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Study on Color Strength of Different Reactive Dyes

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Abstract

The use of reactive dyed products has dramatically increased over the last 50 years. Reactive coloring components are inert into materials which are adhered to the base substrate by the application of soda ash which act as fixing agent. The aim of our project is to know the color strength of Mono-flurotriazine-vinyl sulphone (MFT/VS), Mono-chlorotriazine-vinyl sulphone (MCT/VS) and Tri-Fluoro-Pyrimidine-Vinyl Sulphone (TFP/VS) reactive dyes. To fulfill the job at first the cotton fabric was scoured and bleached. Then dyeing was carried out with MCT/VS, MFT/VS and TFP/VS reactive dyes by exhaust method. For each types of reactive dye, light shade (0.5%), medium shade (1%) and deep shade (1.5%) were produced. After that K/S values were measured of each reactive dyed fabric. Also color fastness to wash was measured to observe the dyed fabric quality. Among the investigated reactive groups MCT/VS reactive dyes showed highest color strength and MFT/VS reactive dyes showed lowest color strength. The rating of color fastness to wash was found higher in MCT/VS reactive dyed samples and the lower rating was observed in TFP/VS reactive dyed samples.

Keywords: Color strength; Reactive dye; Dyed fabric; Cotton fabric; Reflectance

Introduction

Reactive dyes are colored compounds that contain functional groups capable of forming covalent bonds with active sites in fibers such as hydroxyl groups in cellulose, amino, thiol and hydroxyl groups in wool or amino groups in polyamides. Bond formation between the functional groups and substrate; result in high wet fastness properties. The commercial application of reactive dyes in the dyeing of cellulose, wool and nylon, either individually or compounds of fiber blends. These dyes also have their application in dyeing silk, hair and leather. Cotton is vastly used fiber in textile sector. Reactive dye is suitable for cotton fabric. There are various types of reactive dyes. Among them Mono-flurotriazine-vinyl sulphone (MFT/VS), Mono-chlorotriazine-vinyl sulphone (MCT/VS) and Tri-Fluoro-Pyridine-Vinyl Sulphone (TFP/VS) were used in this project to identify their color strength, color difference and color fastness to wash. Strength of any colorant (dyestuff / pigment) is related to absorption property. We measure reflectance and not absorbance. It is known to us that when reflectance is more, absorbance is less and when reflectance is less, absorbance is more. Here the dye contains a reactive group and this reactive group makes covalent bond with the fiber polymer and act as an integral part of fiber. This covalent bond is formed between the dye molecules and the terminal –OH (hydroxyl) group of cellulosic fibers on between the dye molecules and the terminal $–NH_2$ (amino) group of polyamide or wool fibers. In a reactive dye a chromophore contains a substituent that reacts with the substrate. Reactive dyes have good fastness properties owing to the bonding that occurs during dyeing. Reactive dyes are most commonly used in dyeing of cellulose like cotton or flax, but also wool is dye able with reactive dyes. Reactive dyeing is the most important method for the coloration of cellulosic fibers. Reactive dyes can also be applied on wool and nylon; in the latter case they are applied under weakly acidic conditions. Reactive dyes have a low utilization degree compared to other types of dyestuff, since the functional group also bonds to water, creating hydrolysis [1].

Materials and Methods

Materials

Fabric specification

- Fabric type: Cotton (100%)
- Fabric state: Grey
- GSM: 160

Chemicals and auxiliaries used

- Reactive dye (MCT/VS, MFT/VS and TFP/VS)
- Caustic soda
- Hydrogen peroxide
- Peroxide stabilizer
- Peroxide killer
- Detergent
- Glauber salt
- Wetting agent
- Sequestering agent
- Levelling agent
- Soda ash

Machines used

- Sample dyeing machine
- Wash fastness tester machine
- Electric balance
- Oven

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- Dryer
- Spectrophotometer (Data Color Machine)

