Chemical and Materials Engineering 2(5): 101-105, 2014
DOI: 10.13189/cme.2014.020501 http://www.hrpub.org

Investigation on Physical Properties of Fluorescent Dyed Cotton Knit Fabric

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Abstract This study attempted to dye the knit fabric with fluorescent dye in different shade percentages(5%,7.5% & 10%)and investigate their effects on physical properties of dyed fabrics e.g. strength, stiffness, fastness properties, k/s value, handle properties etc. Exhaust dyeing method was applied in the experiments for 100% cotton knitted fabrics. The physical properties of the dyed knitted fabrics , before and after the treatment of fluorescent dyes were determined and evaluated . Also knit dyed fabrics were compared with woven fabrics in terms of color exhaustion. This work evinces that fluorescent dye has no inauspicious effect on the physical properties of cotton knit fabric.

Keywords Fluorescent Dyestuff, Cotton knitted fabric, Physical properties

1. Introduction

Fluorescent dyes are used according to fashion trends in leisurewear clothes, especially sportswear and in the work clothes worn outside. And the physical properties of dyed fabric are very much important to meet those functional purpose. Knit fabric is formed by the intermeshing of loops. TPI of yarn is comparatively lower than woven fabric [1]. The knit fabric shows high amount of stretch and elasticity due to loop structure and dimensionally less stable than woven fabric [2]. Air permeability is more due to voluminous structure of knitted fabric. Jersey is a knit fabric used predominantly for clothing manufacture. In 1930′s it has been experienced that certain dyes and resins combination produce brighter colors than normal colors and had the unique effect of "glowing" under ultra violet or black light. Fluorescent dyes are considered to be those dyes which absorb and emit radiation in the visible spectral range [3]. In 1971, Bayer designated the fluorescent dye he discovered as 'fluo-rescine'. Since this time, several dozen dyeing substances showing fluorescent ability have been recognized. Phosphorescent paints also emit light when excited by visible or ultraviolet light, but do so over extended periods [4]. This long-lasting effect of phosphorescent also allows kids to enjoy "glow-in-the-dark" adhesive stars on the ceilings of their rooms. Several works on fluorescent colors in the field of medical has been done with great success. In medical sector, the research makes widespread use of fluorescence to understand biological processes and in diagnosis. In this case fluorescent dyes help to mark antibodies, for example, or can reveal the flow of body fluids like blood or tears [5]. The purpose of this research is to compare the physical properties of cotton knit grey fabric before and after dyeing with fluorescent dye.

2. Materials and Methods

2.1. Materials

The investigation has been carried out with single jersey 100% cotton knitted fabric. The yarn count was 30 $^{s}/_{1}$ carded yarn, the fabric weight per unit area was 123 g/m^2, stitch length=3cm and course per inch(CPI) = 31 and Wales per inch(WPI) = 46 respectively. The fabric was scoured and bleached by caustic soda and hydrogen per oxide in a single-bath stage with the standard recipe [6]. Then the knitted fabrics were dyed with fluorescent dye in various shade%.

2.2. Methods

2.2.1. Scouring and Bleaching

The knitted cotton fabric has been subjected to scouring and bleaching process for removal of natural impurities such a wax, pectin, fat, oil, pigment etc from cotton fibers [7]. Here scouring and bleaching was carried out by using following suitable recipe with maintaining proper time and temperature.

2.2.2. Dyeing

The scoured and bleached fabric was treated with 5 gm/l catanizer (Cat MDN-96, Texodyes Company, Bangladesh) at 50^{0}C temperature for 20 minutes at pH 8.5.Then the dye bath was prepared for 5%, 7.5% and 10% of fluorescent red and fluorescent yellow separately and the liquor ratio was

1:10. Sample was added to each dye bath and dyeing was commenced 10 minutes at room temperature then raised temperature to 60^0C for 20 minutes. The dyed sample was washed with cold water and treated with 3 gm/l binder for 3 minutes and finally softener was applied at room temperature. Then washed and dried in air oven [8].

