Faculty of Engineering

Department of Textile Engineering

Project (Thesis) Report on

Study on Determination of Color Depth in Dependence on Concentration for Reactive Dyed Knitted Cotton Materials and Analysis Their K/S, Wash and Rubbing Fastness

Course Code: TE 4214 Course Title: Project (Thesis)

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A Thesis report submitted in partial fulfillment of requierments for the degree of

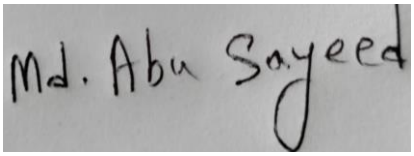
Bachelor of science in Textile Engineering

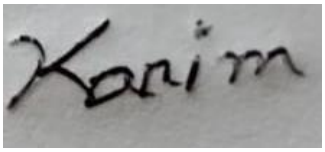
Major in Wet Processing Technology

DECLARATION

I am pleased to inform that I completed this Thesis report under the guidance of Md. Kamrul Islam, Lecturer, Department of Textile Engineering, Faculty of Engineering, Daffodil International University. Additionally, I hereby announce that this article or any part it has been presented in consideration for any degree award.

Submitted by:





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LETTER OF APPROVAL

This thesis report was made by Md Abu Sayeed (ID:191-23-570) and Md Karim Khan (ID: 191-23-596) has partially approved to meet the requirements for degree of Bachelor of Science in Textile Engineering. The above mentioned students have completed their thesis work under my supervision. During the research, I discovered them to be sincere, hardworking and enthusiastic.

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ACKNOWLEDGEMENT

At first, we very grateful to the Almighty Allah for giving us good health and well- being were necessary to complete this thesis. We are very thankful to our mentor Md. Kamrul Islam, a lecturer in the department of textiles. Engineering, Daffodil International University's Faculty of Engineering. Our supervisor's extensive expertise and passionate interest in textile dyeing and finishing, as well as his unending patience, academic guidance, regular encouragement, active supervision, constructive criticism, helpful counsel, and significantly less reading, encouraged us to complete our thesis. This thesis has been after extensive drafting and revision.

For his gracious assistance in bringing our Project Thesis report to a conclusion, I would like to thank Md. Mominur Rahman, Head (In-Charge) of Daffodil International University and Department of Textile Engineering, Faculty of Engineering. Finally, we would like to thank our entire course partners at Daffodil International University .who participated in the discussion during the completion and writing of the Thesis report.

Dedication

This Project (Thesis) report is dedicated to my love with the affection, love, inspiration and prayers of my father, mother and my sisters and teachers, I have been able to achieve such success and respect.

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Abstract

In this study dyeing is done for 100% cotton knitted cotton fabric with reactive dye at various shade percentage. Used shade percentages are 2%, 3%, 5%,6%,7%. The method of dyeing is Exhaust dyeing for 100% cotton knitted fabrics.

The main focus of this study is to determine the saturation level of reactive dyes for dyeing cotton materials. Scouring and bleaching is done in a single bath at 98°C and dyeing is done at 60°C. After the dyeing process, we measured the K/S value by using spectrophotometer for determination of the color strength for 2%, 3%, 5%, 6% & 7%. We have got almost similar K/S value for 6% & 7% shade.

Also find out the fastness properties like color fastness to washing and color fastness to rubbing for 2%, 3%, 5%, 6% & 7% shades of the reactive dye from this experiment. The rating of the color fastness to washing is same for 2%, 3%, 5%, 6% shade. But in 7% shade, it is found that rating of the color fastness to washing is better if we compare with 2%, 3%, 5% & 6%. In addition, the rating of the color fastness to rubbing for 5%, 6% & 7% is very low and higher rating for 2%, 3%. So from this study, we can say that with the increasing shade % rating of the wash fastness is high and rubbing fastness rating become low.

Key Word: reactive dye, cotton fibre, spectrophotometer, color fastness, shade, color strength

CHAPTER -01

INTRODUCTION

1.1 Introduction

Reactive dyes are the most compatible dyes for the cellulosic fibre especially cotton fibre is mostly dyeing with reactive dye due it's fastness qualities and ability to form strong covalent bond with cellulosic fibre. Reactive dye is an anionic dye which contain reactive group. Reactive dye is water soluble dye. This dye imparts brighter shade. This dye is available and cheap.

Cotton fibre is a natural fibre. It is a hollow fibre which is naturally soft, cool and breathable as well as absorbent. Cotton is known as the king of the fibre. Cotton fibre is a cellulosic fibre which has a versatile uses in textile due to its excellent properties. Cotton fibre has good durability. Cotton fibre can be dyed with different dyes like Reactive dye, Direct dye, Sulphur dye, Vat dye. Reactive dye is mostly used for dyeing of the cotton fibre.

Shade is depth of color or hue. It is a widely used term in dyeing. Shade percentages are percentages of the dry weight of the fiber to be dyed that represent the amount of dye used for the dyeing. Color strength is the most crucial factor to consider when evaluating a sample's depth of color-dyed fabric. color strength which is influence by the change of shade percentage. More shade percentage provides more color strength. Color strength varies with the changes of the shade percentage of the dyes.

Color strength of a dye is a strength which defines as the dye's capability to impart color to the other material.

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

Fastness is the resistance of a material to the destructive factor. Color fastness is the capacity of the completed textile's original color to withstand any difficulties that may typically arise during its working lifetime. In addition, it is resistant quality of the textile fabric. Color fastness is the ability to withstand color fading or reduction from the surface of textile materials when subjected to various mechanical, physical, and chemical processes.

Color fastness to wash means the resistance of a material to change in any of its color characteristics as result of washing with household detergent. It is very important fastness properties in colorfastness. If the wash fastness of the dyed textile fibre will not at good, fabric fading will be carried out due to washing.

Rubbing fastness is the capacity of dyed fabrics to maintain their original color when rubbed is referred to as rubbing color fastness. Dry rubbing color fastness describes the circumstance of dyed fabric fading and staining when rubbed with regular white cloth.

The purpose of the study is to determine how color depth varies with reactive dye concentration

CHAPTER-02

Literature Review

2.1 Cotton fibre

Cotton fibers are naturally hollow fibers that are soft, cool, breathable, and absorbent. Cotton fibers can hold up to 24-27 times their own weight in water. They are durable, dye absorbent, and resistant to abrasion and high temperatures. Cotton is, in a word, comfortable. Cotton wrinkles, so combining it with polyester or applying a permanent finish gives cotton garments the proper properties. Cotton fibers are frequently blended with other fibers such as nylon, linen, wool, and polyester to maximize each fiber's properties

2.1.1 Origin of the cotton

Three thousand years ago, cotton was being farmed, spun, and fashioned into textile in the Pakistani Indus River Valley. Natives of Egypt's Nile Valley began producing and using cotton clothes around the same time. Around 800 A.D., Arab traders introduced cotton cloth to Europe. The Bahama Islands were home to cotton farms when Columbus first arrived in America in 1492. By the year 1500, cotton was well-known on a global scale.