Methods

Pretreatment: In pretreatment, the scouring and bleaching process were performed in same bath. By scouring and bleaching process the absorbency of fabric increased as per requirement for a good quality fabric. The process was performed by exhaust method (Table 1 and Figure 1)

A) Recipe

- NaOH: 3 g/L
- Wetting agent: 1 g/L
- Sequestering agent: 1 g/L
- Detergent: 1 g/L
- H_2O_2: 3 g/L
- Peroxide stabilizer: 0.5 g/L
- pH: 10-11
- Temperature: 90-95°C
- Time: 40-50 min
- M:L 1:50

b) Procedure

At first the additional water is taken to the dye bath. Then all the required auxiliaries are taken to the dye bath and stirred till dissolved properly. Then the fabric immersed in the dye bath liquor and temperature about to 90-95°C and the pH should be maintained at 10-11. This process was for 40-50 minutes. After completing scouring and bleaching drain out the liquor from dye bath and cold wash [2].

MFT/VS type reactive dye			
Shade%	Salt (g/l) (20% stock solution)	Soda ash (g/l) (5% stock solution)	Leveling agent (g/l) (2% stock solution)
0.5% (Red, Yellow, Blue)	30	3	1
1.0% (Red, Yellow, Blue)	40	5	1
1.5% (Red, Yellow, Blue)	60	8	1
Time		40 min	
Temperature		60°C	
M:L		01:10	

Table 1: MFT/VS type reactive dye.

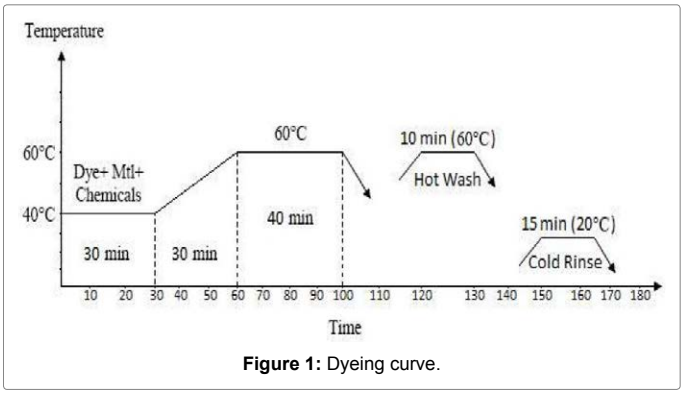

Figure 1: Dyeing curve.

Peroxide killing process

A) Recipe

- Peroxide killer enzyme: 3 g/L
- Acetic acid: 1 g/L
- Temperature: 40-50°C
- Time: 20 min
- pH: 4-5
- M:L 1:50

b) Dyeing: Dyeing of cotton fabric was done with different reactive dyes containing MCT/VS, MFT/VS and TFP/VS reactive groups by sample dyeing machine (Figure 2).

c) Procedure: At first required dye, salt, soda ash and leveling agent was taken in a dye bath at room temperature. Then fabric was immersed into dye bath and kept into a sample dyeing machine. Then fabric was dyed for 30 min at 60°C. After dyeing the fabric was taken out from dye bath and washed with acid and detergent individually. After washing the fabric was dried with the help of dryer [3,4].

Testing

Measurement of K/S value The K/S value was assessed by Spectrophotometer to observe the color strength of different reactive dyes which works on Kubelka-Munk equation:

$$\frac{K}{S}=\frac{(1-R)^2}{2R}$$

Where, R is the decimal fraction of the reflectance of dyed fiber.

Where R=1.0 at 100% reflectance.

