Faculty of Engineering

Department of Textile Engineering

Study on photo Fading and color fastness evaluation of disperse dye on Polyester fabric

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A thesis submitted in partial fulfillment of the requirements for the degree of

Bachelor of science in Textile Engineering

Advance in Wet Processing Technology

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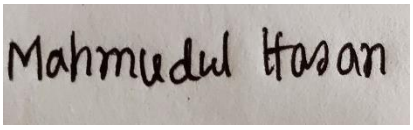
Declaration

I hereby declare that, this industrial Attachment has been done by me under the supervision of **Nawshin Farzana, Assistant Professor** , **Department of Textile Engineering** Daffodil International University. I also declare that neither this report nor any part of this report has been submitted elsewhere for award of any degree .



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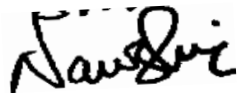
Introduction

LETTER OF APPROVAL

This project report prepared by Mahmudul Hasan (ID: 191-23-587), is approved in partial fulfillment of the requirement for the degree of Bachelor of science in Textile Engineering. The said students have completed their project work entitled **"Study on photo Fading and color fastness evaluation of disperse dye on Polyester fabric** under my supervision. During the research period I found them sincere, hardworking and enthusiastic.



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Firstly, we express our gratefulness to almighty Allah for his divine blessing makes us possible to complete this project successfully.

We are grateful to our supervisor **Ms. Nawshin Farzana**, Assistant Professor, Department of Textile Engineering, Faculty of Engineering, Daffodil international University. Deep knowledge and keen interests of our supervisor in the field of textile dyeing and finishing influenced us to carry out the project work. Her endless patience, scholarly guidance, continual encouragement, energetic supervision, constructive criticism, valuable advice, reading many inferior draft and correcting these at all stages have made it possible to complete this project.

We would like to deliver thanks to our entire course mates in Daffodil International University, who took part in the discussion while completing the course work.

Finally, we would like to express a sense of gratitude to our beloved parents and friends for their mental support, strength and assistance throughout writing the project report.

DEDICATION

"We dedicate this thesis work to our beloved teacher and our parents"

Table of the content

Contents **Page no**

Abstract

In this study, dyeing of polyester fibre in different shade (1%, 2%, 3%) with disperse dye is carried out. Here high temperature method is used in dyeing of polyester fiber with disperse dye.

The main purpose of this study is to find out the evaluation of the photo fading of the difference shade% of the disperse dye with polyester fiber. The dyeing is carried out at 130 ℃ where we use different chemical for dyeing. I also find out the color fastness rating for the different shade percentage of the disperse dye. I have measured the color fastness to wash, color fastness to rubbing, color fastness to perspiration. these testing is done according to the ISO method. Color fastness to washing rating is excellent for each shade. Color fastness to rubbing is excellent for each shade. Also, color fastness to perspiration is excellent for each shade.

CHAPTER-01

INTRODUCTION

Introduction:

Disperse dye is a non-ionic dye which has a low solubility to water. Generally, it is used for dyeing of hydrophobic fibre like polyester, nylon. It is also water insoluble dye. Molecular size of the disperse dye are so small that they can be aggregate with each other if dispersing agent are not used. This dye is used to dyeing of hydrophobic fibre like polyester, nylon etc. Dyeing of the plyester fibre with disperse dye carried out at acidic condition where we need to use acid to maintain pH . Dyeing of polyester fibre with disperse dyes is carried out two methods 1. Carrier method, 2. high temperature method. Carrier method of dyeing is now obsolete. Nowadays, high temperature method is used to dyeing of polyester fibre with disperse dye where dye molecule is penetrated into the fibre at 130℃.

Polyester fibre is a manmade fibre which is not naturally originated. It is synthetic fibre which is made by the long chain polymer. PET chips is used to made the. Polyester fibre is mostly used in the world due to it's good characteristics. This fibre is durable and have a excellent resistance to acid but low resistance to alkali. Polyester fiber has good resistance to shrinkage as well as stretching. Furthermore, polyester fibre has good resistance to crease.

Shade is a term which is used in dyeing that denotes the depth of the color. It is very important to maintain accurate shade percentage to meet up buyer requirement. The more shade percentage indicates the dyed fabric is more deep in color. Depth of the color of the dyed sample is varied with shade percentage.

