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Sonargaon University (SU)

সোনারগাঁও ইউনিভার্সিটি (এসইউ)

WE WILL RISE UP WE WILL SHINE

Department of Textile Engineering

Project On

Study on The Reactive Dyeing of Cotton Fabric Using Two Type of Reactive Dyes for Comparing Color Fastness to Light.

Course Title : Project Work (Thesis)
Course Code : TEX-441

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The Thesis presented in partial fulfilment of the requirements for the degree of
Bachelor of Science in Textile Engineering

Duration Time: May-August, 2025

LETTER OF APPROVAL

08 September 2025
To The Head,
Department of Textile Engineering.
Sonargaon University (SU).
GP Ja-146, Wireless gate, Mohakhali, Dhaka-1212.

Subject: Approval of Thesis Report of B.Sc. in Textile Engineering Program.

Dear Sir,
We are just writing to let you know this project report titled as study on, "The Reactive Dyeing of Cotton Fabric Using Two Type of Reactive Dyes for Comparing Color Fastness to Light. " has been completed by the students are bearing **Md. Jahangir Alom ID : TEX-2201025037, Md. Jahid Hasan ID : TEX-2103024036, Md. Abu Raihan ID : TEX 21030204045, Md. Roknuzzaman ID : TEX-2103024006, Md. Fahad Hossen, ID : TEX-1903018042** for final evaluation. The whole report is prepared based on proper Investigation and understanding though critical analysis of empirical data with required belongings. The students were directly involved in their thesis activities and the report becomes vital to spark of many valuable information for the readers.

Therefore, it will highly be appreciated if you kindly accept this thesis report and consider it for final evaluation

……..

Engr. Mohammad Abdul Baset
Associate Professor & Head
Department of Textile Engineering
SONARGAON UNIVERSITY (SU)

DECLARATION

We hereby declare that, this Industrial Thesis report has been done by us under the supervision of **Mohammad Abdul Baset**, Associate Professor & Head Department of Textile Engineering, Sonargaon University. We also declare that neither this industrial attachment report nor any part of this report has been submitted elsewhere for award of any degree.

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DEDICATION

At first, we want to dedicate this attachment report to almighty Allah for giving us this opportunity to prove ourselves. Without almighty helps nothing would be possible. Then we want to dedicate our parents. We love them very much for completing our study they play a vital role to complete this attachment. It's very pleasure for us. Without their help it is impossible for us to complete this attachment. And we also want to dedicate this attachment of our teacher.

ACKNOWLEDGEMENT

At first, we want to thank the almighty Allah for making it possible to complete our industrial attachment program successfully. We are highly delighted to express our regards & gratitude to our supervising teacher Mohammad Abdul Baset (Associate Professor) for all necessary information for preparing this report.

During the attachment we were scheduled to work with all the departments of SM Knitwear Ltd (SM Group). So, we would like to thank the officials of dyeing, washing, knitting, garments, maintenance & all other departments who gave their valuable time in helping us to achieve our intended goal.

We also take this opportunity to express our sincerest gratitude to Tawhid Hossen-Manager (HR, Admin), Toufiqul Islam- Sr. Lab Manager, Aminul Haque- Sr. GM (Dyeing), Sohel Rana- AGM (Dyeing), Abdul Kader-Manager (Dyeing), Abdullah Al Masud-Sample Manager (Dyeing), who has allowed us to work in his organization within a congenial atmosphere during the industrial training period.

Thanks go to Managers of different sections, executives and personnel for their excellent guidance & co-operation during the period of our training.

Our deepest appreciation goes to them for their sincere co-operation, support and advice which they have provided us during these two months of training. Our sincere appreciation goes to the entire knit concern Group team for extending their hands of cooperation throughout the training period.

Finally, we would like to acknowledge that we remain responsible for the inadequacies & errors, which may unintentionally remain in the following report.

ABSTRACT

This study investigates the reactive dyeing of cotton fabric using two different types of reactive dyes for the purpose of comparing their color fastness to light, wash, rubbing & perspiration. Cotton samples were dyed under standardized conditions, and the performance of each dye type was evaluated through controlled exposure to light sources. The study focused on the differences in dye–fiber bonding mechanisms and how these impact the durability and stability of color when subjected to light-induced fading. Results indicated that bifunctional reactive dyes exhibited superior light fastness compared to monofunctional dyes, likely due to their ability to form stronger and more stable covalent bonds with cellulose fibers. This research provides valuable insights for textile manufacturers seeking optimal dyeing solutions for enhanced color retention in light-exposed environments.

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Chapter-1

Introduction

1.1 Introduction

Reactive dyes are widely used in the textile industry for dyeing cellulosic fibers, particularly cotton, due to their vibrant colors, wide shade range, and strong affinity for the fiber. Unlike other dye classes, reactive dyes form covalent bonds with hydroxyl groups in the cellulose structure of cotton, resulting in excellent wash fastness and bright coloration. The efficiency of reactive dyeing depends on various factors, including dye structure, application method, and dye–fiber bonding. Among the different classifications, monofunctional and bifunctional reactive dyes are the most commonly used due to their distinct chemical reactivity and bonding behavior.

Monofunctional reactive dyes contain a single reactive group that forms one covalent bond with the fiber. These dyes are generally easier to apply and cost-effective but can be less stable under external conditions, such as prolonged light exposure. On the other hand, bifunctional reactive dyes contain two reactive groups, which allow them to form more stable, multiple covalent bonds with the fiber. This dual bonding capability is believed to enhance the dye's fixation rate, overall fastness properties, and resistance to degradation caused by environmental factors, including light.

Color fastness to light is a critical performance parameter in textile products, especially for garments and fabrics that are regularly exposed to sunlight or artificial lighting. Poor light fastness can result in noticeable fading, loss of color vibrancy, and reduced product value. Reactive dyes, though generally better in wash fastness, show varying degrees of light fastness depending on their chemical structure. Therefore, understanding how different types of reactive dyes perform under light exposure is essential for selecting the right dye for specific end uses.

This study aims to compare the light fastness of cotton fabrics dyed with monofunctional and bifunctional reactive dyes under controlled conditions. By applying standardized dyeing procedures and exposing the dyed samples to artificial light, the experiment evaluates the extent of color fading in each case. The findings are expected to reveal the relationship between the dye structure and its resistance to photodegradation, providing practical insights for textile manufacturers, designers, and quality control experts.

In conclusion, the research underscores the importance of selecting the appropriate dye type for achieving desired fastness properties in cotton textiles. Through comparative analysis, the study highlights the advantages and limitations of monofunctional and bifunctional reactive dyes in terms of light fastness. This knowledge contributes to more informed decision-making in textile production, particularly for products intended for outdoor use or environments with significant light exposure.

1.2 Objectives

1. To compare the light fastness properties of cotton fabrics dyed with two types of reactive dyes.
2. To analyze the dye–fiber bonding mechanisms of two type of reactive dyes.
3. To evaluate the effect of dye structure on the photostability of dyed cotton fabrics.
4. To determine the extent of color fading in cotton fabrics after exposure to artificial light sources.
5. To identify which type of reactive dye provides better performance in terms of color retention under light exposure.
6. To provide recommendations for selecting suitable reactive dyes for applications requiring high light fastness.

1.3 Scope of the Work

This study focuses on evaluating and comparing the performance of two types of reactive dyes—when applied to cotton fabric, specifically in terms of their color fastness to light. The research is limited to 100% cotton woven fabric dyed under controlled laboratory conditions using standardized dyeing procedures. The investigation includes the selection of representative dyes from each category.

The assessment of light fastness is conducted using artificial light exposure in accordance with recognized textile testing standards (e.g., ISO or AATCC methods). The degree of color change or fading is measured using grayscale ratings and spectrophotometric evaluation to ensure accuracy and objectivity. The study does not explore other fastness properties such as wash, rub, or perspiration fastness, nor does it include dyeing on blended or synthetic fabrics.

The scope also involves analyzing the molecular structure and reactivity of each dye type to understand their bonding mechanisms with cotton fibers and how this influence resistance to photodegradation. However, the research does not delve into environmental or economic assessments of dye use, such as effluent treatment or dye cost analysis.

By narrowing the focus to color fastness to light, the study aims to provide textile manufacturers, dye houses, and quality control professionals with practical insights into selecting appropriate reactive dyes for applications where exposure to light is a critical performance factor. The findings may contribute to improved product durability and customer satisfaction in sectors such as apparel, home textiles, and outdoor fabrics.

Chapter-2

Literature Review

2.1 Cotton

2.1.1 Introduction of Cotton

Cotton is a natural fiber obtained from the seed hairs of the cotton plant. It is one of the most widely used fibers in the textile industry due to its softness, breathability, and comfort. Cotton fibers are spun into yarns and woven or knitted into fabrics for clothing, home textiles, and industrial uses. It is valued for its durability, moisture absorption, and versatility. Cotton can be easily dyed and blended with other fibers, making it adaptable for many fabric types. Its biodegradability and natural origin also make it an eco-friendly option compared to synthetic fibers.

The phrase **"Cotton is king of fiber"** reflects the idea that **cotton** is one of the most important and widely used natural fibers in the world.