Relationship of K/S to concentration

K/S=kc

Where

K=light absorbed

S=light scattered

k=constant of proportionality

C=concentration of colorant

Since K/S factors for each dye at a particular

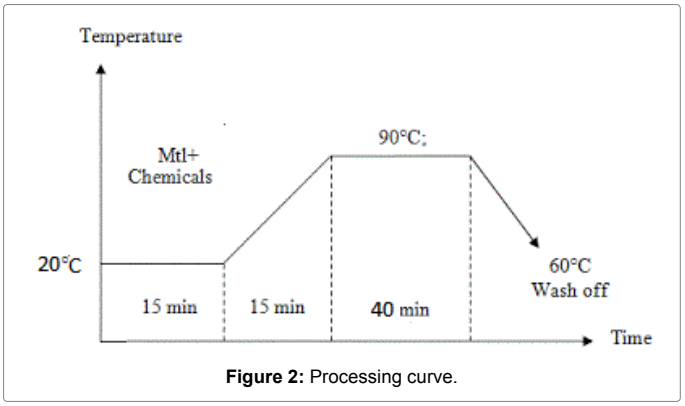

Figure 2: Processing curve.

Color difference (ΔE)

Color difference was observed by spectrophotometer to see the color difference between different reactive dyed fabric.

Color difference denoted by ΔE

Color difference according to ΔL*, Δa*and Δb* is

$$\Delta E=[(\Delta L^*)^2+(\Delta a^*)^2+(\Delta b^*)^2]^{1\backslash 2}$$

Where,

ΔL*=Difference in lightness/darkness value, +ve represents lighter and -ve represents darker

Δa*=Difference on Red/Green axis, +ve represents Redder and -ve represents Greener

Δb*=Difference on Yellow/Blue axis, +ve represents Yellower and -ve represents Bluer.

ΔC*=Difference in chroma, +ve represents brighter and -ve represents duller.

Δh*=Difference in hue.

Color fastness to wash of dyed fabric

Color fastness to wash was measured according to the I.S.O test method-105. It was measured to know the dyed fabric quality.

Results and Discussion

Color strength

K/S values of different reactive dyed samples for 0.5% shade (red): The K/S values of MCT/VS have higher strength than MFT/VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 0.5% shade (red) (Figure 3).

K/S values of different reactive dyed samples for 1% shade (red): The K/S values of MCT/VS have higher strength than MFT/VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 1% shade (red) (Figure 4).

K/S values of different reactive dyed samples for 1.5% shade (red): The K/S values of MCT/VS have higher strength than MFT/VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 1.5% shade (red) (Figure 5).

K/S values of different reactive dyed samples for 0.5% shade (yellow): The K/S values of MCT/VS have higher strength than MFT/VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 0.5% shade (yellow) (Figure 6).

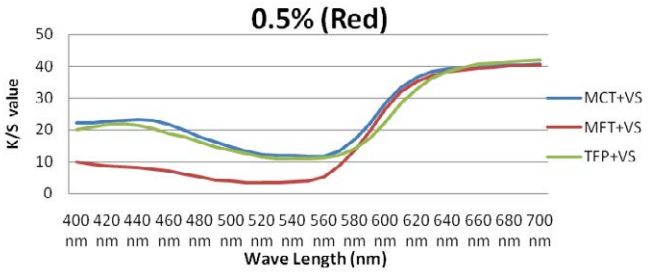

Figure 3: K/S values of different reactive dyed samples for 0.5% shade (Red).

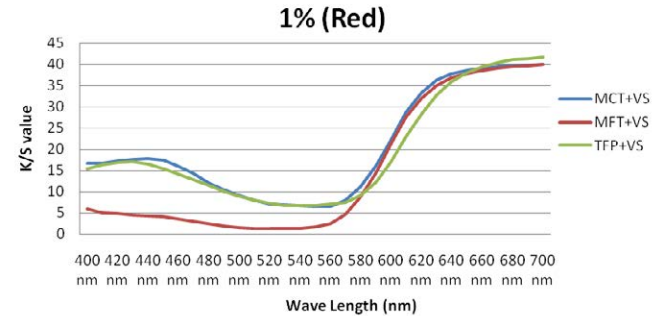

Figure 4: K/S values of different reactive dyed samples for 1% shade (Red).