Fastness is a resistance to the destructive factor of a material. Color fastness is a term which indicates that the resistance of a color of a dyed fabric to the destructive factor. There are lot of evaluation for color fastness. They are color fastness to light, color fastness to water, color fastness to rubbing, color fastness to perspiration. Color fastness to light indicates the resistance of colored

sample against the light source. More color fastness to light indicates the more resistance to fading due to light. Color fastness to water determines that the resistance of colored sample against the water. Also color fastness to wash determines the resistance of colored sample against the washing. In addition, color fastness to rubbing indicates that the resistance of a colored sample against the rubbing. Furthermore, color fastness to perspiration determines the resistance of the colored sample against the persperation. These evaluation is follow to evaluate the fastness properties of the dyed fabric.

The purpose of this study to determination of photo fading & color fastness evaluation of polyester fabric by using disperse dye.

Objective of the study

- To find out the photo-fading effect in dependence on various shade percentage of the disperse dye.
- To evaluate the color fastness to wash, rubbing & perspiration for different shade percentage of the disperse dye.

CHAPTER-02

LITERATURE REVIW

2.1 polyester fiber

Polyester fibre is a manmade fibre which is originated by the industrial manufacturing process. It is synthetic fibre which is made by the long chain polymer. PET chips is used to made the. Polyester fibre is mostly used in the world due to it's good characteristics. Polyester fibre can be blended with cotton fibre. Polyester & cotton blended fibre is mostly used in textile industry. They provides a good properties of the fabric. The dimensional stability of the polyester fiber is very good.

2.1.1. Structure of the polyester fiber

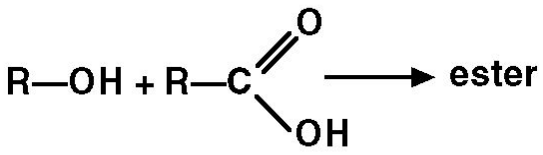


Figure 2.1: Structure of the polyester fiber

2.1.2 Origin of the polyester fibre

Polyester started as a polymer group in W.H. Carothers' research facility. Carothers found that alcohols and carboxylic acids could be successfully mixed to produce fibers while working for DuPont. Polyester, on the other hand, was put on the back burner once Carothers found nylon. Many British scientists, including J.R. Whinfield, J.T. Dickson, W.K. Birtwhistle, and C.G. In 1939, Ritchie took over Carothers' job. Terylene, the first polester fiber, was invented in 1941. In 1946, DuPont purchased all legal rights from the British and developed a new polyester material known as Dacron. Polyester was initially made available to the general public in the United States

in 1951. It was marketed as a wonder material that could be worn without ironing for 68 days and yet look decent.

Eastman Chemical Products, Inc. invented a new polyester fabric named Kodel in 1958. The polyester market continued to grow. Because it was such a cheap and durable material, numerous tiny textile factories sprung up all across the country, many of which were housed in former gas stations, to create low-cost polyester apparel. Polyester sales increased steadily until the 1970s, when they fell precipitously due to the unfavorable public image that formed in the late 1960s as a result of the in famous polyester double-knit fabric. Polyester is still frequently considered as a "cheap, unpleasant" material today.

2.1.3 Properties of the polyester fiber

- The fiber is durable, tough, and long-lasting.
- It is extremely resistant to stretching and shrinkage.
- The fiber is resistant to a wide range of substances.
- The fiber dries rapidly.
- Polyester fiber has good resistance to acid.
- Polyester fiber has higher degree of polymerization.
- Moisture regain of the polyester fiber is 0.4%
- Specific gravity of the polyester fiber is 1.38
- Cross section of the polyester fibre is circular.
- Polyester fiber is hydrophobic fibre that has no affinity towards water.

2.2 Disperse dye

Disperse dye is a dye that is used for organic coloring substance which is free from ionizing group. This dye is a non-ionic dye as well as this dye has low solubility to water. This dye is used to dyeing the hydrophobic fiber like polyester, nylon, acrylic fibre. Especially manmade fiber like polyester fibre is frequently dyeing by using disperse dye. The derivatives of the disperse dye is azo, anthroquinone, nitro & quinone group. For the dyeing disperse dye with

polyester fibre requires dispersing agent which helps to evenly disperse the dye molecule into the fibre.