2.1.1 Picture of Cotton

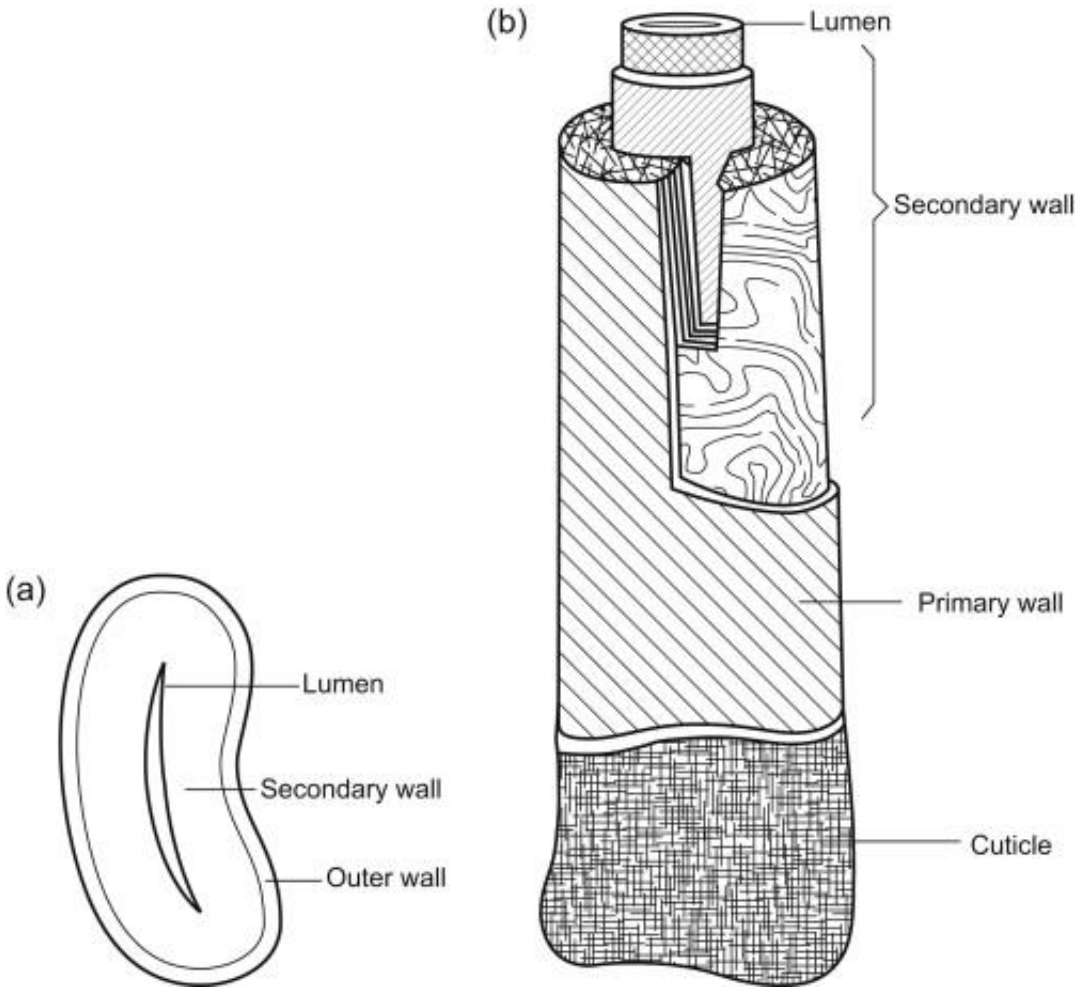
2.1.2 Properties of Cotton

1. **Physical Properties**
    - **Softness**: Cotton fibers are soft, making fabrics comfortable to wear.
    - **Length**: Staple fiber length varies, generally from 10 to 65 mm.
    - **Color**: Naturally off-white or cream, but can be easily dyed.
    - **Strength**: Moderate strength; stronger when wet.
    - **Absorbency**: Highly absorbent, can hold up to 25 times its weight in water.
    - **Moisture Regain**: About 7-8%, meaning it absorbs moisture from the air, keeping fabrics breathable.
    - **Texture**: Smooth with a natural twist (convolution) that helps yarn spinning.

2. **Chemical Properties**
    - **Composition**: Primarily cellulose (about 90%).
    - **Reaction to Heat**: Cotton burns readily and leaves a fine ash.
    - **Reaction to Chemicals**: Resistant to alkalis but weakens with acids.

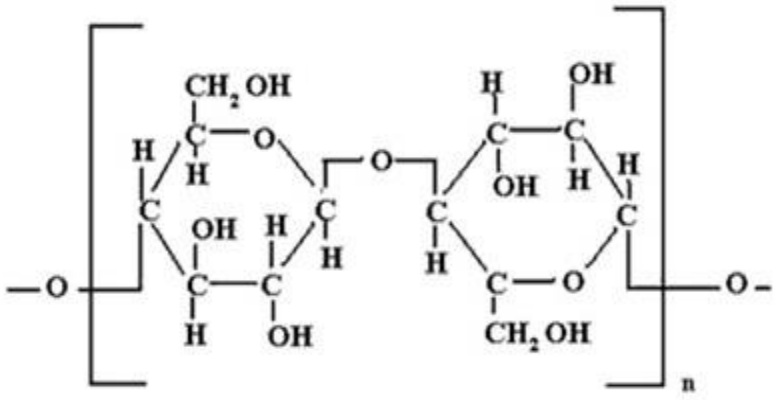
2.1.3 Structure of Cotton

Physical Structure : The **physical structure of cotton** refers to the way the cotton fiber is built on both a microscopic and macroscopic level. Its unique structure contributes to the properties that make cotton so valuable—like softness, strength, and absorbency.



2.1.3 (a) Figure : Physical Structure of Cotton

Chemical Structure : Cotton is primarily composed of cellulose, a natural polymer made up of repeating units of glucose molecules. The chemical structure of cotton can be understood by looking at the structure of cellulose, which forms the main component of the cotton fiber.



2.1.3 (b) Figure : Chemical Structure of Cotton

2.1.4 Cotton Dyeing with Reactive Dye

Dyeing is the process of imparting color to textile materials, and cotton being a natural cellulose fiber, requires dyes that can firmly bond with its structure. **Reactive dyes** are the most widely used dyes for cotton due to their ability to form a strong covalent bond with the fiber. This chemical bonding results in excellent color fastness, making reactive dyeing ideal for cotton fabrics used in clothing and home textiles.

Reactive dyeing involves treating the cotton fabric in a dye bath containing reactive dyes, an electrolyte (usually salt), and an alkali (such as soda ash) that activates the fiber for dye fixation. The process ensures vibrant, bright colors with good resistance to washing, light, and perspiration. Due to these qualities, reactive dyes have become the preferred choice for sustainable and high-quality cotton fabric dyeing.

2.2 Reactive Dyes

2.2.1 Introduction to Reactive Dyes

Reactive dyes are a type of synthetic dye that chemically react with fibers, especially natural cellulose fibers like **cotton**, **linen**, and **rayon**. What makes them unique is their ability to form **covalent bonds** with the fiber, making the dye part of the material itself. This results in **excellent wash fastness**, **bright shades**, and **durability**.

Reactive dyes are widely used in the textile industry for both **dyeing** and **printing**. They work best in **alkaline conditions**, and popular dyeing methods include **cold pad batch**, **exhaust dyeing**, and **continuous dyeing**. Although reactive dyeing typically consumes a lot of water and chemicals, new eco-friendly technologies—like **low-salt**, **bio-based dyes**, and **digital reactive printing**—are helping reduce environmental impact while maintaining high color quality.



2.2.1 Picture: Reactive Dyes

2.2.2 Types of Reactive Dyes

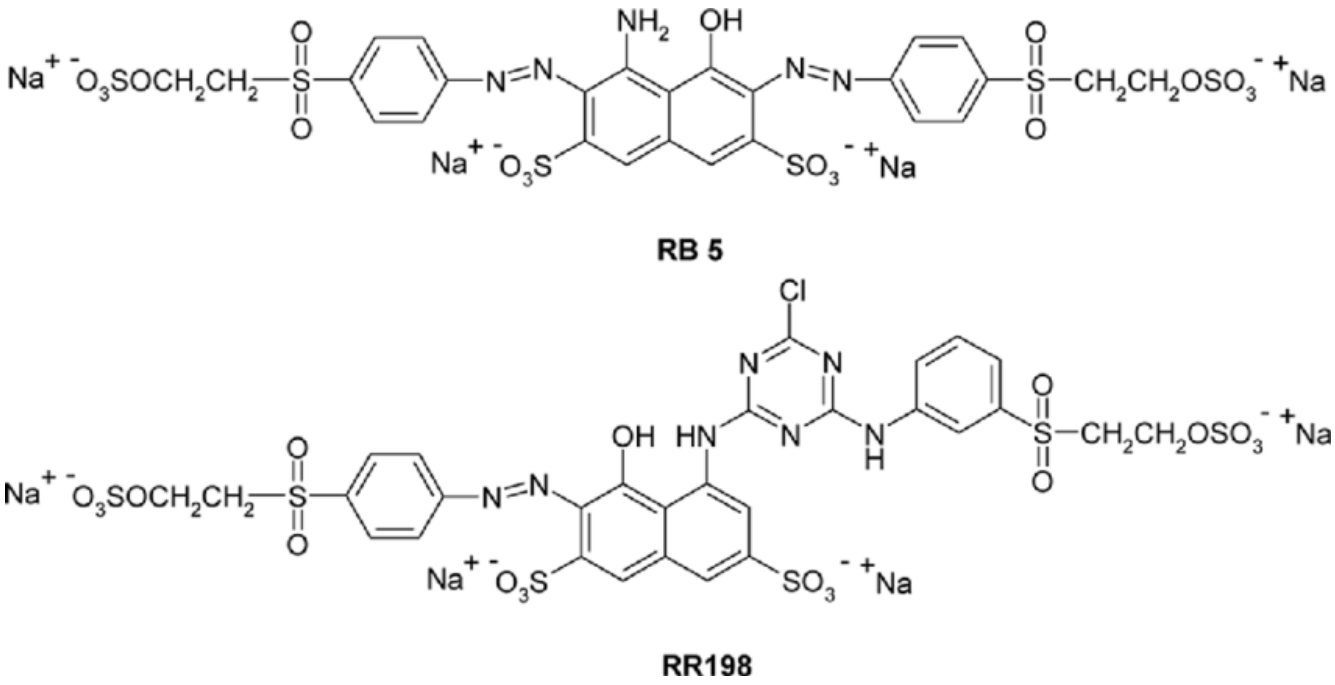
Reactive dyes are categorized based on the nature of their reactive groups. Common types include:

- **Monochlorotriazine dyes (MCT)** – React at lower temperatures; moderate reactivity.
- **Dichlorotriazine dyes (DCT)** – More reactive, require lower temperatures; suitable for cold dyeing.
- **Vinyl sulfone dyes** – Require hot conditions (typically 60°C) and are stable over a wide pH range.
- **Bi-functional dyes** – Contain two different reactive groups for improved fixation and performance.

