Faculty of Engineering

Department of Textile Engineering

Comparative Study on K/S Values and Wash Fastness using Bi-Functional and Mono-Functional Reactive Dyeing on 100% cotton knitted fabric.

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Advance in Wet Processing Technology

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Kamrul Islam, Lecturer**, Department of Textile Engineering, Faculty of Engineering, entitled with **"Comparative Study on K/S Values and Wash Fastness using Bi-Functional and Mono-Functional Reactive Dyeing on 100% cotton knitted fabric**.**"**, Daffodil International University. We also declare that, neither this report nor any part of this has been submitted elsewhere for award of any degree.

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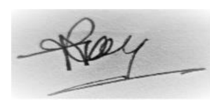
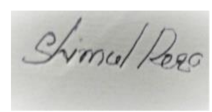
Anup Roy	172-23-312	
Shimul Reza	172-23-346	

Faculty of Engineering

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LETTER OF APPROVAL

This project report prepared by **Md. Anamul Haq (ID# 172-23-310), Md. Sazzad Hosain Shaon (ID# 172-23-311), Anup Roy (ID# 172-23-312) & Shimul Reza (ID# 172-23-346)** is approved in Partial Fulfilment of the Requirement for the Degree of BACHELOR OF SCIENCE IN TEXTILE ENGINEERING. The said students have completed their project work under my supervision entitles with **"Comparative Study on K/S Values and Wash Fastness using Bi-Functional and Mono-Functional Reactive Dyeing on 100% cotton knitted fabric"**. During the research period I found them sincere, hardworking and enthusiastic.

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DEDICATION

"This Projects Report is dedicated to our dignified **parents** and **teachers**

may they live long"

ABSTRACT

In this study, a mixed bi-functional reactive dye and Mono-functional reactive dye was applied to the cotton fabrics. Their K/S values and wash fastness properties were compared. In the knitwear industry, the dyeing of 100% cotton knitted fabric is on the whole achieved with reactive dyes, due to the fact of their precise fastness homes and versatility of applications. The ease of application, vast coloration range, excessive brilliancy, and brilliant moist fastness residences make the reactive dyes desired preference for the dyeing of cellulosic fabrics. The most essential attribute of reactive dyes is the formation of covalent bonds with the substrate to be colored, i.e. the dye varieties a chemical bond with cellulose. Fiber reactive dyes are the most everlasting of all dye types. Unlike different dyes, it clearly types a covalent bond with the cellulose or protein molecule. Once the bond is formed, what you have is one molecule, as the dye molecule has emerge as an authentic section of the cellulose fiber molecule. From the results, it was observed that the 100% cotton knitted fabric K/S value very little increase in cotton fabric & little decrease in after applying finishing agent. Colorimetric value indicate that cotton batch fabric are lighter, reddish & yellowish than standard sample. But color difference value in both sample are acceptable. After applying finishing agent, the wash fastness (color change & Staining) of viscose fabric is better than cotton fabric.

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Chapter One
Introduction

1.1 Introduction

Cotton is a characteristic cellulosic fiber. Cellulose contain 44% carbon, 6.2% Hydrogen and 49.4% oxygen [1]. Cotton is the world's most mainstream fiber for material creation [22]. A wide scope of material items can be made by utilizing this cotton strands. To deliver overwhelming or lighter texture cotton fiber are utilized. Overall cotton is most well known as a result of its less cost. The material items which are made by cotton are reasonable for utilizing all the year both in home and mechanical employments. Cotton texture are agreeable to wear as a result of its high dampness sponginess ability and fast dampness discharge capacity. For the most part cotton fiber length ranges from ½ crawls to 2 inches and its dampness recover presentence is 8% and its quality is increment 10 % when it became wet [22]. There are numerous kinds of cotton fiber discovered everywhere throughout the world, they are Asiatic cotton, Egyptian cotton, Canton cotton, Sea Island cotton, American Upland Cotton, Organic Cotton, Pima cotton, French Terry cotton, Bamboo cotton and so forth. There are numerous sorts of completing procedure should be possible in cotton texture, for example, water repellent completion, mold finish, simple consideration finish, Antiseptic completion, Flame safe completion and so on. Cotton items can be use in both home materials and articles of clothing item. [22]

1.2 Objectives of the Study:

- **Spectral analysis**: Comparative Study on Spectral value of 100% Cotton with reactive dye.
- **Strength test:** Comparative study on Physical Strength of 100% Cotton & with reactive dye.
- **Color Fastness to wash test:** Comparative Study on Fastness property (Wash) of 100% Cotton with reactive dye.

1.3 Limitation of the Study:

A thesis paper needed Practical result where a researcher shown their papers test elements, result, output, and discuss about their result based on topic, but during the present situation of whole world we are affected on COVID-19 for that reason we cannot do lab test for our research and don't give any output for our paper. Here we shown just possibility of result.