2.2.1 Structure of the disperse dye

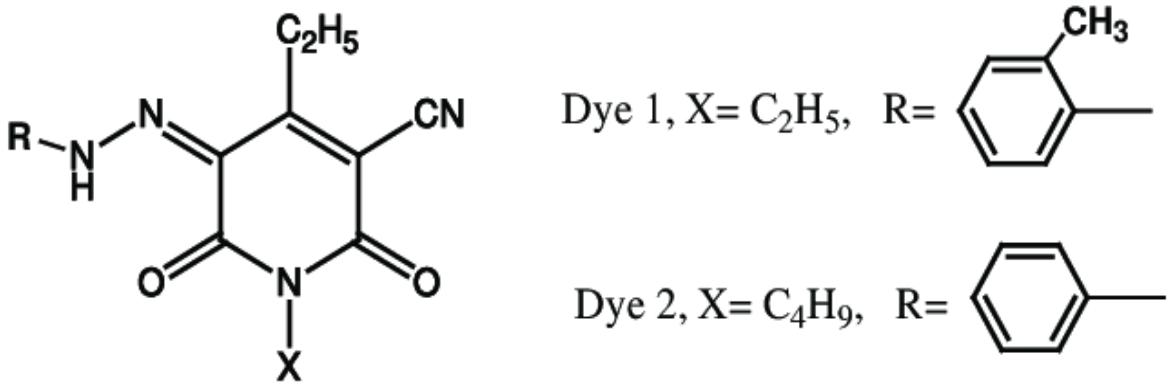


Figure 2.2: Chemical structure of the disperse dye

2.2.2 Properties of the disperse dye

- Disperse dye is a synthetic dye which has low solubility to water.
- It is a non-ionic dye.
- It is generally water insoluble dye.
- Molecular size of the disperse dye are so small that they can be aggregate with each other if dispersing agent are not used.
- This dye is used to dyeing of hydrophobic fibre like polyester, nylon etc.
- Dyeing of the plyester fibre with disperse dye carried out at acidic condition where we need to use acid to maintain pH .
- Dyeing process of disperse dye with polyester fibre carried out at high temperature method where temperature increases into 130℃.
- This dye is cheap & economical.
- Wash & light fastness of the disperse dye is excellent.

2.3 Dyeing mechanism of polyester fibre with disperse dye

There have two method of dyeing polyester fabric by using disperse dye . One is High temperature method another is carrier method .Dispersing agent are used in disperse dye .Dispersing agent make the disperse dye very shorter is size . So this small size dyes can easily penetrated into the fibre . In HT as like 125-135℃ the process are done . pH shoube be 4.5-5.5 . For the HT the fibre will be swell and dye can easily penetrated . After decrease the temperature fibre return it's original position that's why dye can't came out from the fibre surface .

Another method is carrier method . Carrier is a swelling agent . It is used for swell the fibre . In this method the temperature are keep 100-110℃ & after decrease the temperature dye can't came out from the fibre surface .

After dyeing reduction clean are needed . After complete the dyeing process some unfixed dyes are present in the fibre surface . For remove the unfixed dyes reduction clean are done in disperse dye process

2.4 Color fastness

Fastness is a property that means the resistance to the destructive factor of a material. Color fastness is a term which indicates that the resistance of a color of a dyed fabric to the destructive factor. There are lot of evaluation for color fastness. They are color fastness to light, color fastness to water, color fastness to rubbing, color fastness to perspiration. Color fastness to light indicates the resistance of colored. sample against the light source. More color fastness to light indicates the more resistance to fading due to light. Color fastness to water determines that the resistance of colored sample against the water. Also color fastness to wash determines the resistance of colored sample against the washing. In addition, color fastness to rubbing indicates that the resistance of a colored sample against the rubbing. Furthermore, color fastness to perspiration determines the resistance of the colored sample against the persperation. These evaluation is follow to evaluate the fastness properties of the dyed fabric.

CHAPTER-03

Materials and method

3.1 Material

This study was done by using 100% single jersey knitted polyester fabric. The GSM of the fabric is 100. The sample fabric sample has been taken from the lab of the Esquire knit composite Ltd. Dye and chemicals which are taken from the store of the lab.