.

2.2.3 Chemical Structure of Reactive Dyes

Reactive dyes are composed of three essential structural components: a **chromophore**, a **reactive group**, and a **bridging group or solubilizing group**. The **chromophore** is the part of the molecule responsible for color and often contains conjugated systems such as azo (-N=N-), anthraquinone, or phthalocyanine structures. Attached to the chromophore is the **reactive group**, which enables the dye to form a covalent bond with the fiber during the dyeing process. Common reactive groups include **monochlorotriazine**, **dichlorotriazine**, and **vinyl sulfone**. These groups typically react with hydroxyl groups on cellulose fibers under alkaline conditions. The **bridging group** connects the chromophore to the reactive group and may also help enhance solubility or improve dye-fiber interactions. This well-defined structure gives reactive dyes their unique ability to form strong, wash-fast bonds with textile fibers bonds with textile fibers.



2.2.3 Figure : Chemical Structure of Reactive Dye

2.2.5 Properties of Reactive Dyes

1. Chemical Properties:

- **Reactive Nature:** Reactive dyes contain reactive groups (e.g., monochlorotriazine, vinyl sulfone) that form covalent bonds with fibers, especially cellulose (cotton, rayon, etc.).
- **Water Solubility:** These dyes are highly water-soluble, often due to the presence of sulfonic acid groups (-SO_3H) or their salts, aiding in easy application in aqueous dyeing processes.
- **Hydrolysis:** Unfixed dye can hydrolyze in water, meaning it reacts with water instead of the fiber, forming a non-reactive compound that must be washed out.
- **Alkaline Reactivity:** Most reactive dyes require alkaline conditions (typically pH 10–11) for proper fixation to the fiber.

2. Physical Properties:

- **Color Brilliance:** Reactive dyes produce bright and vibrant colors with a wide shade range.
- **Good Fastness:** They exhibit excellent wash and light fastness due to the strong covalent bond with fibers.

3. **Application Temperature:** Varies depending on dye type:

- Cold brand (e.g., MCT) – 20–40°C

Hot brand (e.g., vinyl sulfone) – 60°C

High-temperature dyes – up to 80°C

4. **Compatibility:** Can be blended or used in combination with other reactive dyes for multicolor dyeing.

2.2.6 Advantages of Reactive Dyes

Reactive dyes offer several benefits over other dye types:

- **Excellent colorfastness** – due to the covalent bonding with fibers, colors are resistant to washing and rubbing.
- **Wide shade range** – available in bright, vibrant colors across the spectrum.
- **Environmental benefits** – compared to other dye classes like vat or azo dyes, reactive dyes require less energy and have lower pollution potential.
- **Cost-effective** – despite higher initial dye costs, long-term durability reduces re-dyeing or replacement needs.

2.2.7 Limitations of Reactive Dyes

While reactive dyes have many advantages, there are also some drawbacks:

- **Water consumption** – reactive dyeing involves multiple rinsing steps, leading to high water usage.
- **Salt and alkali use** – large quantities of salt and sodium carbonate are used, which can contribute to environmental pollution if wastewater is not properly treated.
- **Hydrolysis** – unreacted dye molecules may hydrolyze in water and lose their reactivity, leading to lower fixation rates.

2.3 Reactive Dyeing

2.3.1 Introduction to Reactive Dyeing

Reactive dyeing is a process in which reactive dyes form covalent bonds with textile fibers, resulting in vibrant, durable coloration. This method is most commonly used for dyeing **cellulose fibers** such as cotton, rayon, and linen. During the process, the fabric is treated with an **alkaline dye bath** containing the reactive dye. The alkalinity, typically provided by **sodium carbonate (soda ash)**, activates the hydroxyl groups in the fiber, allowing them to chemically react with the reactive groups in the dye molecules—such as **monochlorotriazine** or **vinyl sulfone**. This results in a **strong chemical bond** between dye and fiber, which is what gives reactive dyeing its excellent **wash and light fastness**.

The reactive dyeing process is highly valued in the textile industry for producing **bright, vivid shades** that are resistant to fading or bleeding. However, it requires **precise control** of pH, temperature, and time to achieve optimal fixation and avoid hydrolysis of the dye (where the dye reacts with water instead of the fiber). Any unfixed dye must be thoroughly washed out to

prevent color bleeding during use. Despite challenges like high water consumption and sensitivity to process conditions, reactive dyeing remains one of the most widely used and reliable methods for coloring natural fibers due to its **color durability** and **environmental compatibility** when properly managed.

2.3.3 Process of Reactive Dyeing

Reactive dyeing is a chemical dyeing process where reactive dyes form covalent bonds with the fiber molecules, ensuring excellent color fastness. The process involves several critical steps to ensure high fixation, shade uniformity, and color vibrancy.

1. Preparation of the Fabric : Before dyeing, the fabric must be scoured (cleaned) to remove natural waxes, oils, and impurities that may interfere with dye absorption.

- **Purpose**: Improve dye penetration and uniformity.
- **Process**: Scouring with alkali and detergent, followed by rinsing.

2. Preparation of the Dye Bath : The dye is dissolved in water to create a dye solution, along with other chemicals that aid in fixation.

➢ **Typical components:**

- Reactive dye.
- Electrolyte (e.g., sodium chloride or Glauber's salt) to promote dye exhaustion.
- Alkali (e.g., sodium carbonate) to promote chemical bonding.

3. Dyeing Process

a. Exhaust Method (most common for batch dyeing)

1. **Dye Application:**

- The fabric is introduced into the dye bath at a specific temperature (20°C–60°C depending on dye type).
- Salt is added to enhance dye uptake (exhaustion phase).

2. **Fixation:**

- Alkali is gradually added after a period of dye absorption.
- Under alkaline conditions, the reactive groups on the dye react with hydroxyl groups on the cellulose to form covalent bonds.
- The temperature and pH are carefully controlled (pH ~10.5).

3. **Time & Temperature Control:**

- Reaction time: 30–90 minutes.
- Temperature: Depends on the dye type:
    - Cold brand (30–40°C)
    - Hot brand (60°C)
    - High-temperature dyes (80°C)

4. **Washing-Off Process :** After fixation, unreacted (hydrolyzed) dye must be thoroughly removed to prevent poor fastness and staining.

Steps:

- Cold wash → removes loose dye
- Hot wash (60–90°C) with detergent → removes hydrolyzed dye
- Soaping → enhances fastness and removes residues
- Final rinsing and drying

5. **Finishing :** The dyed fabric may undergo softening, drying, or other finishing processes depending on the desired final properties.

2.4 Color Fastness to Light

2.4.1 Introduction of Color Fastness to Light

Color fastness to light refers to the ability of dyed textiles to resist fading or discoloration when exposed to light, particularly sunlight or ultraviolet (UV) radiation. It is a crucial property in evaluating the durability and appearance of fabrics, especially those used in outdoor applications, home furnishings, or garments frequently exposed to daylight. Light can break down the chemical structure of dyes, leading to fading or changes in shade over time. The level of color fastness to light depends on factors such as the type of dye used, the fiber it is applied to, and the strength of the dye-fiber bond. In cotton dyeing, reactive dyes are commonly used due to their ability to form strong covalent bonds with cellulose fibers, which can improve their resistance to fading. However, not all reactive dyes perform equally, and testing is often required to compare their performance under controlled light exposure.

2.4.2 Introduction of Color Fastness to Rubbing

Color fastness to rubbing, also known as crocking fastness, is an important property of dyed or printed textiles that determines their resistance to color transfer when subjected to friction. During use, garments, upholstery, and other fabrics often come into contact with different surfaces, and poor rubbing fastness can cause staining of adjacent materials as well as deterioration of the fabric's appearance. The test is carried out in both dry and wet conditions using a crock meter, where a white cotton rubbing cloth is rubbed against the fabric under controlled pressure and motion. The degree of staining on the rubbing cloth is then evaluated using a grey scale rating, where grade 5 represents no

staining and grade 1 represents severe staining. This test is especially important for fabrics dyed with deep shades, dark colors, or pigments that may not fully penetrate into the fibers. Since reactive dyes form covalent bonds with cotton fibers, they generally provide good rubbing fastness, although incomplete fixation or insufficient washing-off of hydrolyzed dye can lead to surface staining.