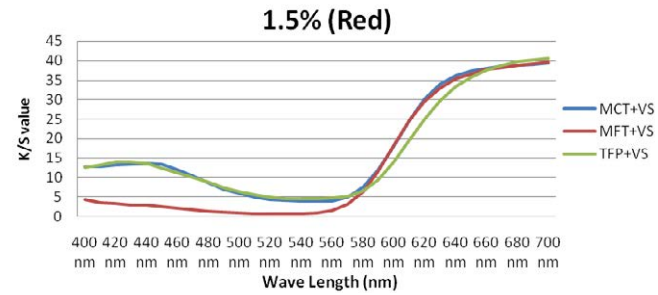

Figure 5: K/S values of different reactive dyed samples for 1.5% shade (Red).

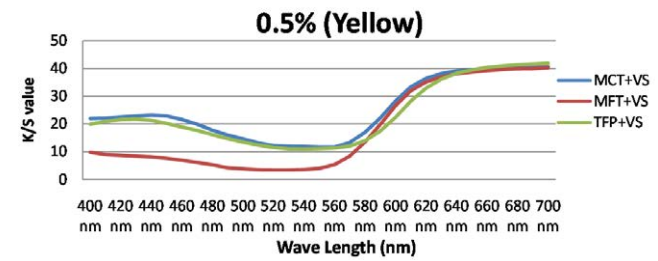

Figure 6: K/S values of different reactive dyed samples for 0.5% shade (yellow).

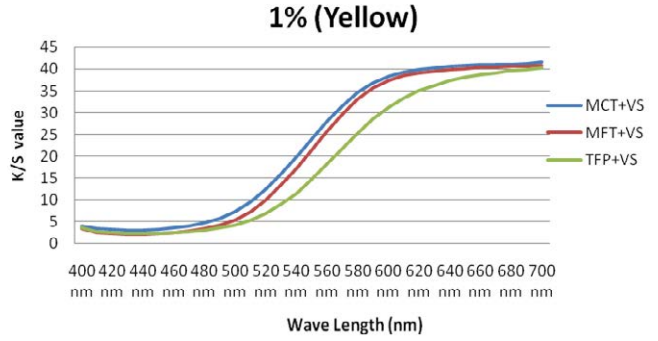

Figure 7: K/S values of different reactive dyed samples for 1% shade (yellow).

K/S values of different reactive dyed samples for 1% shade (yellow): The K/S values of MCT/VS have higher strength than MFT/VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 1% shade (yellow) (Figure 7).

K/S values of different reactive dyed samples for 1.5% shade (yellow): The K/S values of MCT/VS have higher strength than MFT/

VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 1.5% shade (yellow) (Figure 8).

K/S values of different reactive dyed samples for 0.5% shade (blue): The K/S values of MCT/VS have higher strength than MFT/VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 0.5% shade (blue) (Figure 9).

K/S values of different reactive dyed samples for 1% shade (blue): The K/S values of MCT/VS have higher strength than MFT/VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 1% shade (blue) (Figure 10).

K/S values of different reactive dyed samples for 1.5% shade (blue): The K/S values of MCT/VS have higher strength than MFT/VS and TFP/VS reactive groups. So, it is concluded that MCT/VS has high color strength for 1.5% shade (blue) (Figure 11).

Color difference

Color difference was measured to see the color difference of reactive dyes of different reactive groups of same shade%. According to spectrophotometer reading, ΔE shows the color difference between TFP/VS and MCT/VS reactive groups and between TFP/VS and MFT/VS reactive groups. The color difference between different reactive groups was found because of different color strength of different reactive dyes.