Chapter Two

Literature Review

2.1: Reactive Dye:

Fiber reactive dyes are the most lasting of all dye types. In contrast to different dyes, it really shapes a covalent bond with the cellulose or protein atom. When the bond is shaped, what you have is one particle, as the dye atom has become a genuine piece of the cellulose fiber atom. No big surprise you can securely wash a piece of clothing that has been dyed in brilliant fiber reactive hues with white attire, a hundred times, without jeopardizing the whites at all – regardless of whether it is all extraordinary splendid hues or even strong dark! Rather than every single other dye, the reactive dyes tie artificially to the material strands, essentially improving the item's shading steadiness and launder ability. In this manner reactive dyeing of cotton is at present the most broad material kicking the bucket procedure on the planet. In a reactive dye, a chromophore contains a substituent that is actuated and permitted to straightforwardly respond to the outside of the substrate. Reactive dyes have great quickness properties inferable from the holding that happens during dyeing. Reactive dyes are most usually utilized in the dyeing of cellulose like cotton or flax, yet additionally fleece is dye able with reactive dyes. Reactive dyes originally showed up economically in 1956, after their creation in 1954 by Rattee and Stephens at the Imperial Chemical Industries Dyestuffs Division site in Bleckley, Manchester, United Kingdom. Reactive dyes or Fiber reactive dyes are essentially a class of profoundly hued natural substances. Reactive dyes utilize a chromophore that contains a substituent that is very equipped for an immediate response with a fiber substrate. General Features of a Reactive Dye.

Molecule, [13]

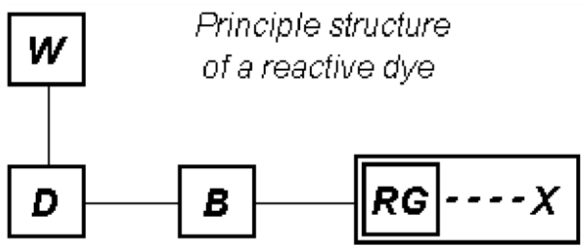
W = water solublising group

D = Dye part or Chromogen

B = Bridging group

RG = Reactive group

X = Leaving group



It is the covalent securities which the reactive dyes structure with the substrates that are liable for connecting the reactive dye to characteristic strands. The dyes contain a reactive gathering (regularly trichlorotriazine), either a haloheterocycle or an initiated twofold bond, that, when applied to a fiber in an antacid dye shower, shapes a compound bond with a hydroxyl bunch on the cellulosic fiber. The reactive dye undergoes two types of reaction [2]

1. Nucleophilic substitution
2. Nucleophilic Addition

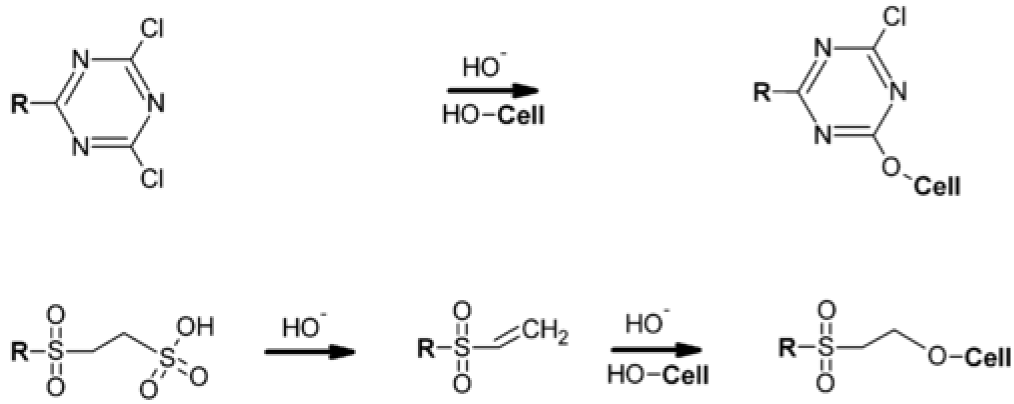
Nucleophilic substitution:

The response with cellulose by nucleophilic replacement of accessible chlorine, fluorine, methyl sulphone or nicotinyl bunch enacted by an adjoining nitrogen particle in a heterocyclic ring.

Halogen containing reactive dyes, under gentle soluble condition, experiences replacement response. [13]

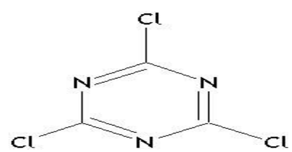
Nucleophilic Addition:

Those responding with cellulose by necleuophilic expansion to a carbon twofold bond normally actuated by an adjoining electron drawing in sulphone gathering. Reactive dyes containing vinyl sulphone bunch under gentle antacid condition, under expansion response. [13]



R = Chromophore

Cell = Cellulose



And trichlorotriazine:

Reactive dyeing is currently the most significant technique for the tinge of cellulosic filaments. Reactive dyes can likewise be applied to fleece and nylon; in the last case, they are applied under feebly acidic conditions. Reactive dyes have a low use degree contrasted with different sorts of dyestuff, since the practical gathering likewise bonds to water, making hydrolysis. [3]

2.2 The dyeing or wet processing flow chart is given below.

Before dyeing a fabric or yarn some pre-treatment and after treatment is needed. A flowchart is drawn here by combining these:

Grey Fabric Inspection

↓

Sewing or Stitching

↓

Singeing

↓

Desizing

↓

Scouring

↓

Bleaching

↓

Mercerizing

↓

Dyeing

↓

Printing

↓

Finishing

↓

Final Inspection

↓

Delivery

This is the most comprehensively used wet dealing with stream diagram on the contemporary material industry. In any case, every so often on certain preparing plants, the scouring and blurring are done at the same time.

In this paper, I will discuss on shading of cotton stock with open hues, as I have worked with responsive hues and its speed properties. Responsive hues are notable in the Bangladesh material industry. Here I have given some ordinary musings on responsive hues. [1]

2.3 Properties of reactive dye

1) Reactive dyes are cationic dyes, which are used for dyeing cellulose, protein and polyamide fibers.
2) Reactive dyes are found in power, liquid and print paste form.