2.4.3 Introduction of Color Fastness to Wash

Color fastness to washing is a key property of dyed or printed textiles that indicates their ability to retain color when subjected to domestic or commercial laundering. During washing, fabrics are exposed to water, detergents, alkalinity, temperature, and mechanical action, all of which can cause dye molecules to loosen, migrate, or fade if they are not firmly fixed to the fibers. The wash fastness test evaluates both color change of the dyed specimen and staining on adjacent fabrics, using a grey scale rating system where grade 5 represents excellent resistance and grade 1 represents poor resistance. Reactive dyes, which form covalent bonds with cotton, generally exhibit very good wash fastness, although unfixed or hydrolyzed dyes may cause slight staining if not completely removed during after-treatment. This property is especially important for ensuring the durability and quality of textiles in everyday use.

2.4.4 Introduction of Color Fastness to Perspiration

Color fastness to perspiration is an important property of dyed textiles that measures their resistance to color change and staining when exposed to the effects of human sweat. During actual wear, fabrics frequently come into contact with acidic or alkaline perspiration, which can cause dyes to fade, bleed, or migrate onto adjacent materials. The perspiration fastness test simulates these conditions by treating dyed samples in standardized acidic and alkaline sweat solutions, applying pressure, and incubating them at body temperature. The resulting color change of the specimen and staining of adjacent fabrics are assessed using the grey scale, with grade 5 indicating excellent resistance and grade 1 representing poor performance. Since perspiration is unavoidable in garments such as sportswear and summer clothing, this test is crucial for evaluating the practical suitability of dyed fabrics.

Chapter-3

Material & Method

3.1 Material

❖ **Fabric** :

We used 4 KG 100% Cotton Bleached Fabric, Single Jersey, 160 GSM.

❖ **Reactive Dye :**

We used 2 type of reactive dye-

- **Dye-1**
  Jakajol : Yellow HQC=0.94%
  Fumojol : Red FN=0.51%
  Fucojol : Blue EBL=0.67%

- **Dye-2**
  Jakajol : Yellow CE=1.0390%
  Jakajol : Red HQW=0.5580%
  Jakajol : Blue HQ=0.8180%

Required Machineries / Equipment's

SL	Name of Machineries / Equipment's	Use For
1	Dyeing Machine	Use for dyeing
2	Rota Wash Machine	Assessment of Color Fastness to Washing
3	Crock-meter	For Rubbing Test
4	Gray Scale	For Color Fastness Assessment
5	Perspiration Meter	For Color Fastness Assessment
6	Multi-fiber	For Color Transfer Assessment

3.2 Method

3.2.1 Process of Reactive Dyeing



3.2.1 Picture : Reactive Dyeing Machine

Dyeing Recipe

❖ Recipe for Dyeing Process-1

Fabric Weight = 2 KG
Dye-1 = 2.12 %
Glubar Salt = 50 g/L
Soda Ash = 12 g/L
Water Ratio = 1:8
Time = 60 min
Temperature = 60°C

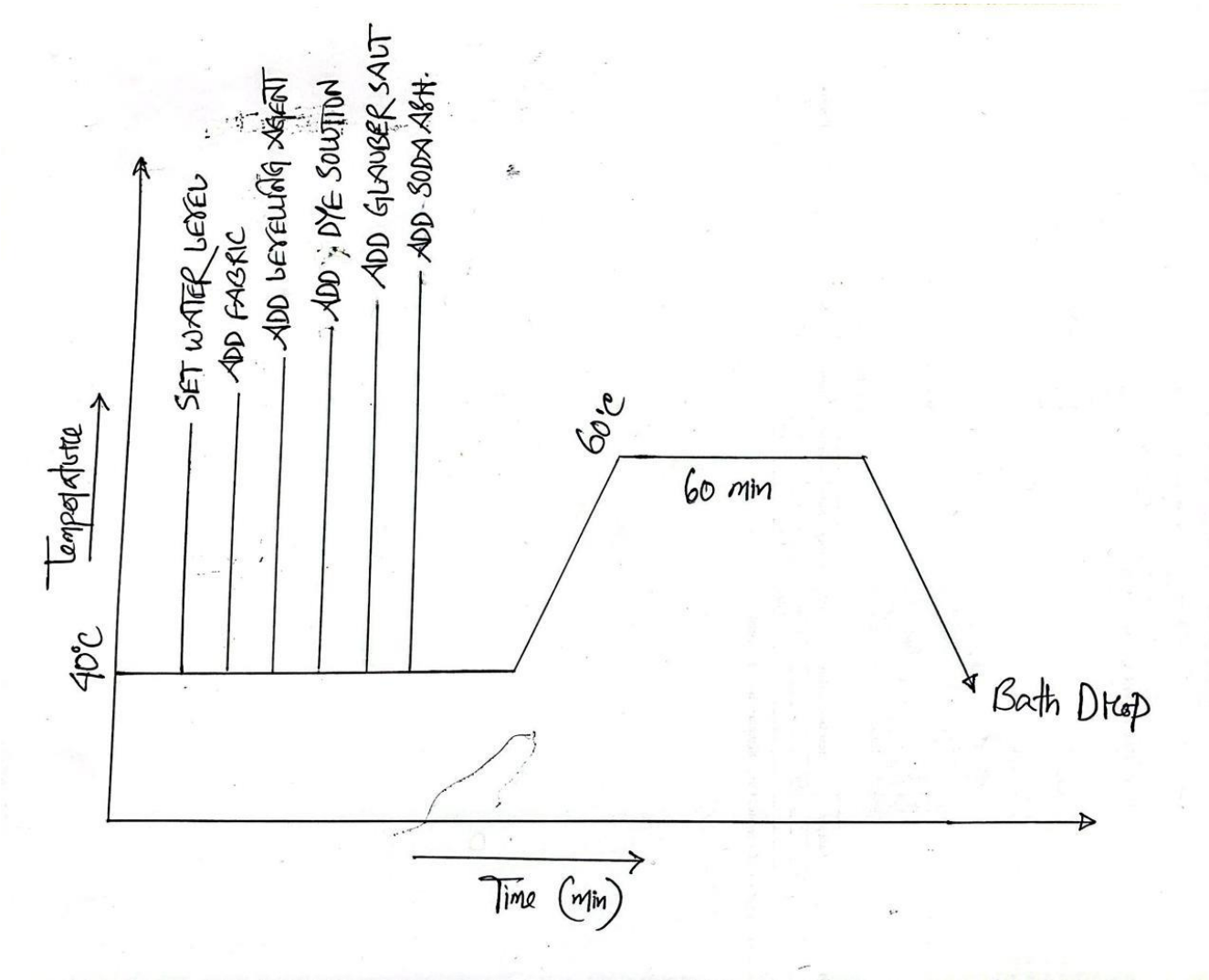
❖ Recipe for Dyeing Process-2

Fabric Weight = 2 KG
Dye-1 = 2.415 %
Glubar Salt = 50 g/L
Soda Ash = 12 g/L
Water Ratio = 1:8
Time = 60 min
Temperature = 60°C

Required Apparatus

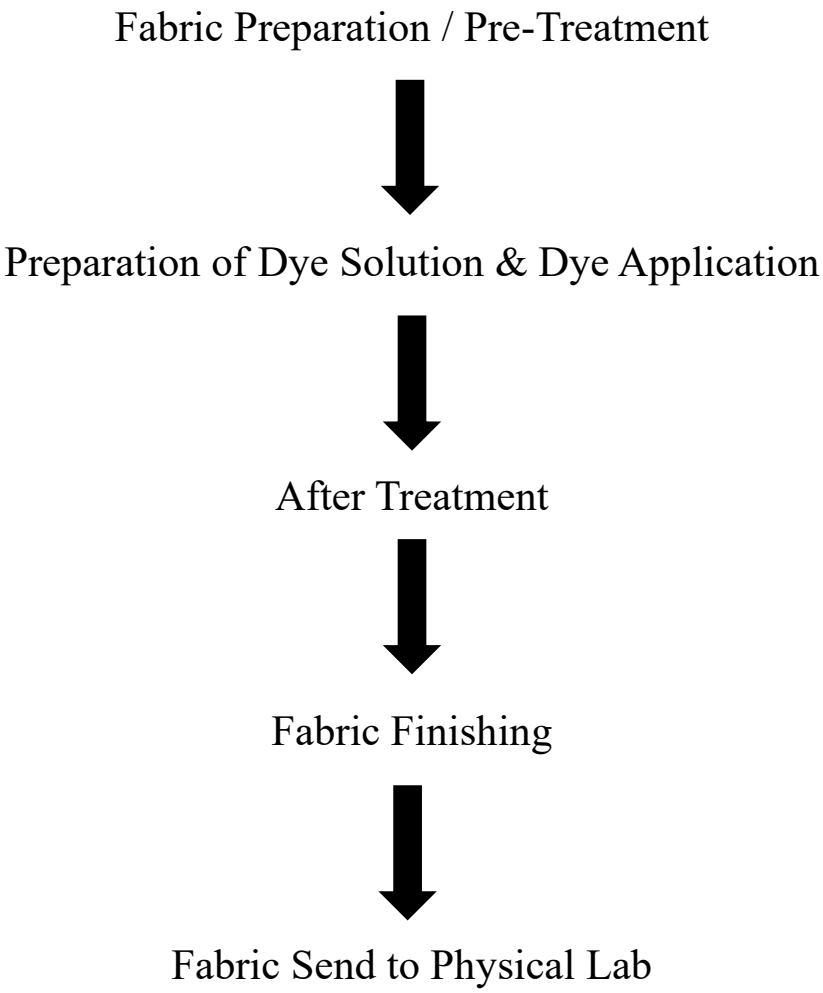
1. Beaker
2. Stirrer
3. Measuring Cylinder
4. Conical Flax
5. Electrical Balance
6. Scissor
7. Thermometer