It is thought that the first cotton seeds were sown in Virginia in 1607 and Florida in 1556. Cotton was being grown by colonists in Virginia near the James River around 1616. Around England in 1730, the first machine-spun cotton was produced. The major position cotton holds in the globe today was made possible by the industrial revolution in England and the development of the cotton gin in the United States.

The first cotton gin may have been constructed by a machinist named Noah Homes two years before Eli Whitney, a native of Massachusetts, obtained a patent on it in 1793, according to records at the patent office. The work may be completed ten times more quickly by the gin, which is short for engine.

The gin made it possible to supply the rapidly expanding textile industry with vast amounts of cotton fiber. The value of the American cotton crop increased from $150,000 to more than $8 million in just ten years.

2.1.2 Properties of the cotton fibre

1.It is a cellulosic fibre

2. Cross section of the cotton fibre is kidney shape.

3.Moisture regain of the cotton fibre is 8.5

4. Specific gravity of the cotton fibre is 1.54

5. Good resistance to alkali

6. Cotton fibre has low resiliency.

2.1.3 Chemical composition of Cotton fibre

Cellulose: 94%

Protein: 1.3%

Ash: 1.2%

Pectin: 1.2%

Oil, fat and wax: 0.6%

Sugar: 0.3%

Others: 0.9%

2.2 Reactive Dye

Reactive dye is defined as a dye that contains a reactive group that forms a covalent bond with the fiber and functions as an integral component of the fiber.

Reactive dyes get their name from the fact that they are the only type of dye to have a reactive group, which interacts chemically with fiber polymer molecules to form covalent bonds. The reactive group and the terminal amino (-NH2) group of polyamide and wool fibers or the reactive group and the terminal hydroxyl (-OH) group of cellulosic fiber polymer produce this covalent bond. Covalent bonds are stronger than ionic bonds, hydrogen bonds, and the van der Waals force of attraction. The reactive group thus becomes an essential component of the fiber. These are the reason for telling reactive dye.

2.2.1 General structure of Reactive dye:

Here, W= Water solublising group

D = Dye part or Chromogen (colour producing part)

B = Bridging part

R = Reactive group bearing part.

X = Reactive group.

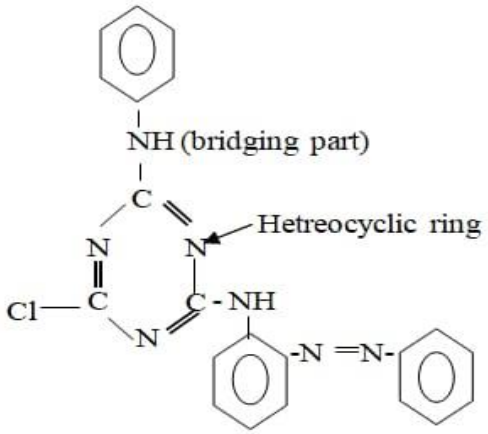
Water solubilizing groups may be -NH2, -NH-CH3, -OH, - NO3, -COOH, -SO3Na.

Bridging groups may be NH-, -NH-CO-, -NH-CO-NH- .

Reactive group bearing part may heterocyclic ring.

Reactive group may be vinyl sulphone, monochlorotriazine, dichlorotriazyne, triazine etc.

2.2.2 Chemical structure



2.2.3 Properties of the reactive dye.

1. Reactive dye is an anionic dye which contain negative charge

2. Reactive dye is water soluble dye.

3. This dye is used for dyeing different types of fibre like cellulosic fibre (cotton,rayon, flax), protein fibre (wool, silk), polyamide fibre(Nylon)

4. Reactive dye which contains reactive group. This reactive group makes strong covalent bond with fibre.

5.Dyeing is done at alkaline condition with the presence of alkali where PH ranges from 10.5-12.5

6.Reactive dyes have good light fastness properties which rating is about 6

7. Wash fastness of the reactive dye is very good with rating 4-5.

8. Rubbing fastness of this dye is moderate.

9. This dye provide brighter shade.

10. This dyes are cheap and method of dyeing is very easy.

2.3 Dyeing mechanism of reactive dye with cotton fibre.

Dyeing mechanism of the reactive dye with cotton fibre is carried out in 3 steps.

They are:

1. exhaustion

2. Fixation

3. Wash off

Exhaustion stage: Cotton fibre is cellulosic fibre. when cotton fibre immersed in dye bath with the solution of reactive dye and other auxiliaries, On the cotton fibre surface negative charge is formed . As reactive dye is anionic so both negative charges are repel with each other. to minimize this problem we need to use electrolyte as a salt. we use sodium chloride or glauber salt as electrolyte. this salt neutralize the negative charge on the fibre surface as a result dye can easily penetrate to fibre. here adsorption, sorption, desorption are occured . when the dye molecule come to the fibre surface then we called adsorption, when dye molecule penetrate into fibre inner suface then it is called sorption. also when dye molecule come out from the inner surface to outer side then it is called desorption. In exhaustion period total amount of dye absorbed by the fibre .

Fixation stage: Fixation stage :in this stage chemically bond is created of cotton fibre with reactive dye. cotton fibre make strong covalent bond with reactive dyes. Here reactive group of the reactive dye makes covalent bond with the terminal hydroxyl group of cellulosic fibre. this fixation occurs in alkaline condition where pH must be more than 7. We need to use soda Ash for maintaining pH of the dye bath where PH ranges from 10.5 to 12. In this way fixation is carried out.

Wash off: Wash off stage : In this stage washing is done with soap to remove unfix dye and chemical from the cotton fibre. It improves wash fastness properties of reactive dyed fabric.

2.4 Color fastness

Fastness is the resistance of a material to the destructive factor. Color fastness is the capacity of the completed textile's original color to withstand any difficulties that may typically arise during its working lifetime. In addition it is resistant quality of the textile fabric. Color fastness is the ability to withstand color fading or reduction from the surface of textile materials when subjected to various mechanical, physical, and chemical processes.

Color fastness to wash means the resistance of a material to change in any of its color characteristics as result of washing with household detergent. It is very important fastness properties in colorfastness. If the wash fastness of the dyed textile fibre will not at good, fabric fading will be carried out due to washing.

Rubbing fastness is the capacity of dyed fabrics to maintain their original color when rubbed is referred to as rubbing color fastness. Dry rubbing color fastness describes the circumstance of dyed fabric fading and staining when rubbed with regular white cloth.

2.5 Color strength

Color strength of a dye is a strength which defines as the dye's capability to impart color to the other material.

Formula of the color strength

K/S value is typically used to describe the color strength of dyed fabric. The reflectance (%) is used to calculate the color strength (K/S) of the dyed samples.

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

2.6 Spectrophotometer

A spectrophotometer is device which is used in color lab of the textile industry to find out how much light a substance absorbs. It is gives the information about color and reflectance percentage . This device that measures spectral transmittance, spectral reflectance. We can find out the color strength of a dyed fabric according to shade percentage.