3.2 Table: sample specification

Sample no	Sample type	Sample weight (gm)	Sample GSM
1	100% knitted S/J Polyester fabric	10 gm	100
2	100% knitted S/J Polyester fabric	10 gm	100
3	100% knitted S/J Polyester fabric	10 gm	100
4	100% knitted S/J Polyester fabric	10 gm	100
5	100% knitted S/J Polyester fabric	10 gm	100
6	100% knitted S/J Polyester fabric	10 gm	100
7	100% knitted S/J Polyester fabric	10 gm	100
8	100% knitted S/J Polyester fabric	10 gm	100
9	100% knitted S/J Polyester fabric	10 gm	100

In this study I use different chemicals. Here give the details about the chemicals

3.3 Table: different chemicals used in this study

Name of the chemical	Function of the chemical
Detergent	It is used to decrease the surface tension of the water and helps to eliminate dust, dirt, etc.
Dispersing agent	It is used to disperse the dye molecule of the disperse dye & evenly distribute the dye molecule into the fibre by minimizing dye aggregation.
Buffer	It is used to maintain the pH of the solotion of the dye bath & maintaining acidic condition.
Reduction cleaning agent	It is used to remove unfix dye and chemical from the fabric after polyester dyeing.

3.4 Method of dyeing

For dyeing the polyester sample Dexter Machine is used. This is the sample dyeing machine of the lab where high temperature is used. By using the following recipe polyester sample is dyed.

3.5 Recipe of dyeing

Table: Recipe for 1% (red, yellow, blue) shade of disperse dye with 100% polyester fiber (M:L=1:10, Sample weight 10 gm)

Name of the chemical	Unit
Acid buffer	1.2 ML
Dispersing agent	1.25 g/L
Reduction cleaning	2 g/L
Disperse dye	1%

Table: Recipe for 2% (red, yellow, blue) shade of disperse dye with 100% polyester fiber (M:L=1:10, Sample weight 10 gm)

Name of the chemical	Unit
Acid buffer	1.2 ML
Dispersing agent	1.75 g/L
Reduction cleaning	2.25 g/L
Disperse dye	2%

Table: Recipe for 3% (red, yellow, blue) shade of disperse dye with 100% polyester fiber (M:L=1:10, Sample weight 10 gm)

Name of the chemical	Unit
Acid buffer	1.2 ML
Dispersing agent	2.5 g/L
Reduction cleaning	2.50 g/L
Disperse dye	3%

3.6 Process of the dyeing

1. Firstly, I have taken the sample of the single jersey knitted polyester fabric which GSM is 100.

2. I have taken water according to the recipe calculation.

3. Then take buffer for maintaining the pH of the liquor.

4. Then take the other chemicals.

5. then I have put the dye into the beaker .

6. Then I have immersed the fabric sample into the beaker .

7. Then loading into the machine.

8. Temperature increases into 135℃ for 40 min.

9. After completing the dyeing process, dyed sample is unloading & normal wash is done.

10. Then reduction cleaning is done at 95°C for 20 min.

11. Then drying is done.

3.7 Process curve of the dyeing

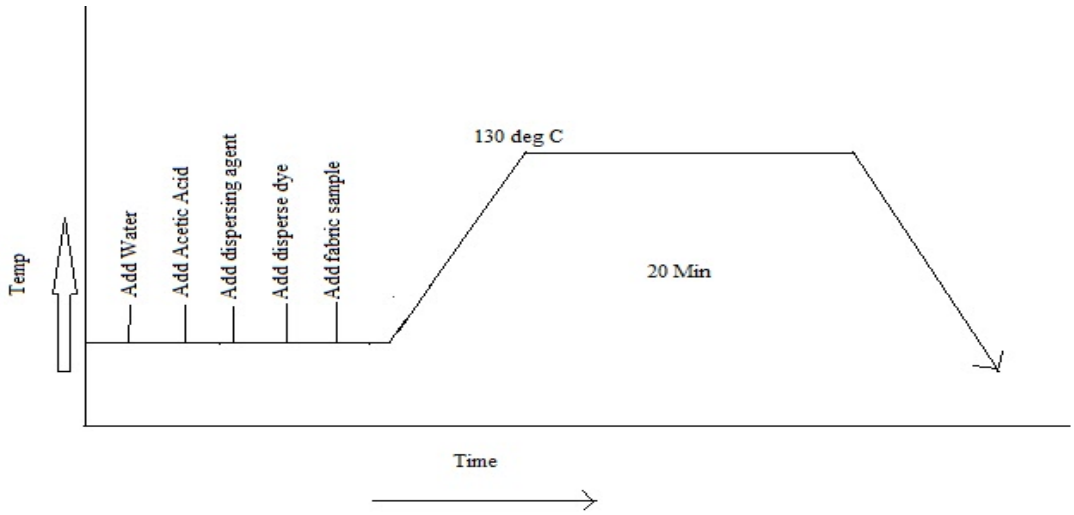
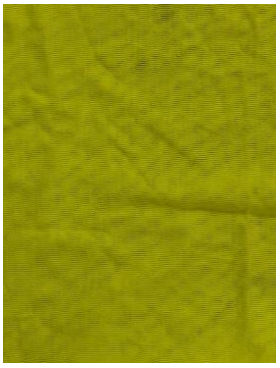