3) During dyeing the reactive group of this dye forms covalent bond with fiber polymer and becomes an integral part of the fiber.
4) Reactive dyes are soluble in water.
5) They have very good light fastness with rating about 6. The dyes have very stable electron arrangement and can protect the degrading effect of ultra-violet ray.
6) Textile materials dyed with reactive dyes have very good wash fastness with rating Reactive dye gives brighter shades and has moderate rubbing fastness.
7) Dyeing method of reactive dyes is easy. It requires less time and low temperature for dyeing.
8) Reactive dyes are comparatively cheap
9) Reactive dyes have good perspiration fastness with rating 4-5.
10) Reactive dyes have good perspiration fastness. [2], [4]

2.4 The Dyeing mechanism of reactive dye

The dyeing mechanism of material with reactive dye takes place in 3 stages:

1. Exhaustion of dye in presence of electrolyte or dye absorption.
2. Fixation under the influence of alkali.
3. Wash-off the unfixed dye from material surface. [3]

Dye absorption:

When fiber is immersed in dye liquor, an electrolyte is added to assist the exhaustion of dye, here common salt or ehydra salt is used as the electrolyte. The electrolyte neutralize the negative charge formed in the fiber surface and puts extra energy to increase dye absorption. So when the textile material is introducing to dye liquor the dye is exhausted on the fiber. At the rate dye absorb to the fiber. Initially this rate remains very high but it reduces upon time. So primary control is very important. [3]

Substantively determinate:

1. Affinity
2. Liquor ratio
3. Temperature
4. Electrolytes concentration
5. PH
6. Fiber situation [3]

Exhaustion Phase Diffusion:

1. Some of the factors effect diffusion, such as:
2. PH of the bath
3. Substantively
4. Dyes aggregation
5. Pretreatment of the fabric, etc.

In exhaust dyeing, all the material contacts all the dye alcohol and the fiber assimilates the dyes. The dye focus in the shower subsequently slowly diminishes. The level of dye shower depletion is subsequently an element of time depicts the rate and degree of the dyeing procedure. For a solitary dye, the fatigue is characterized as the mass of the dye taken up by the material partitioned by the absolute beginning mass of dye in the shower, yet for a shower of consistent volume. It decides response pace of the dyes. Reactivity decides measure of soluble base, temperature and dyeing time. Additionally, dosing arrangement of salt. Control of this factor is significant for uniform dyeing. A large portion of the running shade issue is occurring for this factor. [3]

Fixation:

Fixation of dye implies the response of the reactive gathering of dye with terminal – OH or NH2 gathering of fiber and accordingly framing a solid covalent bond with the fiber and along these lines shaping a solid covalent bond with the fiber. This is a significant stage, which is constrained by keeping up appropriate PH by including salt. The soluble base utilized for this reason relies upon the brand of dye and dyeing temperature. Here by and large harsh pop, soft drink debris or $NaHCO_3$ is utilized as antacid relying on the reactivity of dye. They make appropriate PH in the dye shower and do as the dye-fixing operator. [3]

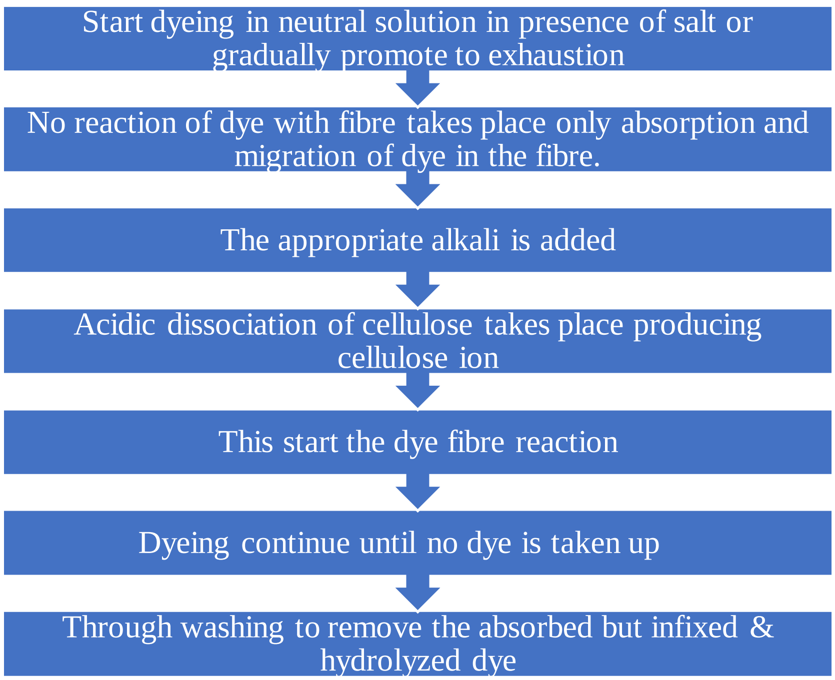
Wash off:

As the dyeing is finished, a decent wash must be applied to the material to expel extra and unfixed dyes from the material surface. This is vital for level dyeing and great wash speed. It is finished by a progression of hot wash, cold wash, and cleanser arrangement wash. [3]

Control Parameters:

1. PH
2. Temperature
3. Dyeing Time
4. Liquor Ratio
5. Concentration of electrolyte (salt)

2.5 Basic Principle of Dyeing with Reactive Dyes. [4]



Typical dyeing condition for a bi-functional. [5]