CHAPTER-03

Materials and method

3.1 Materials

This investigation was conducted using a single jersey made of knitted 100% cotton fabric which GSM OF 160. The fabric sample was well scoured with bleached. Also fabric sample was taken from the textile lab of the Aboni Textile Ltd. From the dye and chemical store of the Aboni textile lab, all necessary dyes and chemicals were taken.

3.2 Table: sample specification

Sample no	Sample type	Sample (gm)	Sample GSM
1	100% knitted S/J cotton fabric	10 gm	160
2	100% knitted S/J cotton fabric	10 gm	160
3	100% knitted S/J cotton fabric	10 gm	160
4	100% knitted S/J cotton fabric	10 gm	160
5	100% knitted S/J cotton fabric	10 gm	160

In this research we use some chemical. Here shows the details of the chemical in the following table

3.3 Table: Chemical use in this experiment

Name of the chemical	Function of chemical
Sequestering agent	To remove water hardness
Soda Ash	To maintain alkaline condition and work as a fixing agent in dyeing of cotton fibre with reactive dye
Glauber salt	It helps to assist exhaustion rate of reactive dye by neutralizing negative charge which form on the cotton fibre surface
Levelling agent	It helps to even distribution of the dye into the fibre
Caustic soda	It also helps to maintain alkaline condition
Peroxide stabilizer	It gives the stabilization during the peroxide bleaching
Hydrogen peroxide	It is used for removing natural color from the fibre
Detergent	It helps to reduce the surface tension of the water also remove natural impurities from the fibre

3.4 Method of the dyeing

To dye the samples, an Eco dyer's quick sample dyeing machine was employed. Using the following recipe, single jersey knitted fabrics made of 100% cotton were dyed.

3.5 Recipe of Dyeing

Recipe for 2% shade of reactive dye with 100% cotton knitted (M:L =1:10, sample weight 10 gm)

Name of the dyes and chemicals	Unit
Reactive dye (Remazol blue)	2%
Sequestering agent	1 g/L (1% stock solution)
Levelling agent	1 g/L (1% stock solution)
Glauber Salt	40 g/L
Soda ash	10 g/L

Recipe for 3% shade of reactive dye with 100% cotton knitted (M:L =1:10, sample weight 10 gm

Name of the dyes and chemicals	Unit
Reactive dye (Remazol blue)	3%
Sequestering agent	1 g/L (1% stock solution)
Levelling agent	1 g/L (1% stock solution)
Glauber Salt	50 g/L
Soda ash	12.5 g/L

Recipe for 5% shade of reactive dye with 100% cotton knitted (M:L =1:10, sample weight 10 gm

Name of the dyes and chemicals	Unit
Reactive dye (Remazol blue)	5%
Sequestering agent	1 g/L (1% stock solution)
Levelling agent	1.5 g/L (1% stock solution)
Glauber Salt	70 g/L
Soda ash	17.5 g/L

Recipe for 6% shade of reactive dye with 100% cotton knitted (M:L =1:10, sample weight 10 gm

Name of the dyes and chemicals	Unit
Reactive dye (Remazol blue)	6%
Sequestering agent	1 g/L (1% stock solution)
Levelling agent	2 g/L (1% stock solution)
Glauber Salt	80 g/L
Soda ash	20 g/L

Recipe for 7% shade of reactive dye with 100% cotton knitted (M:L =1:10, sample weight 10 gm

Name of the dyes and chemicals	Unit
Reactive dye (Remazol blue)	7%
Sequestering agent	1 g/L (1% stock solution)
Levelling agent	2 g/L (1% stock solution)
Glauber Salt	80 g/L
Soda ash	20 g/L

3.6 Dyeing process

1. At first we take 10 gm sample of knitted S/J fabric which is well scoured and bleached.

2. Then we take the water according to recipe calculation .

3. In this step we add sequestering agent to remove water hardness.

4. Then add leveling agent and adding dye.

5. We will add salt and soda.

6.Then we will put the sample into the dye bath.

7.Then increase the temperature 60 degree celcius run time 30 min.

8. After completing dyeing rinsing is done .

9. Hot wash done at 90 degree for 10 min.

10. Finally drying the dyed sample.

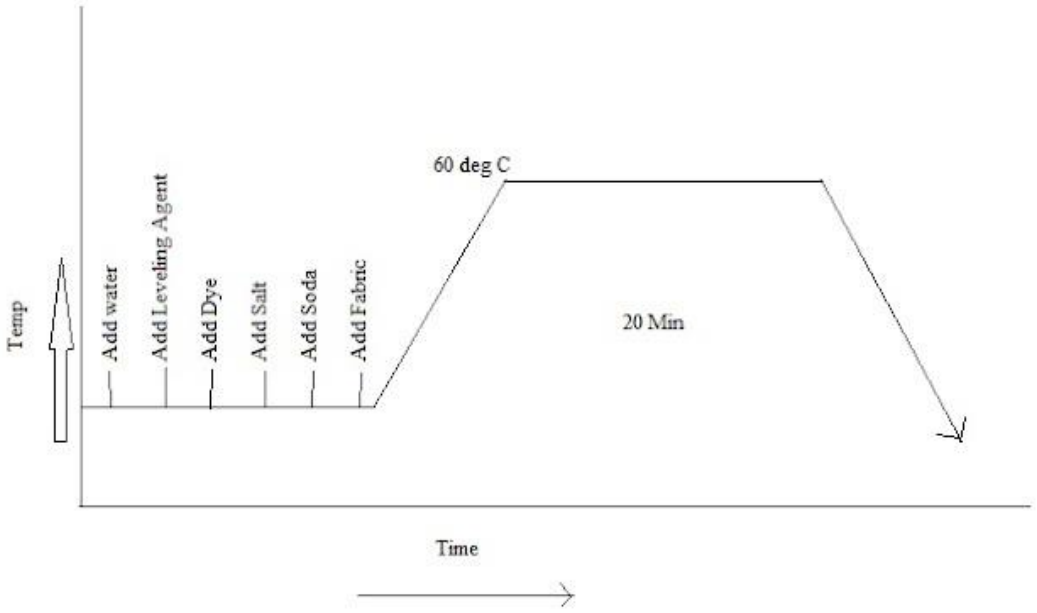


Figure: process curve of dyeing

3.7 After treatment:

After dyeing, a cold wash is performed twice and a normal hot wash is performed twice, followed by acetic acid neutralization and rinsing. After being hydro dyed, the samples were dried in a "Rapid" hydro machine for 3 minutes at a maximum temperature of 140°C.