Figure 3.1: process curve of the dyeing of polyester fiber

3.8 Sample Attachment for various shade% (1%,2%,3% shade of yellow, blue, red)

1%



2%

3%

1%

2%

3%

1%

2%

3%

3.9 Color fastness test:

Testing of color fastness to light : It is a term which determines the resistance of a dyed textile material against fading of color due the light source like sunlight. It is very important fastness properties of the textile material as textile material is subjected to the light sources. Due to the effect of sun light. Colored sample can be fade. So it is very necessary to evaluate the light fastness test. In this study, I have followed ISO 105 method for evaluating color fastness to light. In this method a xenon arc lamp is used. A testing sample is taken. The sample is 1 cm is cut & properly marked. More than one sample is tested together. Placing the prepared sample into the holder. The sample which exposed to the light need to be uncovered. Then we take the reference sample as a blue scale which has a total of 8 grade. Then we place the sample into the machine and placed the reference sample into machine. Then we fixed the temperature at 50°C where relative humidity is 40%. Then we run the machine for 24 hours. After 24 hours we unload the sample and measure the sample by using blue scale. If the grade is 8 then we can say that colorfastness to light is excellent. If the grading is 1 it indicates color fastness to light is very poor.

3.10 Sample attachment of the color fastness to light of 1%, 2% & 3% (red, yellow, blue)

Fig: Color fastness to light for 1%(Grade: 4)

Fig: Color fastness to light for 2%(grade:6)

Fig: color fastness to light for 3% (grade: 7)

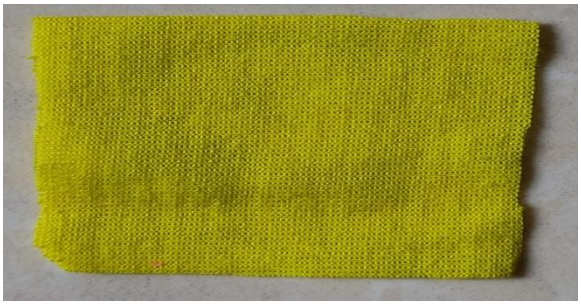


Fig: color fastness to light for 1%(grade: 8)

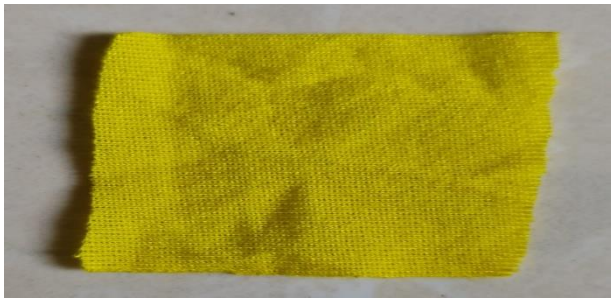


Fig: color fastness to light for 1%(grade: 8)

Fig: color fastness to light for 3%(grade: 8)

Fig: color fastness to light for 1%(grade: 8)

Fig: color fastness to light for 2%(grade: 8)

Fig: color fastness to light for 3%(grade: 8)

Testing of the color fastness to wash: It indicates the resistance of a colored textile material against fading due to washing. In this study color fastness to wash is evaluated by using ISO 105 method. At first we take the sample of the sample and cut the sample into 10×4 cm. Then we placed the sample inside the undyed sample and stitch round the edge. Undyed sample are called composite sample. The composite sample is treated in a water shaking bath with the necessary water and a stock solution for 30 minutes at 50 or 52℃. The sample is removed from the washing solution after testing for 30 minutes. The sample will be washed in running cold water for ten minutes after being rinsed twice in cold distilled water. The sample is then gently pressed. On two long sides and one short side, the stitching has been taken off. The sample is currently drying in a tumble dryer at 60℃. Grayscale color change is used to assess the contrast between the treated and untreated samples, and a staining scale in a color-matching cabinet is used to compare the staining of adjacent cloth.