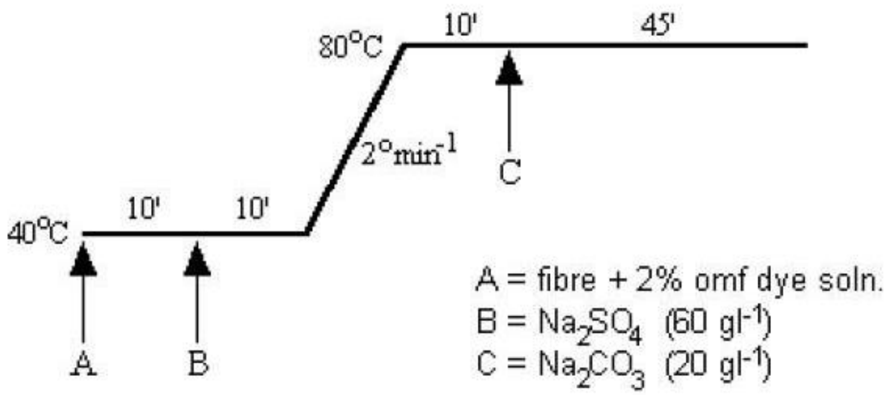


Figure – 1

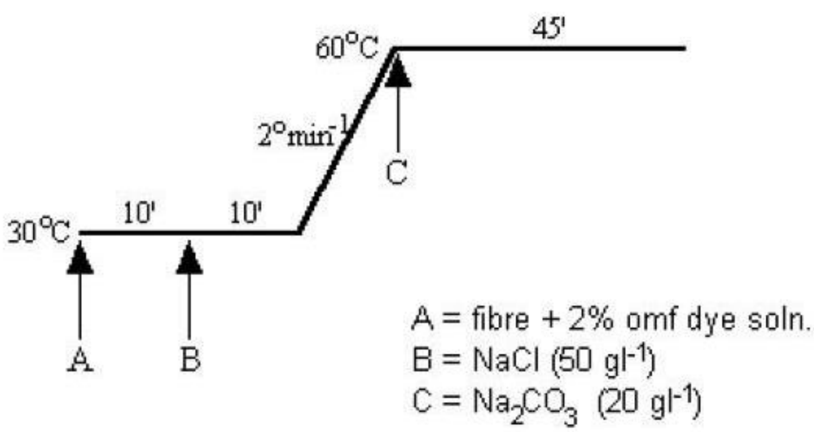


Figure – 2

Reactive dyes are categorized by functional group. [5]

Functional	Fixation	Temperature	Included in Brands
Monochlorotriazine	Haloheterocycle	80˚	Basilen E & P CibacronE ProcionH,HE
Monofluorochlorotriazine	Haloheterocycle	40˚	Cibacron F & C
Dichlorotriazine	Haloheterocycle	30˚	Basilen M Procion MX
Difluorochloropyrimidine	Haloheterocycle	40˚	Levafix EA DrimareneK & R
Dichloroquinoxaline	Haloheterocycle	40˚	Levafix E
Trichloropyrimidine	Haloheterocycle	80-98˚	Drimarene X & Z Cibacron T
Vinyl sulfone	activated double bond	40˚	Remazol
Vinyl amide	activated double bond	40˚	Remazol

2.6 Reactive Dyestuff Selection for production

Solvency of individual dyestuff in g/l without salt (straight) and with salt ought to be checked critically to dye determination for a mix conceal. In a tri-chromatic mix, all the reactive dyes ought to have practically comparative solvency portrayed. The reactive dyestuff that gets influenced by the nearness of salt would,

a) Produce totally different shade,

b) Produce poor rubbing and wash fast dyeing

c) Batch to batch difference in depth and tone would result.

We must consider the following things while reactive dyeing:

The determination of reactive dyestuff for a tri-chromatic or bi-chromatic mix assumes a significant job in the exhibition and reproducibility of reactive dyeing in material handling. There are some urgent Points that ought to be in your mind while you are choosing the reactive dyes for dyeing texture. [6]

Solubility Characteristics of Reactive Dye:

Solubility of individual dyestuff in g/l without salt (straight) and with salt should be checked importantly to dye selection for a combination shade. In a tri-chromatic combination, all the reactive dyes should have almost similar solubility characterized. The reactive dyestuff that gets affected by the presence of salt. [6]

Using of Primary Colors:

One should try to use the Basic Colors such as Red, Yellow and Blue. The secondary colors should be avoided as far as possible.

The Red's and Blue's varies with shade and requirement of fastness properties. [6]

Dyes with similar Exhaustion and Fixation values:

The Reactive dyeing takes place in three steps. Viz.

1. Exhaustion
2. Fixation
3. Wash off

Normally two types of exhaustion take place while dyeing. These are primary and secondary exhaustion. Primary Exhaustion is the amount of dyestuff migrated on the substrate in the presence of salt. While secondary exhaustion is the total amount of dye migrated on the substrate in the presence of salt and alkali. [3]

Dyes with Similar Affinity:

By and large, the dyes are delegated Low, Medium, High, and Very High-liking dyes. For Exhaust dyeing, high and exceptionally high-proclivity dyes and liked. While low-liking dyes are utilized in nonstop dyeing. In the event that anybody follows the above advances you will have the option to appropriately choose reactive dye.

The dye take-up of the texture can be resolved spectrophotometric ally by identifying the measure of dye staying in the dye bath in the wake of dyeing is finished. A typical practice is that the centralization of the dye is resolved by its adjustment bend in water since a direct relationship is normally found among absorbance and focus. For the estimations to be solid, the eradication coefficient of the dye, as decided from the slant of the Beer-Lambert alignment diagram, ought to be steady, despite the fact that the creation and the temperature of the dye arrangement may differ. Notwithstanding, some reactive dyes give articulated changes in the termination coefficient when the salt focus or pH of the arrangement is changed or when the arrangement is bubbled. Along these lines it is exceptionally hard to acquire dependable information of dye bath depletion/fixation yield.