3.8 Sample attachment for different shade % (2%, 3%, 5%, 6%, 7% shade)

Figure: scoured and bleached sample

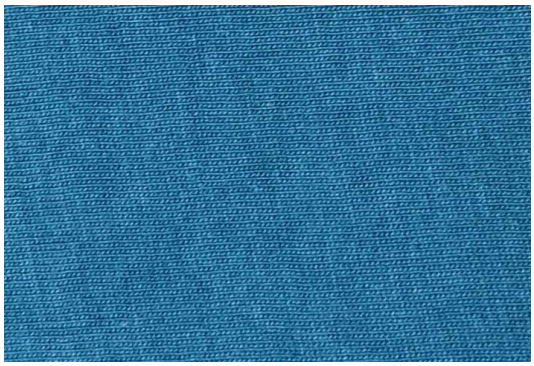


Figure: 2% shade of dyed sample

Figure: 3% shade of dyed sample

Figure: 5% shade of dyed sample

Figure: 6% shade of dyed sample

Figure: 7% shade of dyed sample

3.9 Color strength: Color strength of a dye is a strength which defines as the dye's capability to impart color to the other material.

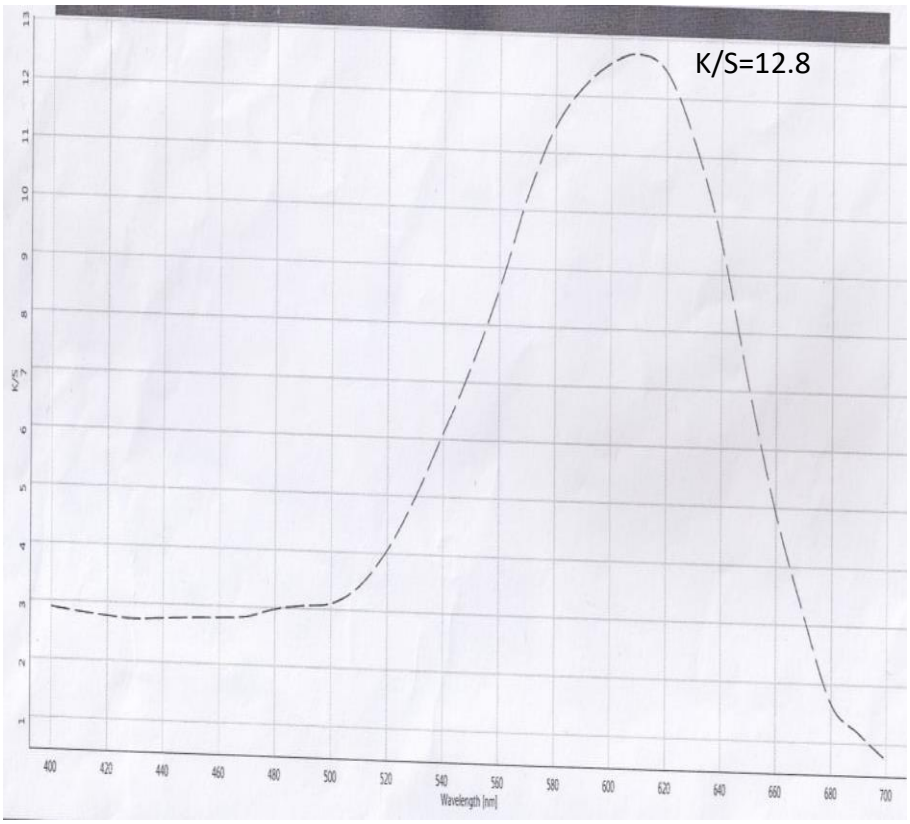
$$K/S = \frac{(1-R)^2}{2R}$$

Here, R denotes reflectance, K denotes absorbance, and S denotes scattering. The color strength of various samples was measured using the above equation.

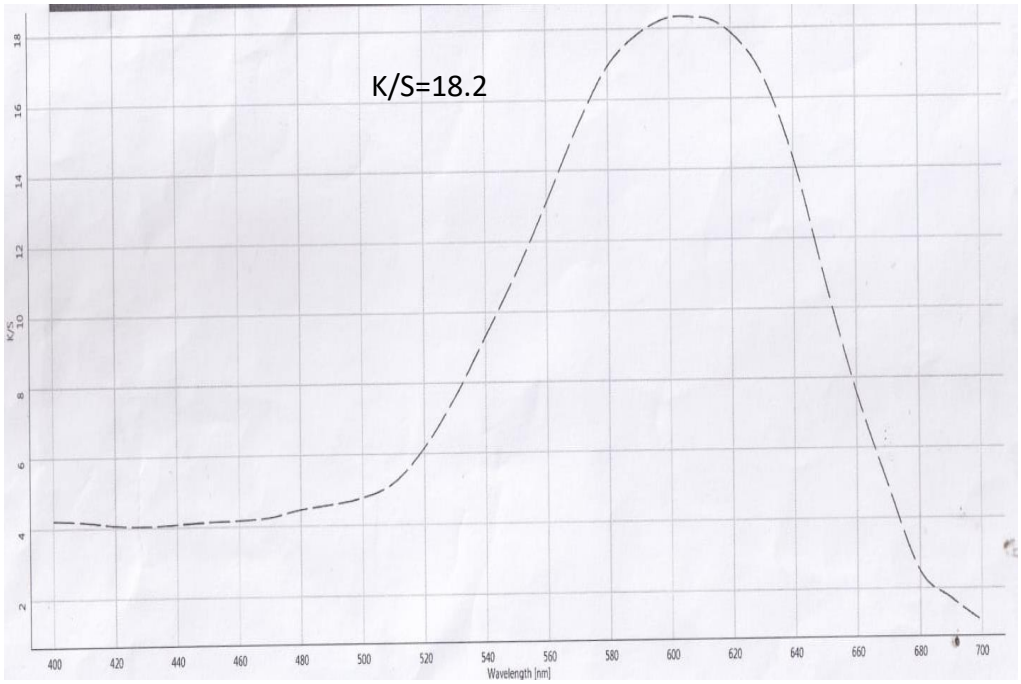
3.9.1 Measurement of color strength

Color strength of the dyed fabrics sample are measured by using data color 850 TM spectrophotometer . this device gives the value of color strength (K/S) through graphical representation.