Table 1. Recipe of scouring and bleaching

Process parameter	Amount
Wetting agent	1 gm/l
Sequestering agent	1 gm/l
Detergent	1 gm/l
Caustic soda	4 gm/l
Hydrogen per oxide	5 gm/l
Stabilizer	2 gm/l
Temperature	95^0c
Time	1 hour

2.2.3. Test Parameter of Fluorescent Dyed Cotton Knitted Fabric

At first the pre treated samples were conditioned in 65% RH and at 20°C for 24 hrs before testing according to ASTM D1776 [9]. Then bursting strength of the fluorescent dyed cotton knitted fabric was determined according to ASTM D 3787 [10] (Ball Burst test). The values for color fastness were rated with a Grey scale for color change according to AATCC test method 61 [11]. Stiffness was measured according to BS 3356 [12] (bending rigidity) with a Shirley stiffness tester. GSM was calculated from the difference in fabric weight before and after fluorescent dyed cotton knitted fabric according to ASTM D3776 [13]. SEM was studied using a scanning electron microscopy (model-040293, Projectina, Switzerland). Dye yield capacities (K/S), reflectance, CMC value of the fabrics were measured by using Data color spectrophotometer according to ASTM D 1925. Drape test of the fabric was measured with drape meter according to BS 5058:1973.

3. Results and Discussions

3.1. Assessment of Color Fastness

In this test we have carried out various types of fastness properties of dyed fabric such as color fastness to rubbing, color fastness to washing color fastness to perspiration.

3.1.1. Evaluation of Color Fastness to Rubbing

Color fastness to rubbing was done for both knitted and woven dyed fabrics. The results (Figure. 1) show that the color fastness to rubbing of knit dyed fabric is better than woven dyed fabric.

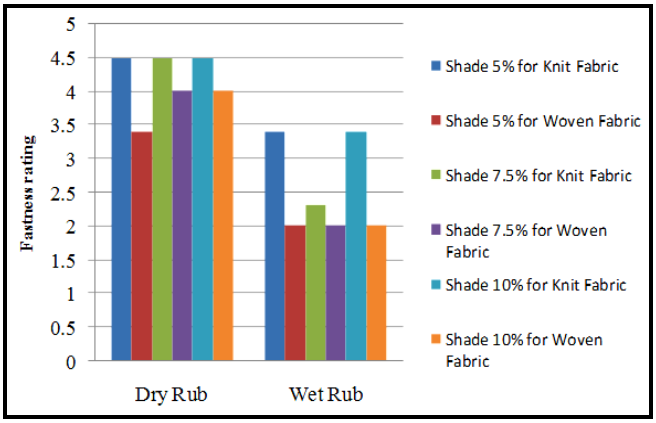


Figure 1. Color fastness to rubbing

3.1.2. Evaluation of Color Fastness to Wash

In this experiment color fastness to wash was used for both dyed fabric. Color fastness was usually assessed separately with respect to fading and staining. The below Figure. 3(a) shows that the color fastness to wash of knit dyed fabric is similar as woven dyed fabric.

3.2.3. Evaluation of Color Fastness To Perspiration

Color fastness to perspiration was used for both dyed fabric such as knit dyed and woven dyed fabric. From below Figure. 3(b) it is clear that the color fastness to perspiration of knit dyed fabric and woven dyed fabrics are mostly similarly.

3.2. Measurement of Fabric Strength

Comparison strength among 5%, 7.5% and 10% knit dyed fabric has been done and the experimental results in Figure.2. shows that the tensile strength of light shade fabric is less than darker shade fabric.