Texture dyeing for the most part requires three fundamental dyes in a blend to accomplish the ideal tone and shade. Dyes with comparable reactive gatherings and same fatigue properties will be supposed to be perfect with one another and are perfect for use in such blends. Choosing good dyes is a piece of guaranteeing an ideal dyeing formula which will most effectively use the dye. Produce ideal dyeing result sand will lessen the quantity of synthetic compounds that enter the wastewater. Along these lines, checking the similarity of dyes is a key method to limit the quantity of dyes utilized just as guaranteeing the coordinating of the particular shade. The fundamental hypothesis of testing of the similarity of reactive dyes is accessible in various content books1 on material dyeing. By testing the similarity of dyes the expenses of dyeing can be diminished and the degree of efficiency can be expanded on account of less time squandered in attempting to get the right shade. This work was completed for three diverse reactive dyes to check their similarity in a dyeing formula. In this technique, Spectrophotometric analysis2 has led and the fixation of each dye was dictated by utilizing a PC shading coordinating framework. [3]

2.7 Fastness properties of reactive dye

Even though reactive dyes have excellent wash fastness properties, often buyers complain of poor wash fastness. This is mainly due to adherence of hydrolyzed dyes onto cotton. If they are not washed off after dyeing, they behave like direct dyes and bleed during the initial washings carried out by the customers. In order to avoid the complaints, some dyers take extra precautions by providing more than the required number of washings. Therefore, the second objective of the present study is to develop a quick method to optimize the number of washings to be given after reactive dyeing to achieve good wash fastness properties, especially for dark and medium shades. [7]

Definition of Fastness:

Fastness is the resistance of textile materials to resist a load or destructive factor such as abrasion, heat, light, perspiration, wearing, acidic and alkaline condition.
Fastness is the property of colored material. It is not the property of colorant or substrate in isolation. [7]

Categories of Fastness:

- ➢ Producers fastness
- ➢ Users fastness [7]

Types of Textile Test Methods:

- ➢ **Test for Colorfastness e.g.**
  - ✓ Colorfastness to Wash
  - ✓ Colorfastness to rubbing
  - ✓ Colorfastness to Perspiration
  - ✓ Colorfastness to Light
  - ✓ Colorfastness to Hot Press etc. [8]

- **Test for Strength e.g.**
  - ✓ Breaking Strength
  - ✓ Tearing Strength
  - ✓ Bursting Strength
  - ✓ Seam Strength etc. [8]

- **Test for Performance:**
  - ✓ Pilling Resistance
  - ✓ Abrasion & Pilling
  - ✓ Water Repellency
  - ✓ Flammability etc. [8]

Objects of fastness testing:

- Research
- Selection of raw material for manufacturing
- Process Control
- Process Development
- Product development as per standards
- Specification testing etc. [8]

What Kinds of changes a colored substrate may undergo?

- Change in depth
- Change in hue
- Change in luster

Factor affecting change in color and stunning:

The shading changes when dyed or printed materials are exposed to a specific are because of either of the accompanying two fundamental driver. The first is simply the breakdown of the colorant inside, the texture, whereby, it is changed over dismal or distinctively hued compound. The second is the unit of them as such from the fiber. There might be an adjustment in the shade of the fiber which will prompt change in the shade of the dyeing perspective. It is critical to underline that colorfastness is a property of shaded material and not of a colorant in seclusion. The degree in the adjustment in shade of hued material and recoloring of nearby on presenting to the specific condition is controlled by various attributes of the colorant and fiber in relationship with one another in the dyeing or print. There are sure factors that influence practically all the speed tests. [9] They are:

1. Chemical structure of the colorant
2. The state of the colorant in the fiber
3. The amount of the colorant in the fiber
4. The fiber
5. Foreign Substances [9]

In the cases of fastness to light, there are few additional factors, they are

1. The spectral composition and intensity of the incident radiation
2. The external atmospheric condition
3. Relative humidity and air temperature
4. Contaminants such as oxides of nitrogen Sulphur on ozone in the air. [9]

The effects of the some of the factors are discussed:

The Chemical Structure of the color

The deterrent of the shading or shade to a creation or photochemical ambush is truly related to its substance fasten. By then, the for the most part rapid to the light of shading of anthraquinone hues on wool and the defenseless light speed to triphenylmethane destructive hues on a comparative substrate are clearly credited to the quality of one and precariousness of the other photochemical ambush.

Also, the incredible snappiness to oxidizing whitening authorities of anthraquinonoid tank hues on cellulosic filaments is related to the high steadfastness of such blends to oxidation.

Exactly when in any event one hues are accessible in the fiber one may catalyze the breakdown of another. A bit of the colorant molecule may revive the offering of the fiber and the weakening of the material. [10]

State of Colorant in the fiber:

The state of the colorant in the fiber is plainly huge. The transcendence of responsive hues over the quick hues in respect of speed to wet treatment on cellulosic strands in the prompt outcome of the covalent association of the open shading to the fiber appeared differently in relation to the association of the quick shading through reversible forces, for instance, hydrogen bond and other discretionary charming forces.

