colour strength values of digital printed cotton samples subjected to multiple washes

Printed samples	Colour strength (K/S)			
	Control	5th wash	10th wash	15th wash
Blue	07.07	05.49 (22.27)	05.21 (26.23)	05.08 (28.14)
Black	13.18	13.82 (04.65)	11.37 (15.87)	09.95 (24.51)
Green	15.40	15.20 (01.31)	15.10 (01.93)	14.98 (02.72)
Red	06.37	05.98 (06.07)	05.53 (13.12)	05.01 (21.37)
Yellow	13.30	12.92 (02.85)	11.93 (10.30)	10.50 (21.05)

Figures in parenthesis indicates percentage

red (71.62%) and black (70.81%) over control. This had been ascribed to the absorption of ultraviolet with higher energy raises the dye molecule to an electronically excited state and initiate the degradation of the dye due to phto-oxidation. Least colour loss was observed for blue probably due to the fact that the deactivation of excited electronic states this study is in line with the study conducted by Stanley (2008).

It is seen from Table 4 Irrespective of media of perspiration maximum loss in colour strength was noticed in green colour (alkali media-41.68 and acid media-39.50%) and least for yellow cotton sample (alkali media-17.97 % and acid media- 17.06 %). The losses in colour strength values were slightly higher in alkali media perspiration than acid media. This may be because of alkali compounds can interfere with the bonding mechanism. This interference causes hydrolysis of the dye, resulting in poor dye fixation. Thus maximum loss in colour strength to alkali media perspiration. Similar results were obtained in the study on reactive dyes on cellulose under light and perspiration carried out by Dehua *et al.* (2007).

Table 2: Colour strength values of digital printed cotton samples subjected to rubbing

Printed samples	Colour strength (K/S)		
	Control	Dry rubbing	Wet rubbing
Blue	07.07	06.06 (14.18)	04.88 (30.90)
Black	13.18	11.55 (12.37)	10.85 (17.69)
Green	15.40	14.38 (06.63)	13.52 (12.21)
Red	06.37	05.60 (12.04)	05.33 (16.31)
Yellow	13.30	12.74 (04.21)	12.50 (06.00)

Figures in parenthesis indicates percentage

Table 3 : Colour strength of digital printed cotton samples subjected to sunlight

Printed samples	Colour strength (K/S)	
	Control	Sample
Blue	07.07	05.18 (26.69)
Black	13.18	03.84 (70.81)
Green	15.40	07.93 (48.53)
Red	06.37	01.80 (71.62)
Yellow	13.30	06.11 (54.02)

Figures in parenthesis indicates percentage

Table 4: Colour strength values of digital printed cotton samples treated with alkali and acidic media of perspiration

Printed samples	Colour strength (K/S)		
	Control	Alkali media	Acid media
Blue	07.07	04.65 (34.15)	04.78 (32.29)
Black	13.18	10.00 (24.10)	10.53 (20.05)
Green	15.40	8.98 (41.68)	09.32 (39.50)
Red	06.37	04.65 (26.96)	05.24 (17.75)
Yellow	13.30	10.91 (17.97)	11.03 (17.06)

Figures in parenthesis indicates percentage

Table 5 : Colour strength values of digital printed cotton samples subjected to sublimation

Printed samples	Colour strength (K/S)			
	Control	Dry sublimation	Damp sublimation	Wet sublimation
Blue	07.07	06.70 (05.23)	06.38 (09.76)	06.00 (15.13)
Black	13.18	13.04 (01.06)	12.69 (03.71)	12.42 (05.76)
Green	15.40	14.30 (07.14)	14.13 (08.24)	12.17 (20.97)
Red	06.37	05.36 (15.90)	05.37 (15.71)	05.05 (20.71)
Yellow	13.30	13.05 (01.83)	12.98 (02.40)	11.11 (16.45)

Figures in parenthesis indicates percentage

It is apparent from Table 5 that irrespective of sublimation tests red colour specimen (Dry -15.90%, Damp- 15.71%, Wet -20.71%) had maximum loss in colour strength over control. Loss in colour strength of all the colour specimen was depicted in increasing order with dry , damp and damp sublimation tests, respectively this may be due to unfixed dye molecules transferred to the adjacent sample in presence of excess water molecules with wet sublimation test than dry and damp tests.

Conclusion:

On subsequent washes the colour strength of printed samples were not affected with the same intensity. Irrespective of colours, wet rubbing fastness attained greater percentage of colour strength loss over control than dry rubbing. Sunlight fastness properties of red and black colour showed maximum percentage of colour strength loss over control samples. The loss in colour strength values were slightly higher in alkali media perspiration than acid media. Loss in colour strength of all the colour specimen was depicted increasing order in dry, damp and damp sublimastation tests, respectively and did not affect much.

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