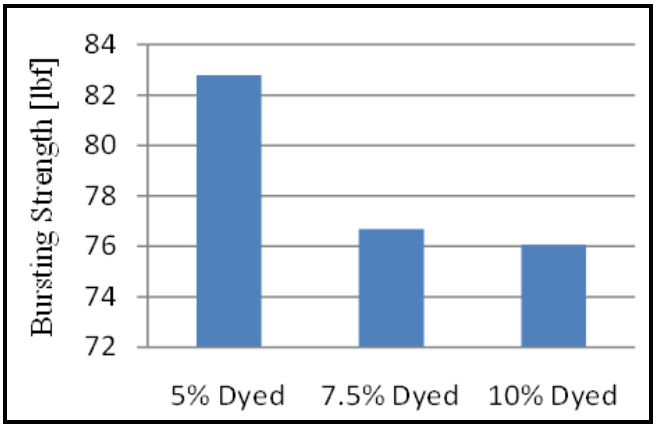


Figure 2. Fabric strength of 5%, 7.5% and 10 % dyed fabric

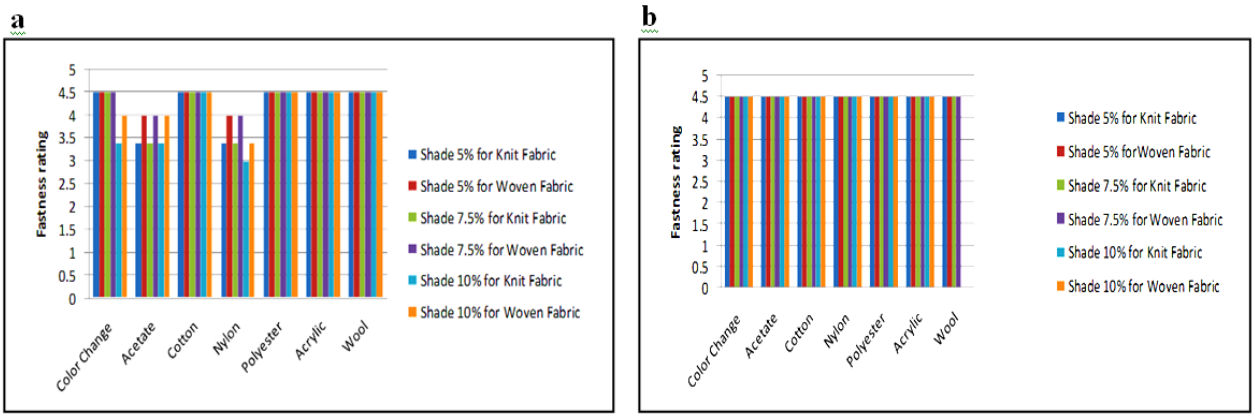


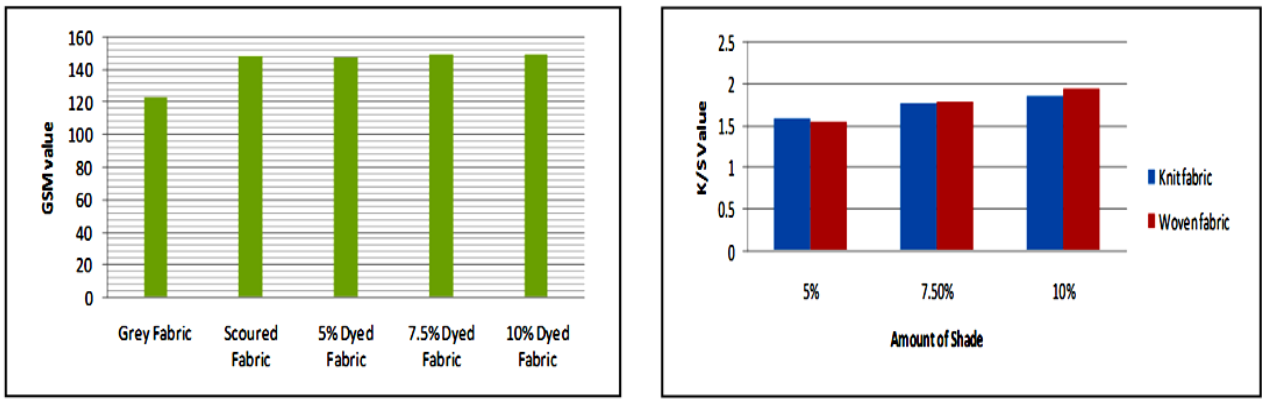
Figure. 3. (a) Graphical representations of Color fastness to wash; (b) Graphical representations of color fastness to Perspiration

3.3. Measurement of Weight Per Unit Area

The mass units (gm/m^2) were measured of dyed samples .Form the below Figure. 4(a) it is clear that with increasing the shade percentage of the fabric, the GSM (gm/m^2) of dyed fabric will also increased due to more absorption of dyestuff.