In the shading or print of responsive shading, the colorant molecule becomes one component and part simply under extraordinary conditions. By virtue of the shading of direct hues on the cellulosic fibers reversal of the shading, the technique is sensibly begun since shading ingestion and upkeep are a result of delicate forces of interest which are viably endure. The incredibly rapid to wet treatment of shading and prints for instance of tank hues, azoic blend and other ingrain hues is a direct result of the way that the shading inside the fiber is an as modestly gigantic particle of the insoluble colorant are ordinarily impenetrable to departure during wet treatment. At the same time the closeness of the colorant in the fiber in these results in progress in its security of compound ambush. [11]

Amount of colorant present on the fiber:

The colorfastness of a profound shading on print of a particular shading consistently differentiates particularly from that of pale shading on print of the equal a comparable shading on a comparable fiber when the standard effect of prologue to explicit condition is to convey a modification in the shade of the material for instance concerning the circumstance with prologue to light it is ordinarily found that the more profound the shading on print (for instance the more noticeable the proportion of shading present on the fiber, the higher is the snappiness in respect of progress in concealing introduction.)

In explicit cases, the speed to the light of profound shading may be at any rate two centers (on the 1 – 8 scale) than that of the pale shading of a comparable shading. This is explained somewhat by the way that the more profound the shading more unmistakable the proportion of the shading which must be crushed before calculate change the shade of the material gets clear. The condition is befuddled by the way that the colorant is accessible

In the fiber as colossal particles of shade for the circumstance even a pale shading or print contains a respectably immense proportion of colorant is a state (all out structure) where it is less frail to photo chromic ambush and thusly, the effect of the profundity of concealing on light speed is impressively less verbalized or event missing. The high briskness to the light of pale shading of reasons for conceal pitch clung to the fiber is a by and large great instance of this.

For this circumstance of condition washing, water, dry warmth (dissipate shading) the speed of the shading of print with respect to recoloring of close by materials decreases of as profundity of shading additions. This is viably fathomed since the more imperative the proportion of shading present practically certain is it that during introduction sufficient to cause recoloring will be isolated from the material. [11]

It is significant presently to disguise some light regarding the matter of standard profundities and standard scale.

Since the concealing pace of shading or print is related to the profundity of concealing it is routinely essential to show the profundity of the shade of the imperative to exhibit the profundity of the shade of the shading or print under test.

This particularly so while deciding the snappiness characteristics of a colorant. To enable this to be done impartially the ISO proposed extent of twenty reference tones named standard profundities covering the range yellow to dim.

Aside from maritime power blue and dim each concealing is appeared in six profundities, implied as 2/1, 1/1, 1/3, 1/6, 1/12 and 1/25 standard profundity independently for the circumstance of maritime power blue dim only two standard profundities are supported the lighter maritime power blue and dull are doled out Nb/L and B/L and hazier maritime power blue and dim being appointed Nb/Dk and B/Dk.

The standard profundities are given by the British standard association reproduced on a matt texture (wool coat) and a splendid material (breathtaking gooey rayon)

The profundity of the shade of the material under test is reviewed by visual connection with the plan of standard profundities of appropriate concealing. [11]

The Fiber:

The colorfastness of colored textiles is related to the chemical structure and physical characteristics of fiber itself. The wet fastness of disperse dye on polyester fiber is much higher than the secondary cellulose acetate materials. This is because of polyester fiber are much more compact in structure are consequently diffusion of dyes within them proceeds much more slowly under given conditions.

Fastness varies with moisture regain properties of different fiber. This is particularly so in case of light fastness which depends on effective humidity that depends on moisture regain.

The fastness properties of basic dyed or printed on acrylic fiber is much better than those on basic dyed / printed silk or wool. [23]

Finally, physical dimension of the fibers or filaments may be a determining factor. The higher fastness to light of certain direct dyes on high filament denier viscose staple fibers for carpets in attributed to the lower surface volume ratio compound with that of the low filament denier yarn used for other textile process. [23]

Foreign Substances:

Substances other than the colorant might be available in the fiber. These incorporate dampness, de radiance for example lithium dioxide remaining dyeing associate for example transporter utilized when dyeing polyester strands, subsequent to treating operators completing specialist for example manufactured tar saved in the fiber to present wrinkle shedding properties and specialists intentionally applied to improve colorfastness to a specific office.

Titanium dioxide can catalyze photochromic assault and hence the light speed of a dye on titanium dioxide might be lower than on the splendid material. It has been realized that the nearness of close to bands of specific transporters for example o – phenyl phenol in a dyed or printed polyester materials can diminish light speed by a much as two focuses on the 1 – 8 scale.

The decrease in the lightfastness of numerous dyes on cellulosic strands which can result from sap completing considered when choosing dyes for use in these circimstaneous. Cationic mixes applied to dye of direct dyes on cellulosic filaments to improve speed to washing (wet medicines) can likewise stretch out on normal impact on lightfastness. [24]

Some common color fastness definition:

Colorfastness to wash:

This method is designed to determine the effect of washing on the color fastness of the textile. A specimen of the colored textile in contact with one or two specified adjacent fabrics is mechanically agitated under specified conditions of time and temperature in a soap solution, then rinsed and dried. The change in color of the specimen and the staining of the adjacent fabric are assessed with the grey scale. [8]

The degree of fading and staining depends on:

- Temperature
- The types of detergent used
- The amount of detergent used
- Mechanical action (No of steel ball used)
- The washing liquor ratio
- The hardness of water

- The rinsing, drying or pressing method used to restore the sample after the washing. [8]

Colorfastness to Rubbing:

The Test is designed to determine the degree of color which may be transferred from the surface of a colored fabric to specific test cloth for rubbing (Dry & Wet). The Crock meter provides a rubbing motion simulating the action of a human finger and forearm. [8]

Colorfastness to Perspiration:

The garments which come into contact with the body where perspiration is heavy may suffer serious local discoloration. This test is intended to determine the resistance of color of dyed textile to the action of acidic and alkaline perspiration. Determine the effect of acid & alkali perspiration on the colorfastness of textile materials. [8]

Colorfastness to Water:

The garments which come into contact with water, may suffer serious local discoloration. This test is intended to determine the resistance of color of dyed textile to the action of water. [8]

Colorfastness to Light:

A Specimen of the Textile to be tried is presented to counterfeit light under recommended conditions, alongside a lot of blue fleece references. The shading quickness is evaluated by contrasting the adjustment in shade of the test example with that of the references utilized.