Process Curve



3.2.1 Figure : Process Curve of Reactive Dyeing

Process Sequences



Dyeing Process in Machine

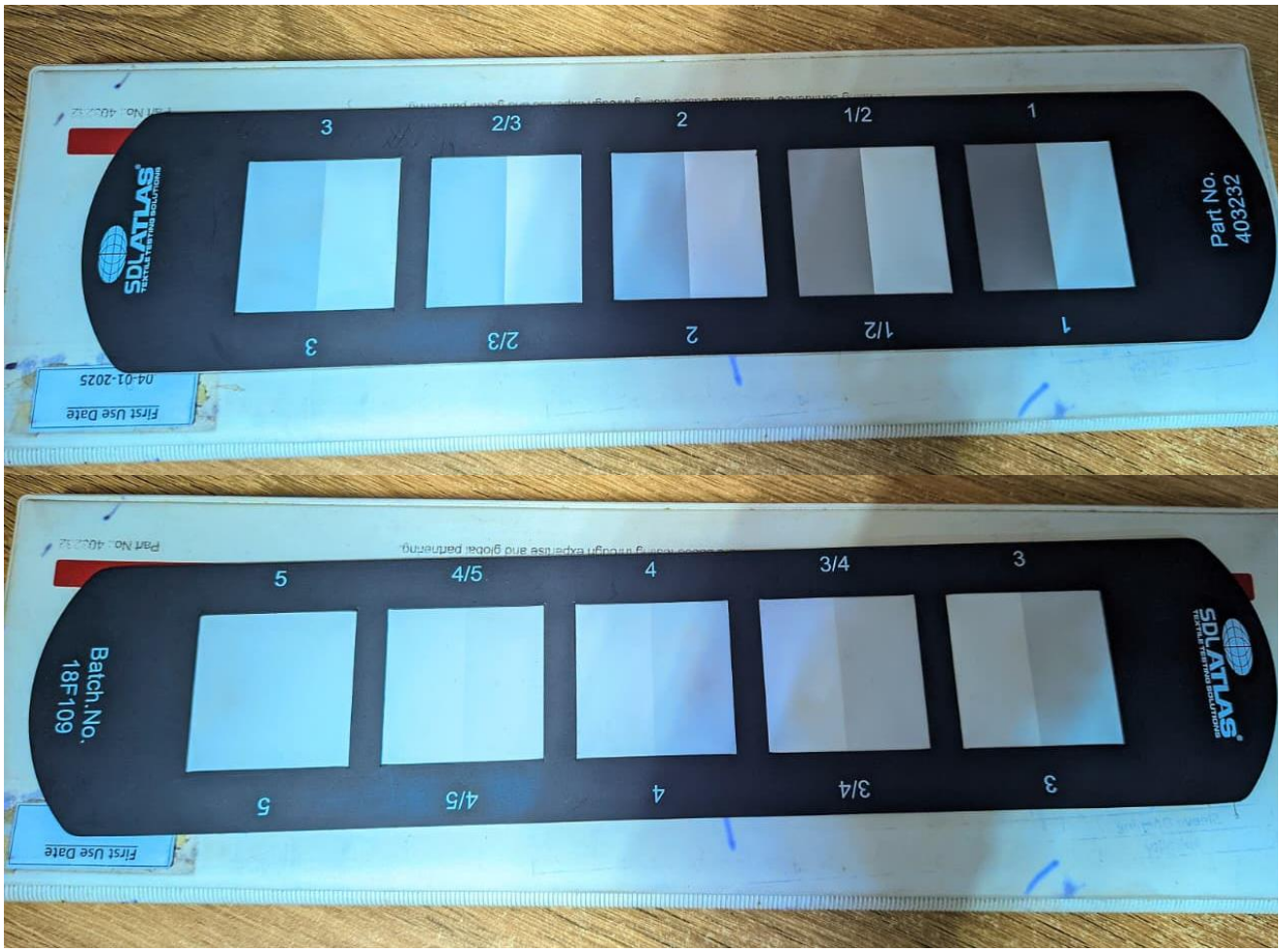
We used dyeing machine to dye the cotton fabric with selected dye-1 & dye-2. These machines work by immersing the textile in a dye bath and using mechanical processes, such as agitation, circulation, or spraying, to ensure uniform color distribution.

3.2.2 Process of Color Fastness to Light Test

We have checked color fastness to Light for both dyed samples.



3.2.2 (a) Picture : Color Fastness to Light Test Machine



3.2.2 (b) Picture : Color Staining Scale

The test is done step by step. Following step is maintained during measure the color fastness to light.

Purpose : To determine the resistance of textile colors to fading when exposed to light, either natural (sunlight) or artificial (Xenon arc, carbon arc).

Work Process :

1. Cut the test specimen 40mm x 100mm
2. The specimen holder set into the light fastness tester machine.
3. The experiment continued at 72 hours.
4. After 72 hours later specimen taken from the tester machine.
5. Then the test specimen compare with the gray scale.

Same steps maintained for both dyed sample.

Evaluation

- Compare the exposed sample to the original (unexposed) portion.
- Also compare to the Blue Wool Standards to determine the equivalent grade.
- Use a gray scale for color change if required.

3.2.3 Process of Color Fastness to Rubbing

We used crock meter to check the color fastness to rubbing for both color.

(Standard Methods : ISO 105 x 12)



3.2.3 (a) Picture : Color Fastness to Rubbing Test Machine



3.2.3 (b) Pictures : Color Changing Scale

Purpose : To determine the resistance of the color of a dyed fabric to rubbing.

The test is done step by step. Following step is maintained for both sample during measure the color fastness to rubbing.

1. Cut specimen at least 50mm x 130 mm.
2. Mount the specimen flat on the base of the crock meter.
3. Set cotton rubbing cloth on the rubbing finger of the crock meter.

For Dry Rubbing :

1. Use a dry rubbing cloth.
2. Rub the specimen with 10 complete cycles.
3. Remove the rubbing cloth.

For Wet Rubbing :

1. Wet a rubbing cloth in distilled water.
2. Mount the wet cloth on the rubbing finger.
3. Rub the specimen with 10 complete cycles.
4. Remove the rubbing cloth & allow it to dry at room temperature.

Assessment :

Compare the stained rubbing cloth with the grey scale for staining. Report result separately for wet & dry rubbing.

3.2.4 Process of Color Fastness to Wash

We have tested the color fastness to wash of both dyed sample with Rota wash machine.

Purpose : To determine the resistance of the color of textiles to domestic or commercial laundering (washing with soap/detergent solution under controlled conditions).



3.2.4 Pictures : Rota Wash Machine

Preparation of Specimen

1. Cut the fabric specimen (40 × 100 mm).
2. Stitch it with adjacent fabric along one edge (forming a composite specimen).
3. Weigh the composite specimen to calculate the correct liquor volume (liquor ratio usually 50:1).

Washing Procedure

1. Prepare the washing solution (e.g., 4 g/L soap/detergent + 1 g/L sodium carbonate).
2. Add the required volume of solution into the stainless-steel container.
3. Place the specimen + adjacent fabric inside the container.
4. Add 10–50 steel balls.
5. Seal the container tightly.
6. Place the container into the Rota Wash machine rotor.
7. Set the machine to rotate at 40 ± 2 rpm.
8. Maintain the specified washing temperature (60 °C) and time 40 min.
9. After completion, remove the specimen.
10. Rinse thoroughly in cold water, then in running water.
11. Squeeze and dry in air at room temperature.

Assessment :

1. Compare the washed specimen with the original specimen using the Grey Scale for Color Change.

2. Compare the adjacent fabric with the Grey Scale for Staining.

3.2.5 Process of Color Fastness to Perspiration

We have tested the color fastness to Perspiration of both dyed sample with Perspiration tester



3.2.5 (a) Pictures : Perspirometer



3.2.5 (b) Picture : Multi Fiber

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Purpose : To assess the resistance of textile colors to the action of human perspiration (both acidic and alkaline conditions).

Preparation of Solution

1. Acidic solution (pH ≈ 5.5) – contains sodium chloride, lactic acid, histidine
2. Alkaline solution (pH ≈ 8.0) – contains sodium chloride, sodium phosphate, histidine.

Preparation of Specimen

1. Cut the test specimen (usually 40 × 100 mm).
2. Stitch it together with multifiber.
3. Prepare two sets of specimens: one for acid perspiration and one for alkaline perspiration.

Test Procedure

1. Immerse one specimen in the acidic perspiration solution and the other in the alkaline perspiration solution for 30 minutes.
2. Remove excess liquor by blotting between filter papers.
3. Place the specimen between two glass/plastic plates of the perspire-meter.
4. Apply a standard pressure 4.5 kg.
5. Keep the mounted specimens in an oven at 37 ± 2 °C for 4 hours.
6. After incubation, remove specimens and separate them from multifiber.
7. Dry in air at room temperature.

Assessment :

1. Compare the washed specimen with the original specimen using the Grey Scale for Color Change.
2. Compare the adjacent fabric with the Grey Scale for Staining.