For each dyed sample graphical representation of the color strength shows below:

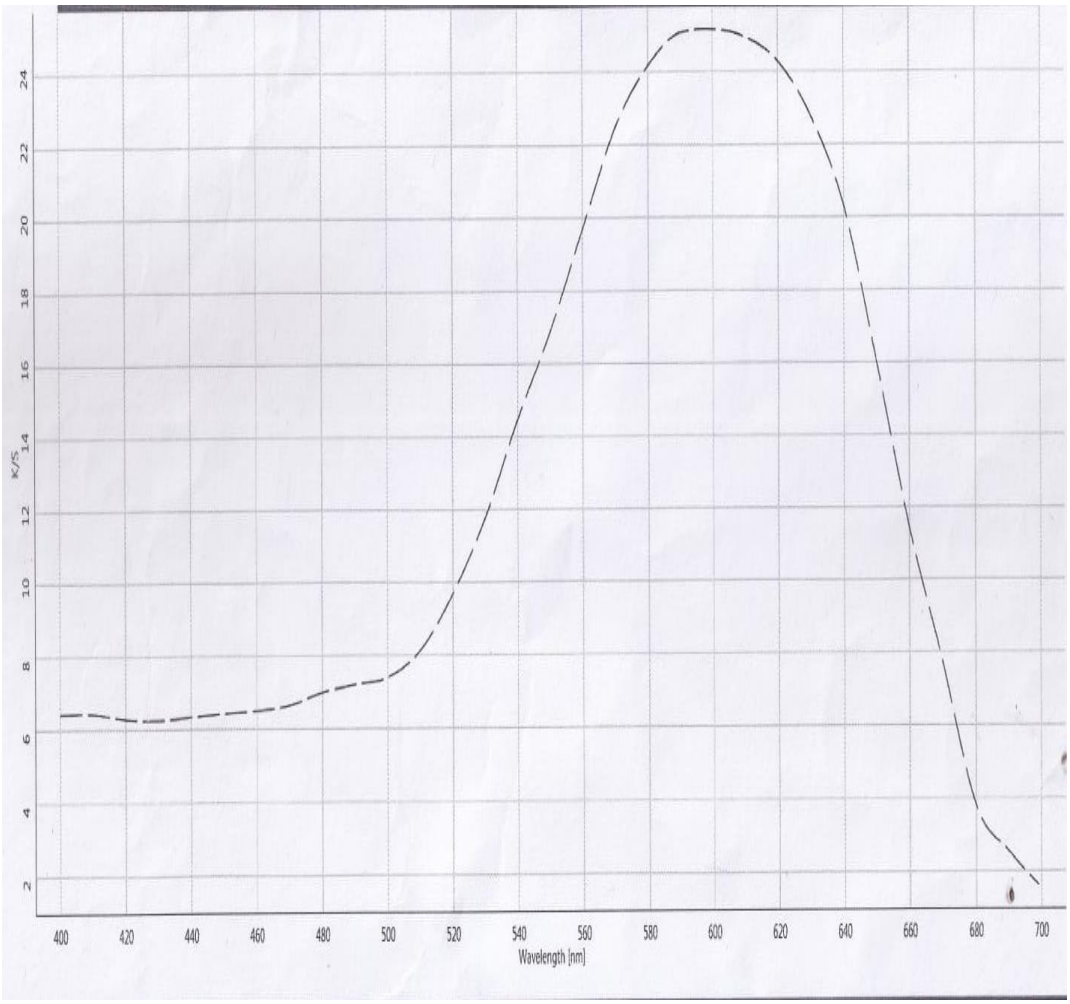


2% shade


K/S=18.2
K/S
Wavelength [nm]
2
4
6
8
10
12
14
16
18
400
420
440
460
480
500
520
540
560
580
600
620
640
660
680
700