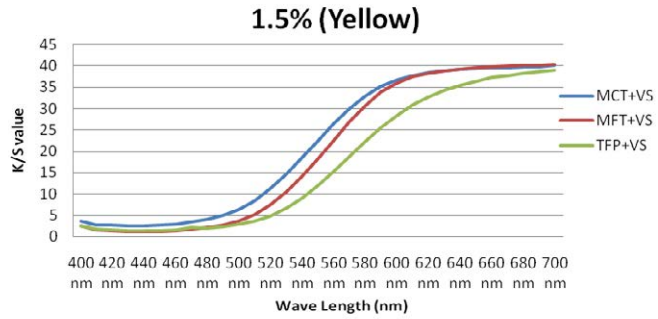

Figure 8: K/S values of different reactive dyed samples for 1.5% shade (yellow).

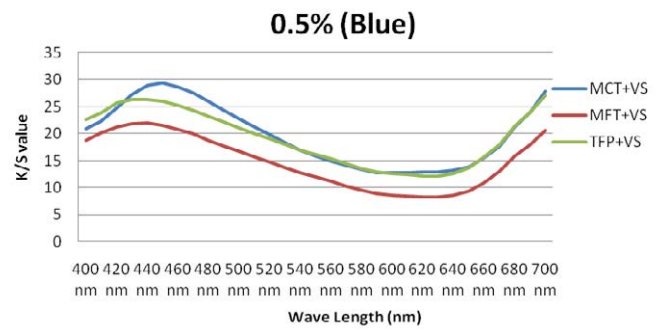

Figure 9: K/S values of different reactive dyed samples for 0.5% shade (blue).

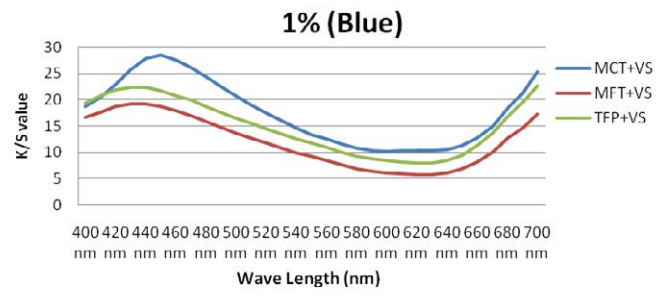

Figure 10: K/S values of different reactive dyed samples for 1% shade (blue).

The color difference between TFP/VS and MCT/VS showed less color difference for 0.5% (red) and color difference between TFP/VS and MFT/VS showed more color difference for 1.5% (red) (Table 2).

The color difference between TFP/VS and MFT/VS showed less color difference for 0.5% (yellow) and color difference between TFP/VS and MCT/VS showed more color difference for 1.5% (yellow) (Table 3).

The color difference between TFP/VS and MFT/VS showed less color difference for 1.5% (blue) and color difference between TFP/VS and MFT/VS showed more color difference for 0.5% (blue) (Table 4).

Color fastness to wash

MCT/VS type reactive dyed fabric (Table 5); MFT/VS type reactive dye (Table 6); TFP/VS type reactive dye (Table 7).

Conclusion

- Color strength is very important parameter for dyeing. Higher the color strength of reactive dyes higher the color yield and

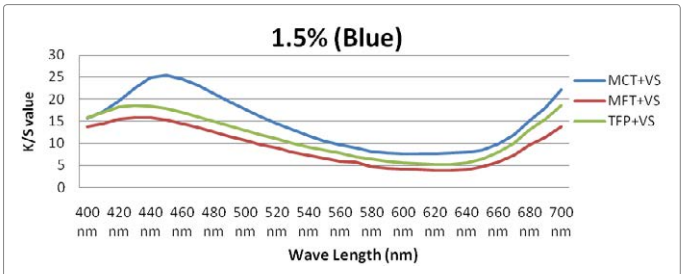

Figure 11: K/S values of different reactive dyed samples for 1.5% shade (blue).