Chapter-4

Result & Discussion

4.1 Result & Discussion of Reactive Dyeing

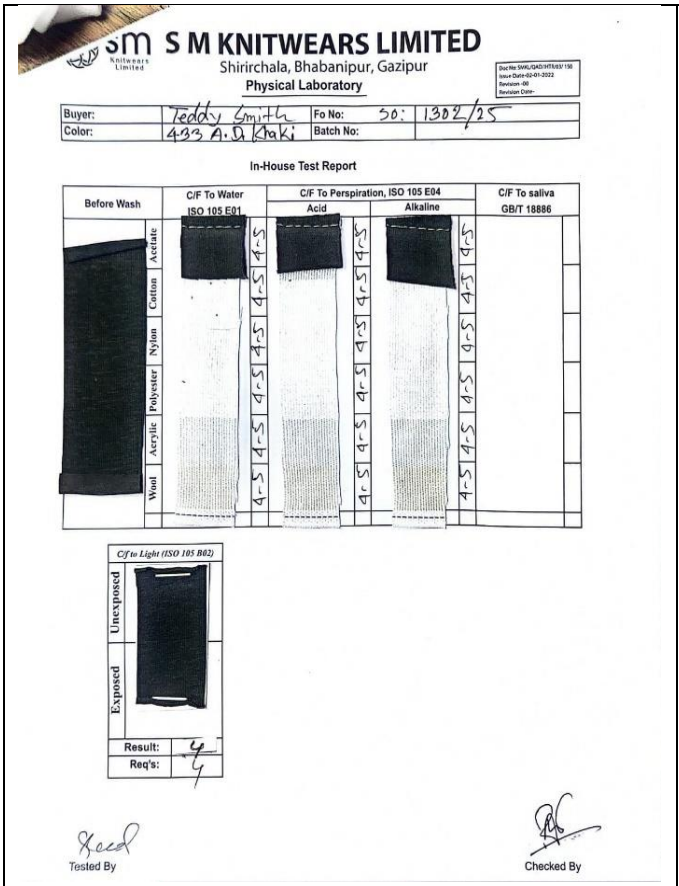
For both sample & recipe

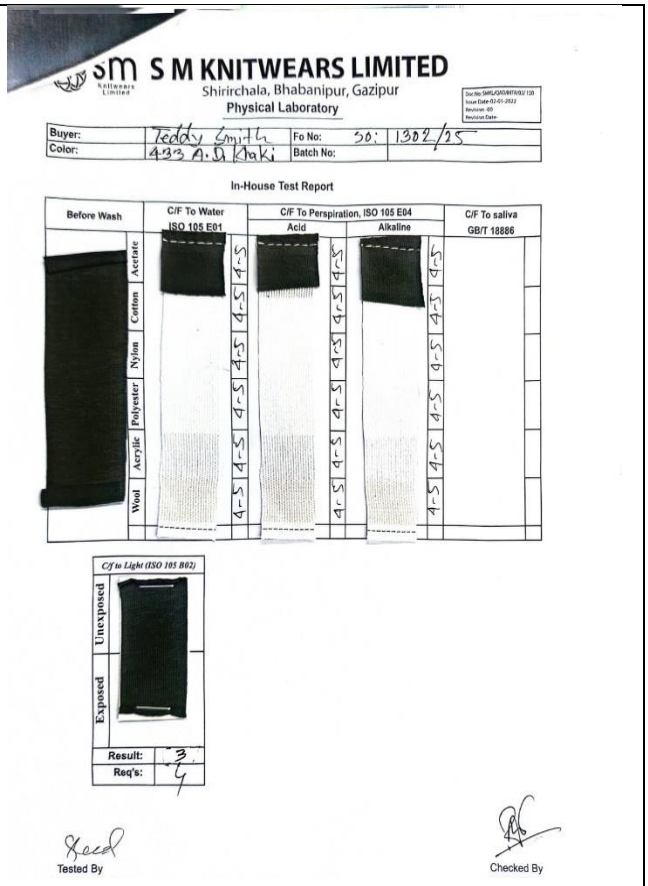
1. The fabric was successfully dyed with reactive dye.
2. The dyed sample exhibited bright and uniform coloration, indicating good dye–fiber interaction.
3. Washing and rubbing fastness tests showed good to excellent ratings, as reactive dyes form covalent bonds with the fiber.
4. Color fastness to Light test result is different for both samples.

Discussion :

The reactive dyeing process produced bright and uniform shades on the cotton fabric, confirming the strong affinity of reactive dyes for cellulosic fibers. The excellent wash fastness observed is due to the formation of covalent bonds between the dye molecules and the hydroxyl groups of cellulose. Overall, the results demonstrate that reactive dyes provide brilliant, fast shades on cotton when dyeing conditions are optimized.

4.2 Result & Discussion of Color Fastness to Light





Sample-1	Sample-2

4.2 Picture :Test Result of Color Fastness to Light

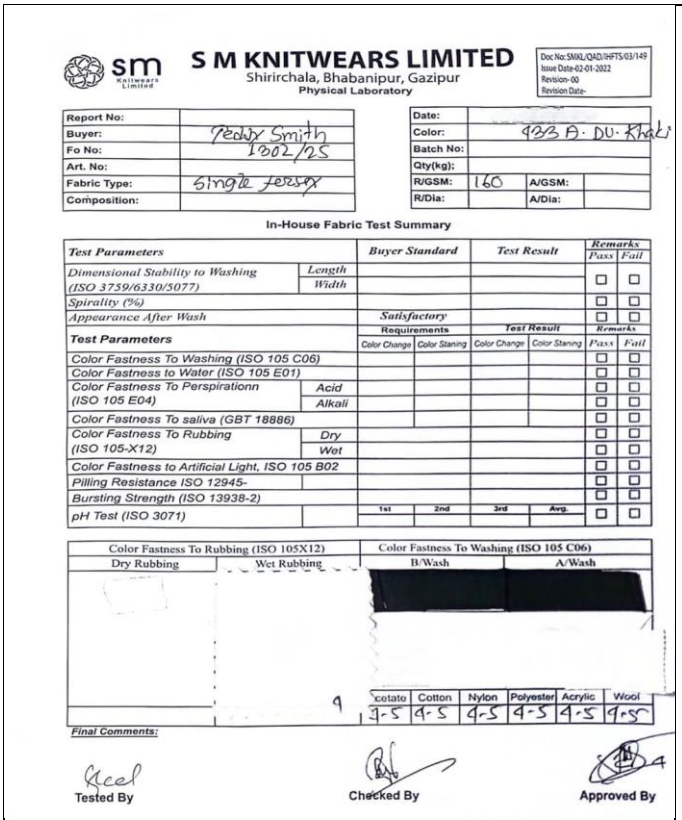
Result :

Sample No.	Scale Rating	Requirement	Result
Dyed Sample-1	4	4	Pass
Dyed Sample-2	3	4	Fail

Discussion : The results of the color fastness to light test indicate that Sample-1 exhibited good resistance to fading, achieving the required rating according to the blue wool standard, and therefore passed the test. This suggests that the dye used in Sample-1 has strong photostability and forms stable bonds with

the fiber, making it suitable for applications where exposure to light is expected. In contrast, Sample-2 failed the test, indicating that the dye was less stable under light exposure, leading to significant fading. The failure could be due to the dye's chemical structure being sensitive to UV or visible light, insufficient fixation during dyeing, or inadequate use of light stabilizers. These results highlight the importance of selecting dyes with high photostability and optimizing dyeing conditions to ensure long-term color retention in sunlight or artificial light exposure.

4.3 Result & Discussion of Color Fastness to Rubbing Test



S M KNITWEARS LIMITED
Shirirchala, Bhabanipur, Gazipur
Physical Laboratory

Doc No: SMKL/QAD/IHFTS/03/149
Issue Date-02-01-2022
Revision- 00
Revision Date-

Report No:		Date:	
Buyer:	Peddy Smith	Color:	923 B. DU. Khali
Fo No:	1202/25	Batch No:	
Art. No:		Qty(kg):	
Fabric Type:	Single Jersey	R/GSM:	160 A/GSM:
Composition:		R/Dia:	A/Dia:

In-House Fabric Test Summary

Test Parameters		Buyer Standard	Test Result	Remarks Pass	Fail
Dimensional Stability to Washing (ISO 3759/6330/5077)	Length				
	Width				
Spirality (%)					
Appearance After Wash		Satisfactory			

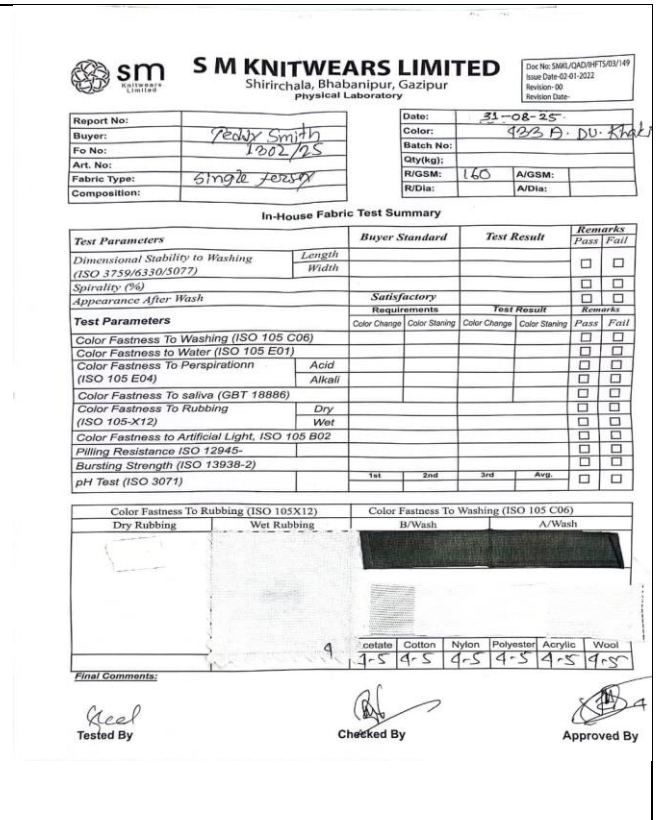
Test Parameters		Requirements Color Change	Requirements Color Staining	Test Result Color Change	Test Result Color Staining	Remarks Pass	Fail
Color Fastness To Washing (ISO 105 C06)							
Color Fastness to Water (ISO 105 E01)							
Color Fastness To Perspirationn (ISO 105 E04)	Acid						
	Alkali						
Color Fastness To saliva (GBT 18886)							
Color Fastness To Rubbing (ISO 105-X12)	Dry						
	Wet						
Color Fastness to Artificial Light, ISO 105 B02							
Pilling Resistance ISO 12945-							
Bursting Strength (ISO 13938-2)							
pH Test (ISO 3071)		1st	2nd	3rd	Avg.		