Quickness estimation by eyes is emotional since it is reliant on the assessment of the eyewitness. Once in a while issues happen in light of the fact that the maker and client give various qualities to a similar quickness test. To kill the abstract view of assessing colorfastness by eyes, instrumental colorfastness estimation strategies have been created and it has been introduced to the administration of the material segment. The point of this investigation is to assess corrosive and essential colorfastness to sweat and colorfastness to the washing of reactive dyed cotton items both with the eye and spectrophotometer.

A few new bi-functional reactive dyes of the Sumifix Supra run that convey monochlorotriazine and sulfate ethyl sulphone reactive frameworks were created and their dyeing execution contemplated. Reasonable trademark properties and speed properties were analyzed over the weaved cotton textures. The dyes were portrayed by otherworldly information and essential examination. The dyes structures were built up by setting up the coupling segment utilizing H-corrosive, cyanuric chloride, and 2-methoxy-5-methyl (sulfate ethyl) SUI-phenyl aniline which was promptly combined with different diazotized 2-amino benzo-thiazole (Figure 1). The outcomes demonstrated great solvency, a serious extent of fatigue and fixation, phenomenal speed degree, and higher substantivity over the sewed cotton textures. [8]

While the cotton texture is a fundamental component in this day and age, reactive dyes are expected to totally prepared to wear attire necessities. With the presentation of the three Procyon dyes by ICI for cellulosic texture in 1956, the covalent holding of cellulosic fiber to the reactive frameworks end up being critical thy. Further exploration on cotton products brought about the inevitable presentation of a recently factor reactive framework in reactive dyes.'

The term heterobifunctional dyes got across the board after the 1980s through the inclusion of four dyes containing monochrome-thiazine veiled vinyl sulphone (VS/MCT) by Sumi-tomo,2 which was later called Sumifix Supra dyes. In 1959, I.C. I3 and, in 1961, Hoechst4 and a couple of different producers guaranteed the advancement of two distinctive reactive gatherings, by introduction duking a few dyes, yet none were popularized aside from one by Hoechst. [8]

Table I: Characterization and spectral data of compound Vlla-l. [16]

Com-pound	Yield (%)	Molecular formula	Calculated C	Calculated H	Calculated N	(C:N)	Found C	Found H	Found N	(c:m)	I.R. (cm^{-1})	PMR (δ_{ppm})
VII_a	80	$C_{30}H_{20}N_8O_{14}S_5Na_3Cl$	36.71	2.03	11.42	3.21	36.82	1.92	11.47	3.21	a	–
VII_b	79	$C_{30}H_{19}N_9O_{16}S_5Na_3Cl$	35.08	1.83	12.30	2.85	35.02	1.87	12.10	2.89	–	–
VII_c	75	$C_{30}H_{19}N_9O_{16}S_5Na_3Cl$	35.10	1.85	12.28	2.85	35.22	2.02	12.39	2.84	–	c
VII_d	80	$C_{30}H_{19}N_9O_{16}S_5Na_3Cl$	35.08	1.83	12.32	2.84	35.00	1.85	12.52	2.79	d	–
VII_e	80	$C_{30}H_{18}N_{10}O_{18}S_5Na_3Cl$	33.62	1.68	13.07	2.57	33.78	1.76	12.89	2.62	–	–
VII_f	76	$C_{31}H_{22}N_8O_{15}S_5Na_3Cl$	36.82	2.18	11.09	3.32	36.92	2.23	11.22	3.29	–	–
VII_g	84	$C_{31}H_{22}N_8O_{15}S_5Na_3Cl$	36.85	2.15	11.05	3.33	36.98	2.02	11.17	3.31	–	g
VII_h	70	$C_{30}H_{21}N_7O_{14}S_5Na_3Cl_2$	35.46	2.06	9.65	3.67	35.58	2.20	9.68	3.67	h	–
VII_i	69	$C_{30}H_{20}N_7O_{14}S_5Na_3Cl_3$	34.28	1.90	9.33	3.67	34 32	1 98	9 28	3.72	–	–
VII_j	86	$C_{30}H_{20}N_7O_{14}S_5Na_3ClBr$	34.76	2.02	9.48	3.67	34.78	1.92	9.56	3.63	–	–
VII_k	82	$C_{31}H_{22}N_8O_{14}S_5Na_3Cl$	37.44	2.23	11.28	3.31	37.49	2.35	11.23	3 33	k	–
VII_l	73	$C_{31}H_{22}N_8O_{14}S_5Na_3Cl$	37.40	2.25	11.23	3.33	37.53	2.18	11.42	3.28	–	–