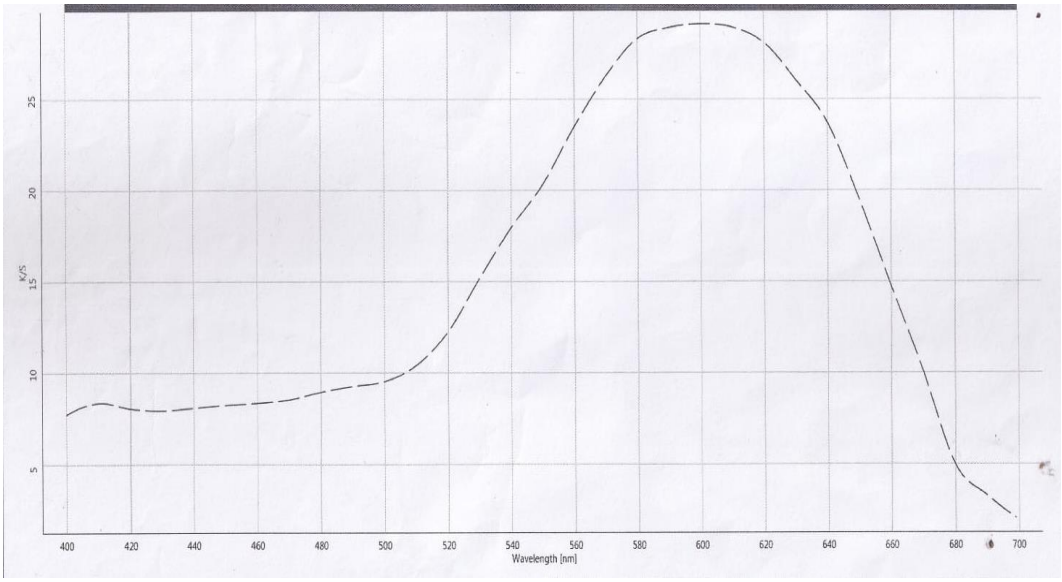
3% shade

K/S=25.5



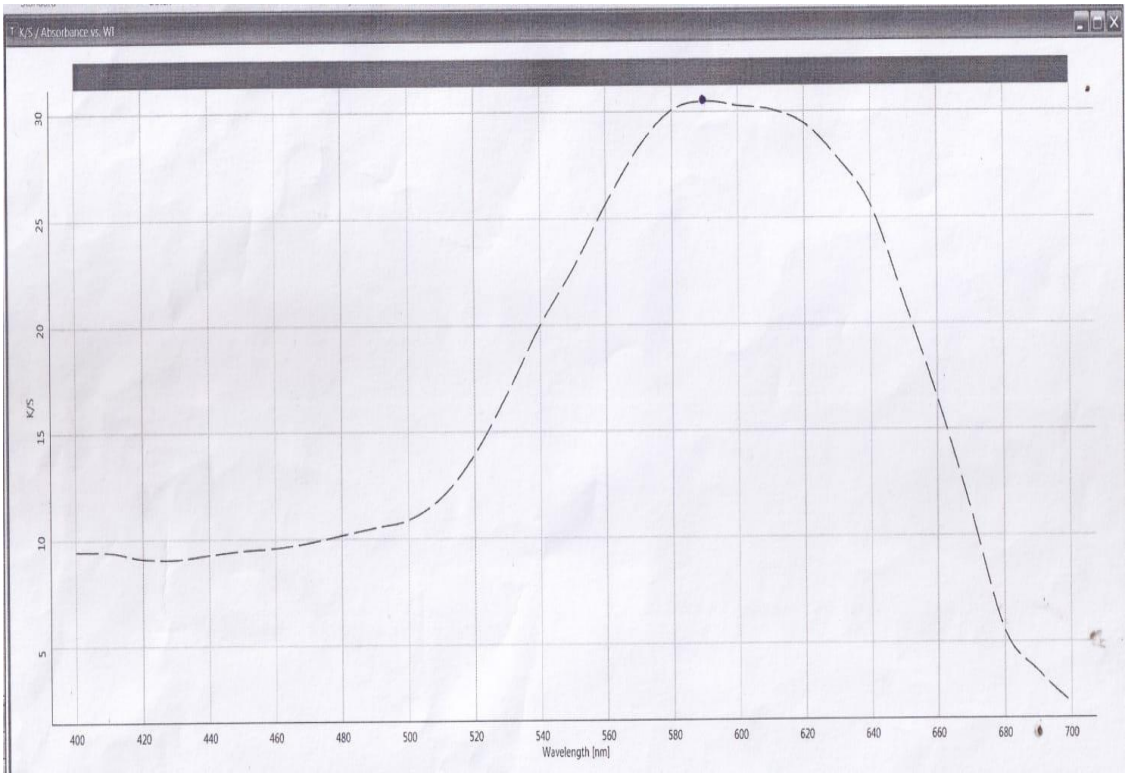
5% shade

K/S=29.6



6% shade

K/S=30.3



7% shade

3.10 Color fastness test:

Testing of Color fastness to wash: In color fastness to wash test ISO 105C06 method was used to test the color fastness of the sample wash. Multi fibre is used to measured color spot. Soak an aggregate sample in a 1:50 liquor solution for a systematic period of time.

30 minutes at 60 degrees Celsius. The staining gray scale was used to assess the outcome of perseverance. This evaluation was carried out on a color matching cabinet in D65 light which is artificial daylight.

3.11 Sample attachment Color fastness to wash of 2%, 3%, 5%, 6%, 7% shade

original

Tested

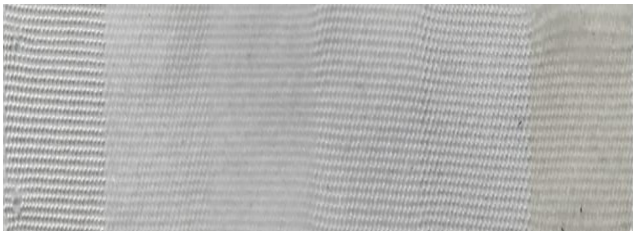


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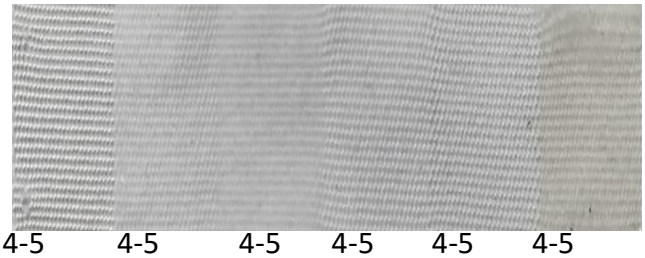
Fig : Color fastness to wash for 2% shade

original

tested

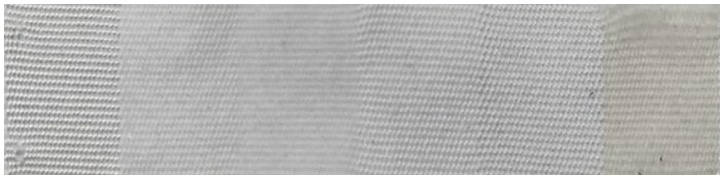


4-5 4-5 4-5 4-5 4-5 4-5

Fig : Color fastness to wash for 3% shade

original

tested

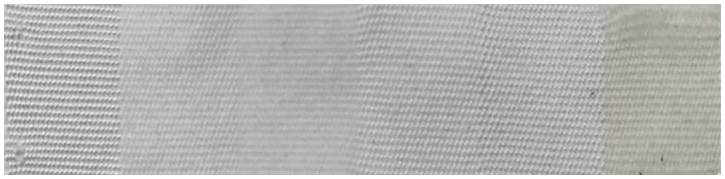


4-5 4-5 4-5 4-5 4-5 4-5

Fig : Color fastness to wash for 5% shade

original

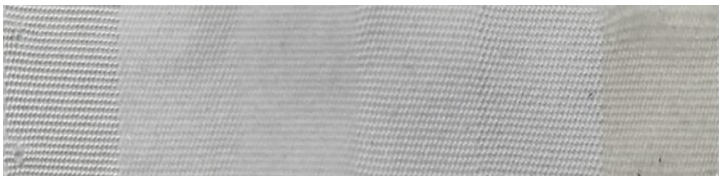
tested



4-5 4-5 4-5 4-5 4-5 4-5

Fig : Color fastness to wash for 6% shade

original



4-5 4-5 4-5 4-5 4-5 4-5

tester

Fig : Color fastness to wash for 7% shade

3.12 Testing procedure of Color fastness to Rubbing: Initial settings for the crock meter include 10 strokes, a stroke length of 100 mm, a downward force of 9 N for typical cloth, and a finger diameter of 16 mm.

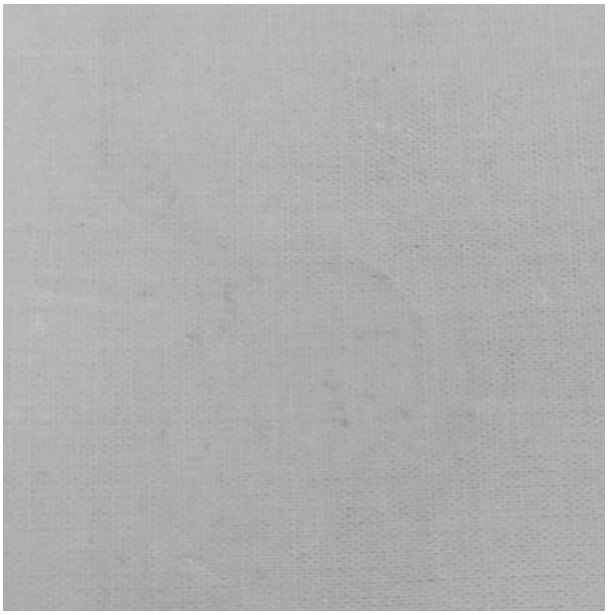
Dry rubbing: Place a clamp on the finger and mount a 5 cm by 5 cm dry cotton rubbing cloth. Start the crock meter, and once the test is through, take a sample of the fabric and a rubbing cloth and set them aside for evaluation

Wet rubbing: Soak the cotton rubbing cloth in distilled water, then squeeze out excess water with blotting paper until it absorbs 65+5% of the water. Repeat the testing with this wet rubbing cloth on the finger. After completing the test, allow the wet rubbing cloth to dry at room temperature before evaluating it.

Assess staining on the rubbing cloth using the grey scale and assign grades accordingly.