Color Fastness To Rubbing (ISO 105X12)		Color Fastness To Washing (ISO 105 C06)	
Dry Rubbing	Wet Rubbing	B/Wash	A/Wash

cetate	Cotton	Nylon	Polyester	Acrylic	Wool
4-5	4-5	4-5	4-5	4-5	4-5

Final Comments:

Tested By | Checked By | Approved By



S M KNITWEARS LIMITED
Shirirchala, Bhabanipur, Gazipur
Physical Laboratory

Doc No: SMKL/QAD/IHFTS/03/149
Issue Date-02-01-2022
Revision- 00
Revision Date-

Report No:		Date:	31-08-25
Buyer:	Peddy Smith	Color:	923 B. DU. Khali
Fo No:	1202/25	Batch No:	
Art. No:		Qty(kg):	
Fabric Type:	Single Jersey	R/GSM:	160 A/GSM:
Composition:		R/Dia:	A/Dia:

In-House Fabric Test Summary

Test Parameters		Buyer Standard	Test Result	Remarks Pass	Fail
Dimensional Stability to Washing (ISO 3759/6330/5077)	Length				
	Width				
Spirality (%)					
Appearance After Wash		Satisfactory			

Test Parameters		Requirements Color Change	Requirements Color Staining	Test Result Color Change	Test Result Color Staining	Remarks Pass	Fail
Color Fastness To Washing (ISO 105 C06)							
Color Fastness to Water (ISO 105 E01)							
Color Fastness To Perspirationn (ISO 105 E04)	Acid						
	Alkali						
Color Fastness To saliva (GBT 18886)							
Color Fastness To Rubbing (ISO 105-X12)	Dry						
	Wet						
Color Fastness to Artificial Light, ISO 105 B02							
Pilling Resistance ISO 12945-							
Bursting Strength (ISO 13938-2)							
pH Test (ISO 3071)		1st	2nd	3rd	Avg.		

Color Fastness To Rubbing (ISO 105X12)		Color Fastness To Washing (ISO 105 C06)	
Dry Rubbing	Wet Rubbing	B/Wash	A/Wash

cetate	Cotton	Nylon	Polyester	Acrylic	Wool
4-5	4-5	4-5	4-5	4-5	4-5

Final Comments:

Tested By | Checked By | Approved By

Test Result for Sample-1	Test Result for Sample-2

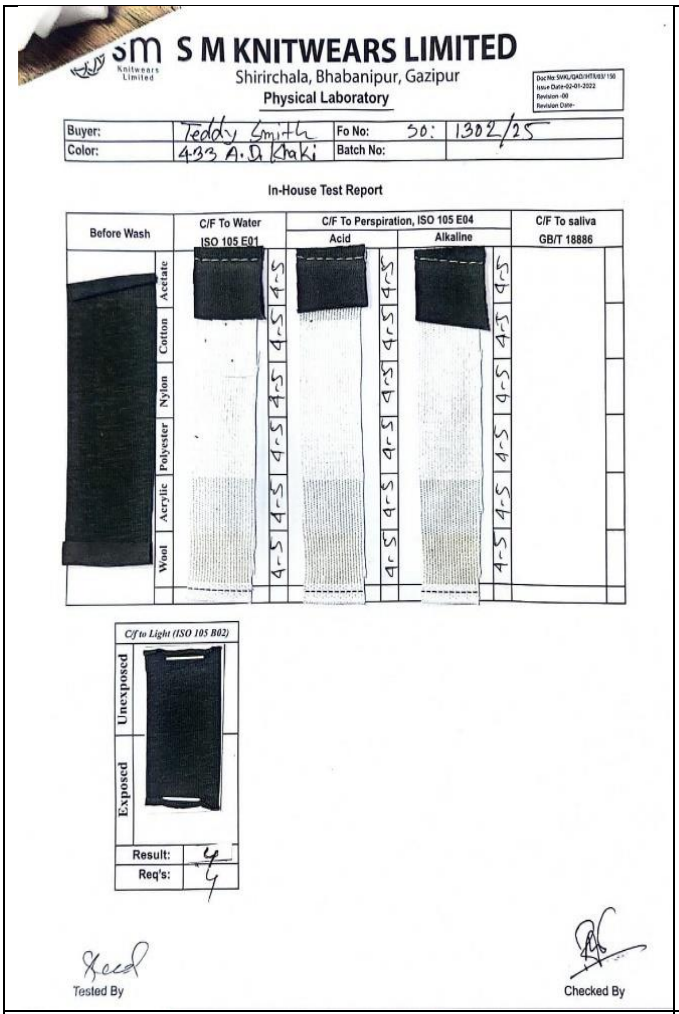
4.3 Picture : Color Fastness to Rubbing

Report :

Test Type	For Sample-1	For Sample-2	Buyer Requirement	Result
Dry	4/5	4/5	4	Pass
Wet	4	4	3/4	Pass

Discussion : The rubbing fastness test of the reactive dyed both samples showed satisfactory results in both dry and wet conditions, indicating that the dye molecules were strongly bonded to the fiber surface. This good performance is mainly due to the covalent bond formation between reactive dyes and the hydroxyl groups of cotton, which prevents the color from easily transferring during friction. The absence of significant staining on the rubbing cloth confirms that most of the unfixed or hydrolyzed dyes were effectively removed during the washing-off process. Thus, the test results demonstrate that the dyed fabric has adequate resistance to rubbing and is suitable for practical end-use.

4.4 Result & Discussion of Color Fastness to Wash


S M KNITWEARS LIMITED
Shirirchala, Bhabanipur, Gazipur
Physical Laboratory

Buyer:	Teddy Smith	Fo No:	50: 1302/25
Color:	433 A.D Khaki	Batch No:	

In-House Test Report

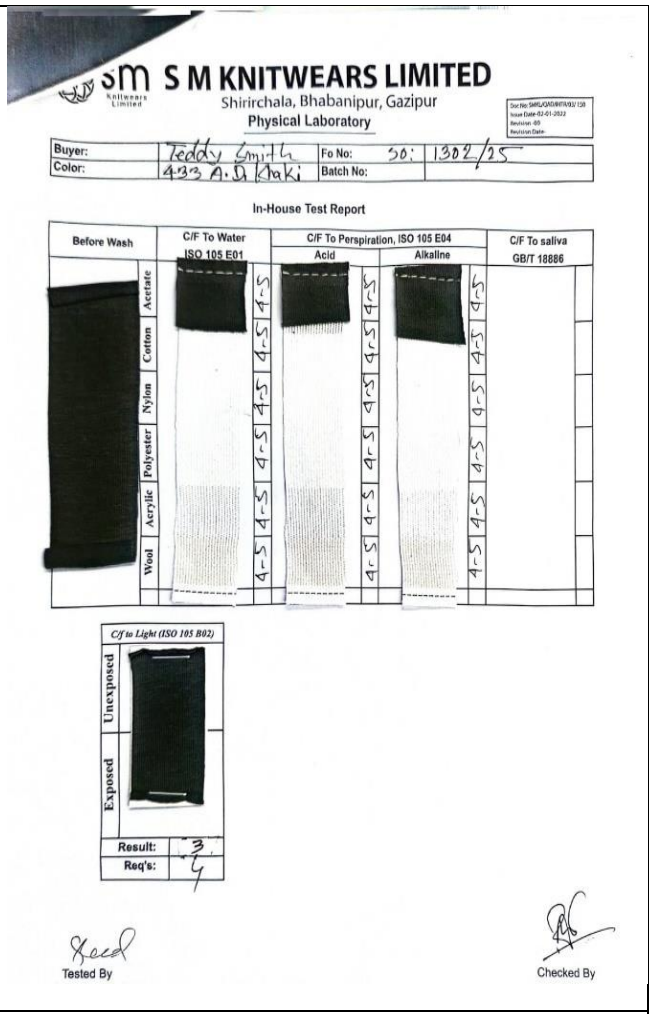
Before Wash	C/F To Water ISO 105 E01	C/F To Perspiration, ISO 105 E04 Acid	C/F To Perspiration, ISO 105 E04 Alkaline	C/F To saliva GB/T 18886
Acetate	4-5	4-5	4-5	4-5
Cotton	4-5	4-5	4-5	4-5
Nylon	4-5	4-5	4-5	4-5
Polyester	4-5	4-5	4-5	4-5
Acrylic	4-5	4-5	4-5	4-5
Wool	4-5	4-5	4-5	4-5

C/f to Light (ISO 105 B02)

Unexposed	
Exposed	
Result:	4
Req's:	4

Tested By

Checked By


S M KNITWEARS LIMITED
Shirirchala, Bhabanipur, Gazipur
Physical Laboratory

Buyer:	Teddy Smith	Fo No:	50: 1302/25
Color:	433 A.D Khaki	Batch No:	