Standard: TFP/VS	ΔE=1.75
Trial: MCT/VS	
Standard: TFP/VS	ΔE=18.64
Trial: MFT/VS	

Table 2: Color difference between TFP/VS and MCT/VS showed less color difference for 0.5% (red) and color difference between TFP/VS and MFT/VS showed more color difference for 1.5% (red).

	Yellow 0.5%	Yellow 1%	Yellow 1.5%
Standard: TFP/VS	ΔE=8.56	ΔE=10.02	ΔE =11.10
Trial: MCT/VS			
Standard: TFP/VS	ΔE=7.70	ΔE=8.90	ΔE=8.60
Trial: MFT/VS			

Table 3: Color difference between TFP/VS and MFT/VS showed less color difference for 0.5% (yellow) and color difference between TFP/VS and MCT/VS showed more color difference for 1.5% (yellow).

	Blue 0.5%	Blue 1%	Blue 1.5%
Standard: TFP/VS	ΔE=2.35	ΔE=2.74	ΔE=3.22
Trial: MCT/VS			
Standard: TFP/VS	ΔE=3.40	ΔE=2.25	ΔE=2.21
Trial: MFT/VS			

Table 4: Color difference between TFP/VS and MFT/VS showed less color difference for 1.5% (blue) and color difference between TFP/VS and MFT/VS showed more color difference for 0.5% (blue).

Fabric Color	Change value	Remark	Staining value	Remark
Blue	Light shade: 4	Good	Light shade:5	Excellent
	Deep shade: 4	Good	Deep shade: 4/5	Good
Yellow	Light shade:4/5	Very good	Light shade:4/5	Good
	Deep shade: 4	Good	Deep shade: 4/5	Good
Red	Light shade: 4/5	Very good	Light shade: 5	Excellent
	Deep shade: 4/5	Very good	Deep shade: 5	Excellent

Table 5: MCT/VS type reactive dyed fabric.

Fabric Color	Change value	Remark	Staining value	Remark
Blue	Light shade: 3/4	Average	Light shade: 4/5	Very good
	Deep shade: 3	Fairly bad	Deep shade: 4	Good
Yellow	Light shade: 5	Excellent	Light shade: 4/5	Very good
	Deep shade: 4/5	Very Good	Deep shade: 4	Good
Red	Light shade: 5	Excellent	Light shade: 5	Excellent
	Deep shade: 5	Excellent	Deep shade: 4/5	Very good

Table 6: MFT/VS type reactive dye.

Fabric Color	Change value	Remark	Staining value	Remark
Blue	Light shade: 3/4	Average	Light shade: 4/5	Very good
	Deep shade: 4	Good	Deep shade: 4	Good
Yellow	Light shade: 4/5	Very good	Light shade: 4/5	Very good
	Deep shade: 5	Excellent	Deep shade: 4/5	Very good
Red	Light shade: 4/5	Very good	Light shade: 4/5	Very good
	Deep shade: 4/5	Very good	Deep shade: 5	Excellent

Table 7: TFP/VS type reactive dye.

lower the dyes required to produce the same shade%. In this study color strength of MCT/VS, MFT/VSandTFP/VS reactive dyes were observed by K/S value. According to the results, MCT/VS reactive dyes showed highest color strength and MFT/VS reactive dyes showed lowest color strength. Color fastness to wash of dyed samples was also observed. MCT/VS reactive dyed fabric showed highest resistance to color fastness to wash and TFP/VS reactive dyes showed lowest resistance to color fastness to wash.

References

1. Broadbent AD (2001) Basic Principles of Textile Coloration. Society of Dyers and Colourists, Canada.
2. Kiron MI (2012) Dyeing Mechanism of Reactive Dye. Textile Learner.
3. Huckell, Lisa W (1993) Plant Remains from the Pinaleño Cotton Cache, Arizona. Kiva Journal of Southwest Anthropology and History 59: 147-203.
4. Kiron MI (2012) Dyeing of Cotton Fabric with Reactive Dyes. Textile Learner.

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