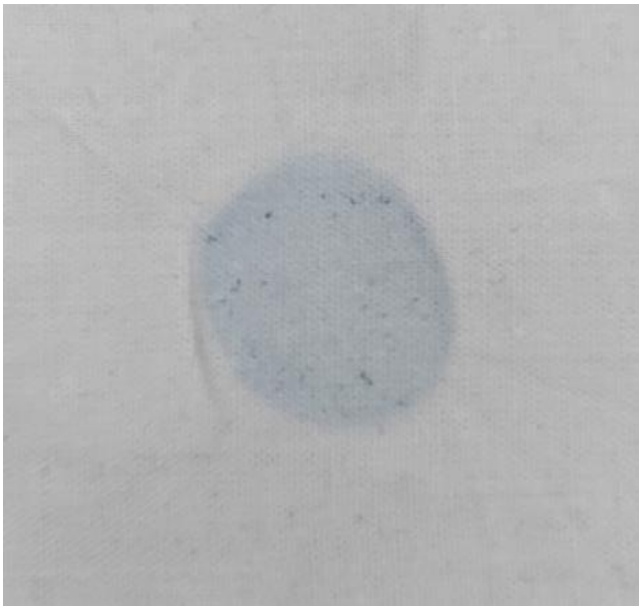
3.13 Sample attachment Color fastness to Rubbing of 2%, 3%, 5%, 6%, 7% shade

Before wash-Dry Rubbing



4-5

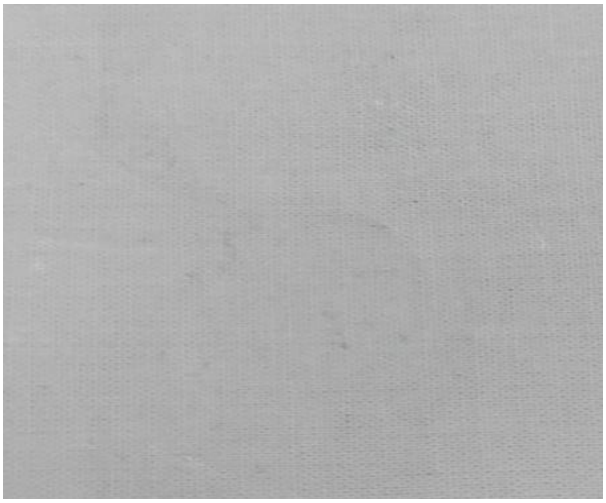
Before Wash-Wet Rubbing



2-3

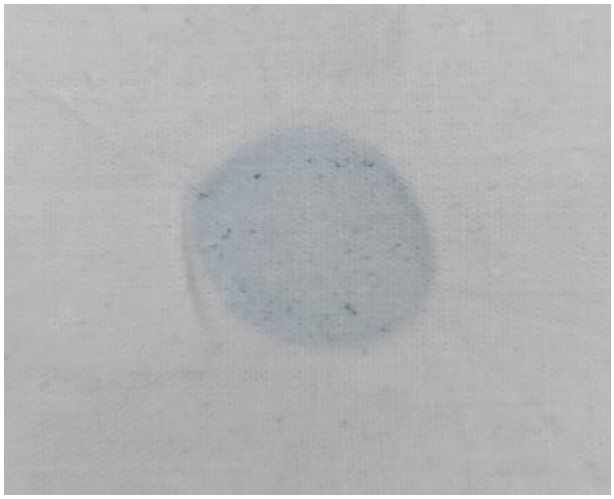
Fig: Color fastness to rubbing for 2% shade

Before Wash-Dry Rubbing



4-5

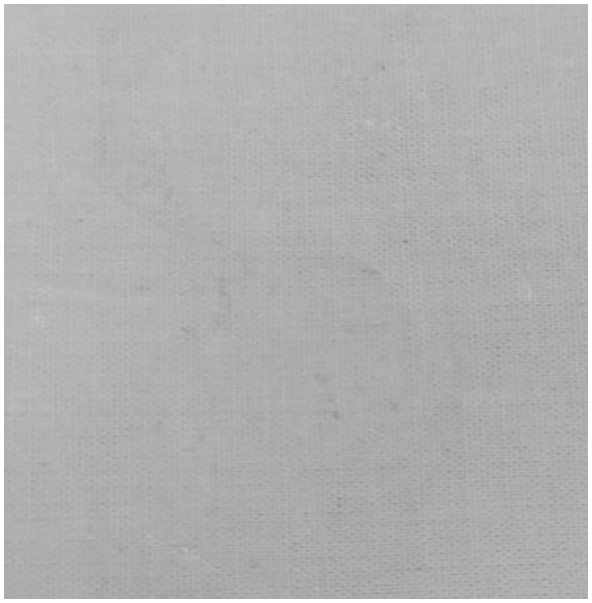
Before Wash-Wet Rubbing



2-3

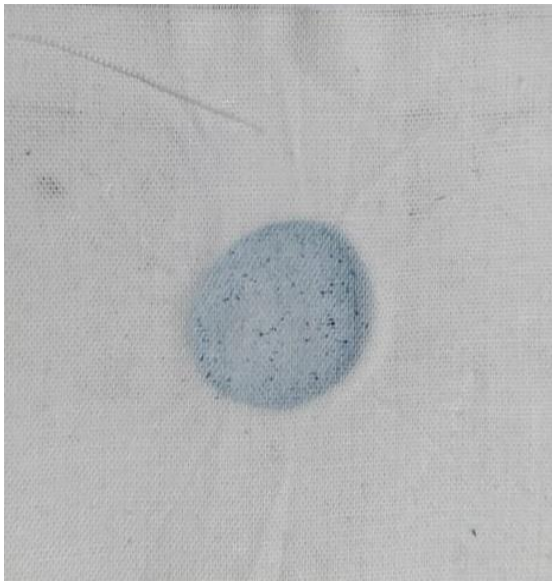
Fig: Color fastness to rubbing for 3% shade