3.11 Sample attachment of the color fastness to wash of 1%, 2% & 3% (red, yellow, blue)

Fig: Color fastness to wash for 1% Red

Fig: Color fastness to wash for 2% Red

Fig: Color fastness to wash for 3% Red

Fig: Color fastness to wash for 1% Yellow

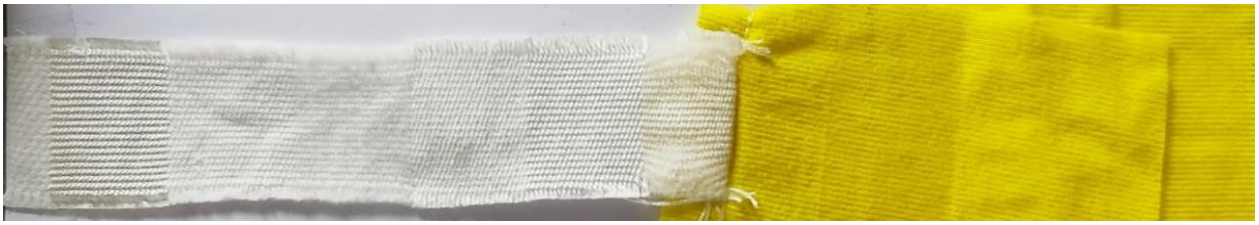


Fig: Color fastness to wash for 2% Yellow

Fig: Color fastness to wash for 3% Yellow

Fig: Color fastness to wash for 1% Blue

Fig: Color fastness to wash for 2% Blue

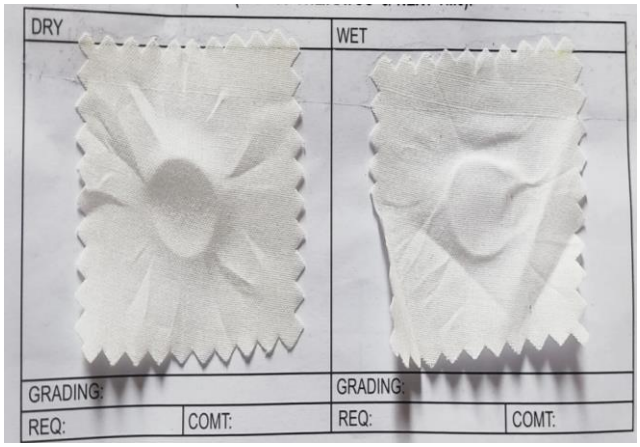
Fig: Color fastness to wash for 3% Blue

Testing of color fastness to rubbing :

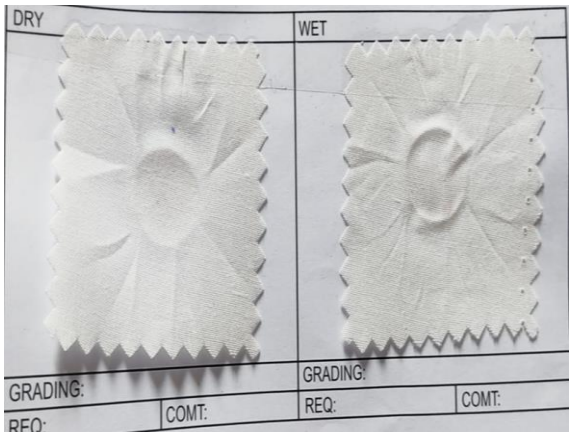
Color fastness to rubbing determines the resistance of a colored textile material against rubbing. In this study color fastness to rubbing is measured by using following method. In this test at first I have taken the dyed sample of polyester fiber in different shade.I have taken the sample size of 14×5 cm for testing for both dry and wet rubbing. For this test use a crock meter to for rubbing which has a finger where white fabric is clamping .A sample frame is remain in this machine which hold the sample . For wet rubbing we place the sample on to the rubbing frame and white fabric is immersed in water for wetting it. Then we clamping the white wet fabric into the finger of the rubbing machine. Then we rubbing will be start.10 times rubbing is carried out within 10 second and then sample fabric is assess by using grey scale with the original color sample.