In-House Test Report

Before Wash	C/F To Water ISO 105 E01	C/F To Perspiration, ISO 105 E04 Acid	C/F To Perspiration, ISO 105 E04 Alkaline	C/F To saliva GB/T 18886
Acetate	4-5	4-5	4-5	4-5
Cotton	4-5	4-5	4-5	4-5
Nylon	4-5	4-5	4-5	4-5
Polyester	4-5	4-5	4-5	4-5
Acrylic	4-5	4-5	4-5	4-5
Wool	4-5	4-5	4-5	4-5

C/f to Light (ISO 105 B02)

Unexposed	
Exposed	
Result:	3
Req's:	4

Tested By

Checked By

Sample-1	Sample-2

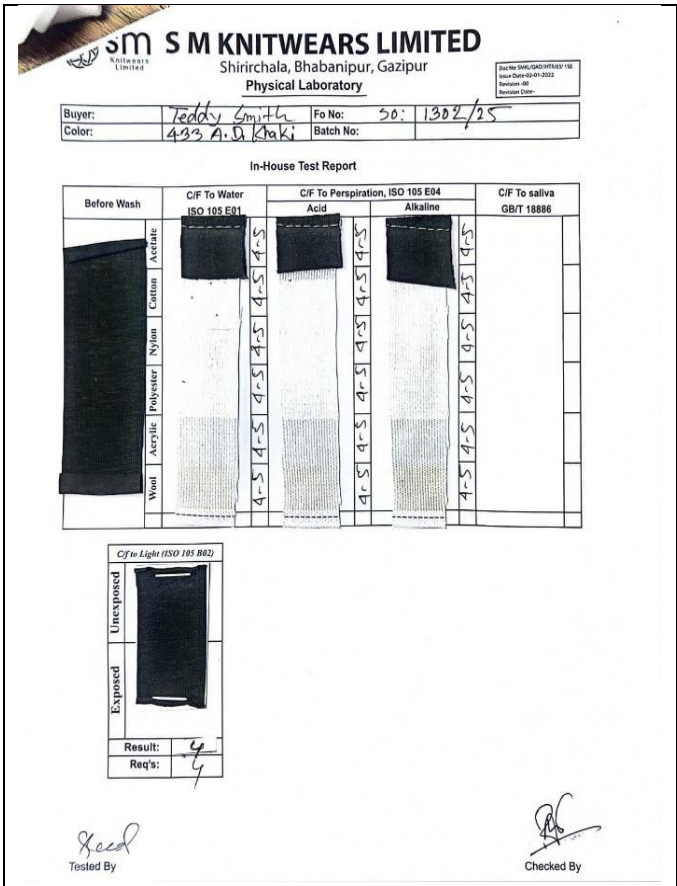
4.4 Picture : Test Result of Color Fastness to Wash

Result :

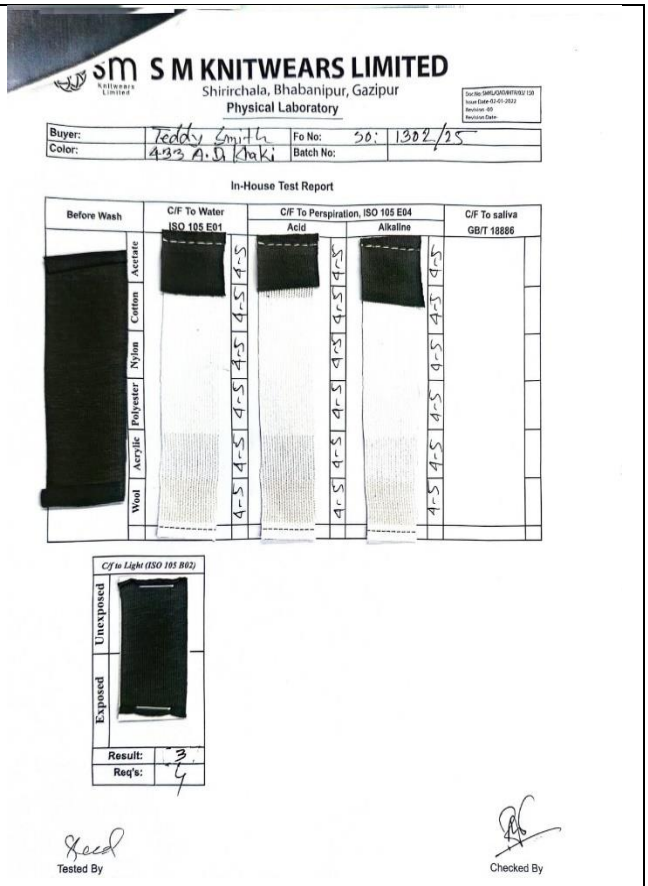
Change Shade	Gary Scale Rating		Requirement	Result
Staining on multifiber	**Dyed Sample-1**	**Dyed Sample-2**		
Acetate	4/5	4/5	4	Pass
Cotton	4/5	4/5	4	
Nylon	4/5	4/5	4	
Polyester	4/5	4/5	4	
Acrylic	4/5	4/5	4	
Wool	4/5	4/5	4	
Cross Staining	4/5	4/5	4	

Discussion : The wash fastness test results of both samples showed a rating of 4/5, which indicates only slight color change and minimal staining on the adjacent fabric. This high level of wash fastness suggests that the dye was well-fixed onto the fiber and that proper after-treatment effectively removed most of the unfixed or hydrolyzed dye. The result confirms that the dyeing process produced durable shades that can withstand normal domestic laundering conditions. However, the small reduction from the maximum rating of 5 may be attributed to the presence of trace amounts of unfixed dye molecules that were not completely washed off. Overall, the performance of both samples can be considered very good and suitable for practical use.

4.5 Result & Discussion of Color Fastness to Perspiration



Sample-1



Sample-2

4.5 Pictures : Test Result of Color Fastness to Perspiration

Result For Dyed Sample-1

Change Shade	Gary Scale Rating		Requirement	Result
Staining on multifiber	Acid	Alkaline		
Acetate	4/5	4/5	4	Pass
Cotton	4/5	4/5	4	
Nylon	4/5	4/5	4	
Polyester	4/5	4/5	4	
Acrylic	4/5	4/5	4	
Wool	4/5	4/5	4	
Cross Staining	4/5	4/5	4	

Result For Dyed Sample-2

Change Shade Staining on multifiber	Gary Scale Rating		Requirement	Result
	Acid	Alkaline		
Acetate	4/5	4/5	4	Pass
Cotton	4/5	4/5	4	
Nylon	4/5	4/5	4	
Polyester	4/5	4/5	4	
Acrylic	4/5	4/5	4	
Wool	4/5	4/5	4	
Cross Staining	4/5	4/5	4	

Discussion : The perspiration fastness test results of both samples were rated 4/5, indicating very good resistance to color change and only slight staining of the adjacent fabrics under both acidic and alkaline conditions. This shows that the dyes were strongly fixed to the fiber and could withstand the chemical action of perspiration to a high degree. The minor reduction from the maximum rating of 5 suggests that a small amount of unfixed or hydrolyzed dye may still have been present on the fabric surface, leading to slight staining. Overall, both samples demonstrated excellent performance, confirming that the dyeing process produced shades suitable for garments that will be exposed to perspiration during wear.

Chapter-5

Conclusion

The experiment on the reactive dyeing of cotton fabric using two types of reactive dyes was carried out to evaluate and compare their performance in terms of color fastness to light, washing, rubbing, and perspiration. The results from the tests provided clear insights into the dye–fiber interactions and the practical applicability of reactive dyes for cotton.

Both types of reactive dyes produced bright and uniform shades on cotton, confirming their strong affinity for cellulosic fibers. The wash fastness test results (4/5) indicated that the dyes formed stable covalent bonds with the hydroxyl groups of cellulose, which resisted washing action effectively. Only slight color change and minimal staining were observed, which could be attributed to traces of unfixed or hydrolyzed dye that remained even after washing-off. Thus, both dyes demonstrated durability in domestic laundering conditions.

The rubbing fastness test showed that the samples maintained good resistance in both dry and wet rubbing, with minimal staining on the rubbing cloth. This performance is expected from reactive dyes, as the strong covalent bonds prevent easy removal of dye from the fiber surface. Any minor staining detected was likely due to surface dye particles that were not completely removed during the after-treatment process.

In the perspiration fastness test, both dyes achieved ratings of 4/5 under acidic and alkaline conditions. This reflects very good resistance to perspiration,

again due to the stability of the dye–fiber bond. The slight staining on adjacent fabrics suggests that some hydrolyzed dye may have been retained on the fiber, which under perspiration conditions migrated slightly. Nonetheless, the results confirm that reactive dyed cotton can perform well under normal wear conditions where perspiration is common.

The major difference between the two dyes was observed in the light fastness test. One sample passed the required rating, while the other failed, demonstrating that light stability depends strongly on the molecular structure of the dye. The passing sample showed good photostability and resistance to fading, making it more suitable for end uses where fabrics are exposed to sunlight. The failing sample, however, faded significantly, highlighting a limitation in its chemical structure or in its resistance to UV degradation.

Overall, the comparative study shows that while both types of reactive dyes can provide excellent wash, rubbing, and perspiration fastness on cotton, their performance against light can vary significantly. This emphasizes the importance of proper dye selection based on the end-use of the fabric. For garments and home textiles that will experience frequent sunlight exposure, dyes with higher light fastness must be chosen, even if both options perform equally well in wash and wear conditions.

In conclusion, reactive dyeing remains one of the most reliable methods for coloring cotton, offering brilliant shades and strong fiber bonding. However, optimizing dye selection, fixation, and after-treatment is essential for achieving balanced fastness properties across all conditions of use.