Before Wash-Dry Rubbing



4-5

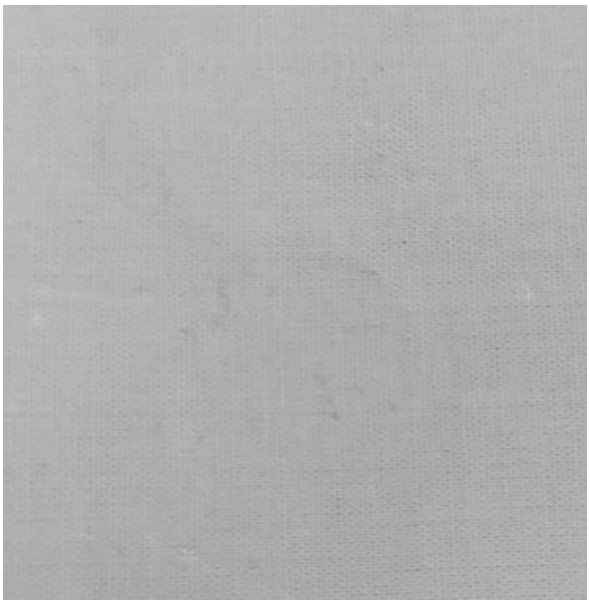
Before Wash-Wet Rubbing



2

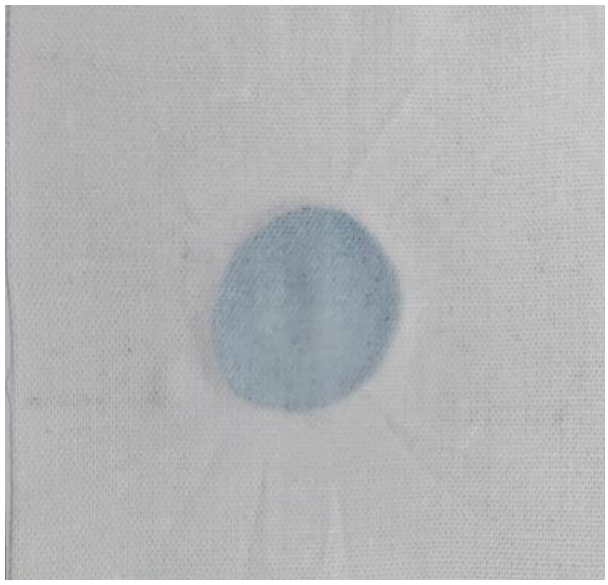
Fig: color fastness to rubbing for 5% shade

Before Wash-Dry Rubbing



4-5

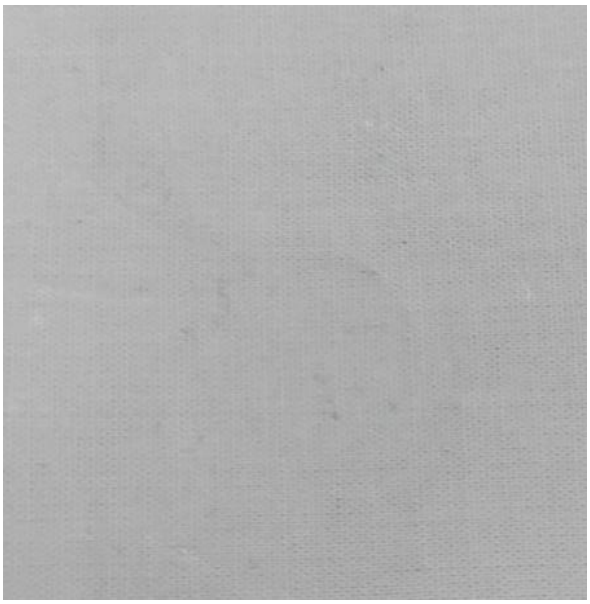
Before Wash-Wet Rubbing



2

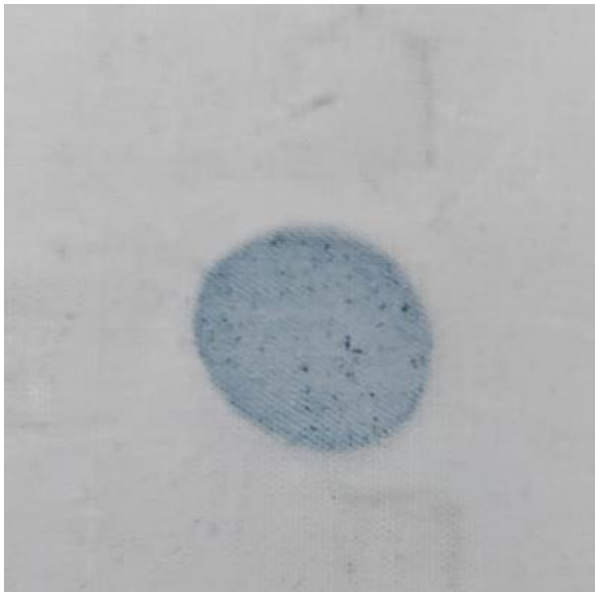
Fig: color fastness to rubbing for 6% shade

Before Wash-Dry Rubbing



4-5

Before Wash-Wet Rubbing



2

Fig: color fastness to rubbing for 7% shade

CHAPTER-04

Result & Discussion:

4.1 Table: Color strength of the dyed fabrics sample according to the shade %

Shade%	Color strength K/S value
2%	12.8
3%	18.2
5%	25.5
6%	29.6
7%	30.3

Here, above the table we can see the color strength K/S value increasing with the increasing of the shade percentage. In this experiment we take 5 different shade percentage of the reactive dye. Cotton fibre is dyeing with 5 different shade%. If I compare color strength according to shade% we can see that color strength value is low for 2% shade. Higher color strength value for 7% shade.

4.2 Table: Rating of color fastness to washing for 2%, 3%, 5%, 6%, & 7% Shade

Shade%	Rating of the color fastness to wash
2%	4
3%	4
5%	4
6%	4
7%	4-5

From the table we can see that wash fastness properties of the cotton dyed fabric sample according to the different shade%. In 7% shade of the reactive dye we see that wash fastness rating is 4-5. For 2%, 3%, 5%, 6% shade wash fastness rating is 4. So we can say that 7% shade gives higher rating than 2%, 3%, 5% & 6% shade. 7 % shade provides excellent wash fastness and other shade percentage provides very good fastness properties.

4.3 Table: Rating of color fastness to rubbing for 2%, 3%, 5%, 6% & 7% Shade

Shade%	Rating of before dry wash rubbing	Rating of before wet wash rubbing
2%	4-5	2-3
3%	4-5	2-3
5%	4-5	2
6%	4-5	2
7%	4-5	2

Above the table we can see that the rubbing fastness properties of the different shade percentage. For 2%, 3%, 5%, 6% & 7% shade rubbing fastness rating for dry rub is 4-5 which is good and acceptable for buyer but wet rub test give poor rating.

4.4 Table: Over all Result of this experiment

Shade%	Color strength K/S	Rating of Color fastness to wash	Rating of Dry Rubbing	Rating of the Wet Rubbing
2%	12.8	4	4-5	2-3
3%	18.2	4	4-5	2-3
5%	25.5	4	4-5	2
6%	29.6	4	4-5	2
7%	30.3	4-5	4-5	2

CHAPTER-05

Conclusion

In this study we take single jersey 100% cotton knitted fabric for dyeing with various shade percentage (2%, 3%, 5%, 6% & 7%) of the reactive dyes for determination of Color depth in dependence on concentration for reactive dyed materials and we also find out the washing and rubbing fastness for 2%, 3%, 5%, 6% & 7% shade. After dyeing of various shade% we found the color strength K/S value for different shade% by using spectrophotometer. 7% shade provides highest color strength and 2% shade provides lowest color strength. From this study, K/S value of 6% & 7% shade is very close and K/S value for 7% shade indicates that cotton fibre can pick highest 7% of the shade. Also wash fastness rating of 7% shade is high with rating 4-5. The rubbing fastness of properties for dry rub for 2%, 3%, 5%, 6% and 7% are good but wet rub rating is poor which rating ranges from 2-3 for 2% & 3%. Also rating of wet rubbing fastness for 5%, 6% and 7% is 2 which is very poor. So from this study, we can say that with the increasing shade % color strength become increasing and rating of the wash fastness become high and rubbing fastness rating become low.

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