According to the reading of the scale we get the grade of the rubbing . For dry rubbing we place the sample on to the rubbing frame. Then we clamping the white fabric into the finger of the rubbing machine. Then we rubbing will be start.10 times rubbing is carried out within 10 second and then sample fabric is assess by using grey scale with the original color sample. According to the reading of the scale we get the grade of the rubbing .

3.12 Sample attachment of the color fastness to rubbing of 1%, 2% & 3% (red, yellow, blue)

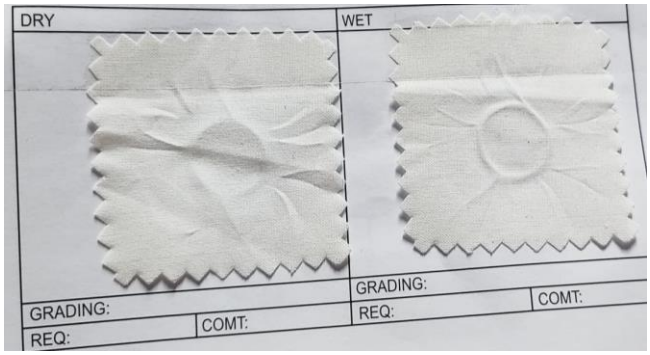


Color fastness to rubbing for 1% Red

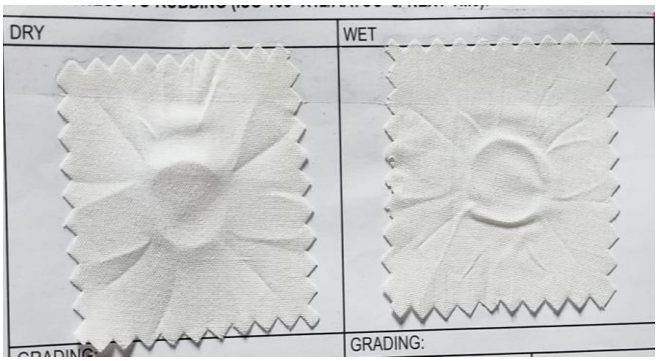


Color fastness to rubbing for 2% Red

Color fastness to rubbing for 3% Red



Color fastness to rubbing for 1% yellow



color fastness to rubbing 2% yellow

Color fastness to rubbing for 3% yellow

Color fastness to rubbing for 1% blue

Color fastness to rubbing for 2% blue

Color fastness to rubbing for 3% blue

Testing of color Fastness to perspiration :

It indicates the resistance of a color textile materials against fading due to perspiration. In this method color fastness to perspiration is evaluated by following ISO 105 E04 method. Perspiration can be two types. One is Acidic Another is alkali. For this Test we have to take a sample which size is 10×4 cm. Then we have to added this sample with same size of Multifibre Sample. we have to need different chemical for acidic and alkali perspiration & Maintain a liquor ratio of 1:50 for done this process. In this test 10 sample are can be test in one time. For this process A weight of 5KG keep upper the sample for make pressure. The sample Is keep in woven dryer for 37℃±2℃ temperature for 4 hours. After that a grey sscale is used for measure the color stain.