3.4. Measurement of Color Strength

The color strength (K/S value) was assessed for knit fabrics and woven fabrics dyed by different shade. For increasing the percentage of dye in the fabric, the K/S value also increased. Considering the results, the Figure. 4.(b) shows that the results were comparatively same for woven and knit dyed samples.



a b

Figure. 4. (a) Graphical representation of different dyed shade fabric GSM; (b)Graphical representation of K/S value comparison between knit dyed and woven dyed fabric.

3.5. Measurement of Color Difference Value

CMC values for different shade percentages are estimated from the woven dyed fabrics and knit dyed fabric. CIE color coordinates include color qualities in terms of L* (lightness and darkness), a* (redness and greenness), b* (yellowness and blueness), c* (chroma) H (hue) of the fabrics are shown in **Table 3**. The ΔE values of differently dyed fabrics. ΔE value contains the information of color depth, shade, and the hue of a sample. ΔE value is calculated by using the CIE L*, a*, and b* values with the equation $\Delta E = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})^{1/2}$ where ΔL*,Δa*, and Δb* values were the difference between L* ,a*, and b* values of a pair of color standard and sample. The larger the ΔE value, the greater will be the color difference between this pair of color standard and sample. The experiment was carried out under light source of D65 at 10^0 and the result shows the satisfactory result remarked as "pass". **Table 3** represents that the CMC values for both shade are less than one. The acceptable range of CMC value is always less than one. So the knit dyed and woven dyed fabrics are in the acceptable range.

Table 2. Stiffness of Grey, 5%, 7.5% and 10% Dyed Fabric

Sl. No.	Types of Fabric	Bending Length [cm]
01	Grey Fabric	2.1
02	5% Dyed Fabric	1.05
03	7.5% Dyed Fabric	1.2
04	10% Dyed Fabric	1.35

Table 3. CMC values of dyed fabric

Shade %	CMC	ΔE	ΔL	Δa	Δb	ΔC	ΔH	Comments
7.5	0.88	2.48	1.50	-1.49	1.29	1.75	0.92	Pass
10	0.97	2.84	1.64	-0.04	-2.31	-2.16	0.82	Pass

3.6. Stiffness Testing

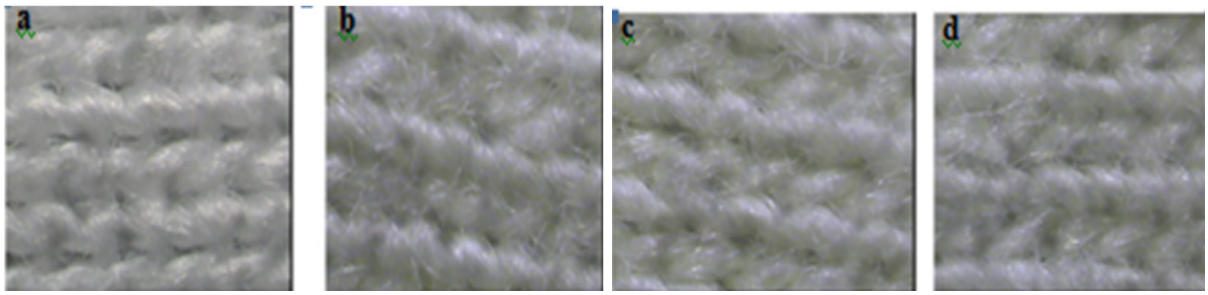


Figure 5. Surface view on Scanning Electronic Microscope (a)Grey fabric ;(b)5% Shade ; (c)7.5% shade; (d) 10% shade

The above SEM image shows that nominal structural changes between the samples (a,b,c,d) of dyed fabric for different shades.

4. Conclusions

This paper shows the properties of dyed knit fabric with fluorescent dye. It shows that the bursting strength of dyed knit fabrics has a vice versa relationship with shade %. The fastness properties of the knit fabric were more or less similar or sometimes better than woven fabric. Stiffness property of the knit fabric has a proportional relationship with shade % . Also the above discussed results reflect that, GSM value was similar to scoured fabric with dyed fabric. CMC value was less than "1" compare to similar shade woven fabric and k/s value and reflectance were more or less similar of the knit dyed fabric. The shade % also has a positive impact on fabric stiffness. The results show no adverse effect on knit fabric during dyeing with fluorescent dye and it can be concluded that the properties of dyed knit fabric has no negative impact during used by fluorescents dyes in dying process.

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