3.13 Sample attachment of the color fastness to Perspiration of 1%, 2% & 3% (red, yellow, blue)

1% Red for alkali

1% Red for Acidic

2% Red for alkali

2% Red for acidic

3% Red for alkali

3% Red for Acidic

1% Blue for alkali

1% Blue for acidic

2% blue for alkali

2% blue for acidic

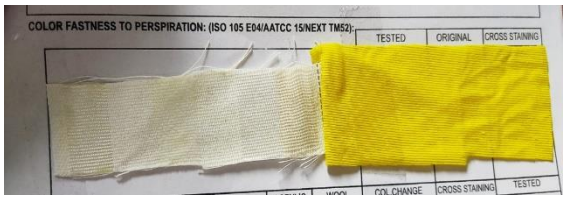
3% blue for alkali

3% Blue for acidic

1% yellow for alkali

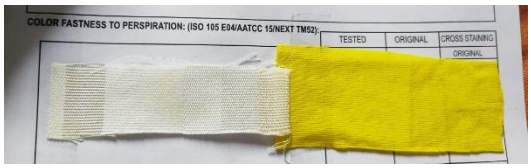
1% yellow for acidic

2% yellow for alkali



2% yellow for acidic

3% yellow for alkali



3% yellow for acidic

Chapter: 5

Result and discussion

4.1 Table: Evaluation of the color fastness to light for 1%, 2%, 3% (red, blue, yellow)

Shade% for red, yellow, blue	Rating
1% (red)	4
2% (red)	6
3% (red)	7
1% (blue)	8
2% (blue)	8
3% (blue)	8
1% (yellow)	8
2% (yellow)	8
3% (yellow)	8

From the table, it reveals that the rating of the color fastness to light for blue and yellow color for each shade percentage are same and they are excellent in their rating but in 1%, 2%, 3% for red is different than them. For red color rating is low. Only 1% of red appear lower rating in color fastness to light.

4.2 Table: Evaluation of the color fastness to wash for 1%, 2%, 3% (red, blue, yellow)

Shade% for red, yellow, blue	Rating
1% (red)	4
2% (red)	4
3% (red)	4
1% (blue)	4-5
2% (blue)	4-5
3% (blue)	4-5
1% (yellow)	4-5
2% (yellow)	4-5
3% (yellow)	4-5

From the table it appears that the rating of the color fastness to wash for each shade percentage of blue & yellow are same. Properties is excellent. For red rating is lower than blue & yellow of the each shade percentage. Wash fastness rating also good for red colored dyed sample.

4.3 Table: Evaluation of the color fastness to rubbing for rubbing of 1%, 2%, 3% (red, blue, yellow)

Shade% for red, yellow, blue	Rating of the dry rubbing fastness	Rating of the wet rubbing fastness
1% (red)	4-5	4-5
2% (red)	4-5	4-5
3% (red)	4-5	4-5
1% (blue)	4-5	4-5
2% (blue)	4-5	4-5
3% (blue)	4-5	4-5
1% (yellow)	4-5	4-5
2% (yellow)	4-5	4-5
3% (yellow)	4-5	4-5

From the table it is appear that the rubbing fastness properties for 1%, 2%,3% of red, yellow, blue are same for wet and dry rub. Color fastness to rubbing is very good of the all colored sample.

4.4 Table: Evaluation of the color fastness to perspiration for 1%, 2%, 3% (red, blue, yellow)

Shade% for red, yellow, blue	Rating
1% (red)	4-5
2% (red)	4-5
3% (red)	4-5
1% (blue)	4-5
2% (blue)	4-5
3% (blue)	4-5
1% (yellow)	4-5
2% (yellow)	4-5
3% (yellow)	4-5

From the table it is appear that the perspiration fastness properties for 1%, 2%, 3% of red, yellow, blue are same for wet and dry rub. Color fastness to perspiration is very good of the all colored sample.

Chapter 5

Conclusion

In this experiment 100% polyester fabric sample is used and dyeing is done with disperse dye for 1%, 2%, 3% of red, yellow & blue to find out the photo fading properties of the colored sample. Also find out the color fastness to wash, rubbing & perspiration.

Color fastness to light: It is seen that the rating of the color fastness to light (photo fading) for blue and yellow color for each shade percentage are same and they are excellent in their rating but in 1%, 2%, 3% for red is different than them. For red color rating is low. Only 1% of red appear lower rating in color fastness to light. Photo fading or color fastness to light is good.

Color fastness to wash: It is reveal that the rating of the color fastness to wash for each shade percentage of blue & yellow are same. Properties is excellent. For red rating is lower than blue & yellow of the each shade percentage. Wash fastness rating also good for red colored dyed sample.

Color fastness to rubbing: It is appear that the rubbing fastness properties for 1%, 2%, 3% of red, yellow, blue are same for wet and dry rub. Color fastness to rubbing is very good of the all colored sample.

Color fatness to perspiration: It is found that the perspiration fastness properties for 1%, 2%, 3% of red, yellow, blue are same for wet and dry rub. Color fastness to perspiration is very good of the all colored sample.

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