a - *3400-3200(OH); 1630-1620(-N=N-); 850(C_3N_3); 2825(-OCH_3); 1320(-CH_3); 3350-3310(2°amine); 1480-1450(-CH_2)*
c - 3.83(S,3H Ar-O-CH_3); 2.58(S,3H Ar-CH_3); 7.07-8.00(S,8H Ar-H); 3.63-3.96(t, 2+2H,CH_2-CH_2); 3.95(br.S. 1H-NHAr
d - 1300(-NO2);850(C3N_3);1500(C=N);3350-3310(2°amine);1630-1620(-N=N-);2825(-OCH3);1320(-CH3)
g - 4.04(S, 3H.Ar-OCH_3); 2.58(S, 3H, Ar-cH3); 5.90(br,s, IH, Ar-OH); 7.07-8.00(S, 8H Ar-H); 3.63-3.96(2+2H,t, -CH_2-CH^2-); 3.95(br, S, IH,-NHAr)
h - 720(Cl);850(C_3N_3); 1500(C=N); 3350-3310(2°amine)i 3400(-OH); 1630-1620(-N=N-); 2825(0CH_3)j1320(-CH_3)
k - 1315(-CH_3); 850(C_3N_3)1500(CsN); 3400(-OH); 1630-1620(-N=N-);3350-3310(2°amine);2825(-OCH_3)

After 1980, the major dyestuff manufacturers have applied for more than 100 patents related to dyes with two or more different reactive groups. This fact demonstrates the importance of the bi-functional dyes in the field of: search as a new generation of reactive dyes.

Bi-functional dyes

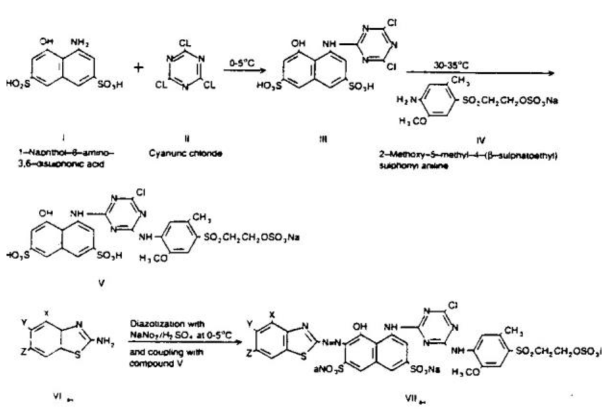
Bi-functional dyes carry two reactive groups. They are known for their excellent dyeing efficiency and overall fast- ness properties. Bi-functional dyes with good dyeing properties are created by the careful selection of the right reactive groups and right chromophores. How- ever, the concepts of dyes with two reactive groups of the same type (e.g. bis-sulphato ethyl sulphonyl and bis-tri- azinyl types[5]) as well as a number of less commercially successful elec-trophillic groups date back to the early days of reactive dyes, and predates the appearance of the first mixed reactive system in the 1980's.[6] [12]

A major advantage of MCT/VS, dyes over the dyes containing either MCT or VS reactive group is the higher degree of fixation of the former and is 1.3 to 2.3 times more than the latter.' It can easily be assessed that dyes with two identical reactive groups and dyes with two different reactive groups exhibit a higher fixation yield than-dyes with one group Studies have demonstrated their excellent solubility, higher degree of fixation, good levelling and good-to-excel lent fastness properties as observed b various researcher8, 9Our aim was to produce certain reactive dyes having MCT-SES reactive systems with overall properties. The present article deal: with the synthesis and analysis of the various dyeing properties over the knit ted cotton fabrics. [12]

Exhaustion and fixation study

The dye-bath exhaustion and fixation was studied by known methods, collecting the samples of exhausted liquor at various intervals and studying the absorbance by diluting the exhaust liquor up to various fold by known methods on a Bausch and Lomb Spectronic- 20 spectrometer. [3]

Figure 1: Reaction of ozone with indigo. [3]



where, X, Y and Z are:
VIa-i , VIIa-i

	X	Y	Z
a	H	H	H
b	NO_2	H	H
c	H	NO_2	H
d	H	H	NO_2
e	NO_2	H	NO_2
g	H	H	OCH_3
h	H	H	Cl
i	H	CL	CL
j	H	H	Br
i	H	H	CH_3

Solubility

Dihydrogen phosphate (0.83 g) in water followed by sufficient sodium chloride

(15.20 g) was added to precipitate the product. All organic impurities were then extracted by washing with a small portion of diethyl ether. All the compounds Vllb-1 was prepared by the same method. [15]

The characterization, elemental analysis and spectral data are fur- nished in Table I of dyes Vlla-1 and the dyeing fastness properties are tabulated in Tables II and Ill.

Dyeing cotton, the dyeing of cotton fabric was performed at a goods to liquor ratio of 1:20 (2% O.W.F) in an exhaust process in three step dyeing by heating up to 60°C within 30 min with 50 g/liter NaCl and 5 g/liter sodium carbonate. This temperature was then held for 30 min, then gradually 4 ml/liter of 32.5% sodium hydroxide and 5 g/l $NaHCO_3$ solution was added so that the pH attained reached 11.5. The dyeing was continued for 45 min longer. The final dyed pattern was rinsed with water for 5 min (at 30°C) and 10 min (at 60°C) so that the final rinse water was colorless.

The samples of dye-bath exhaust Due to the presence of the OH and

NH functional group in the dye molecule, a dissociation resulted in a higher solubility during the dyeing process at a low liquor ratio. Also, the presence of the sulfonic chromophores (two to three) and the novel sulphatoethylsul- phone groups promoted the solubility of the new bifunctional (MCT/SES) dyes. Also, during the dyeing process7no urea was required and the dye was highly soluble in the presence of com- mon salt at a low liquor ratio. [15]

Rf value

The Rf value of synthesized dyes was calculated through a thin layer chromatography system on Silica Gel G (1.0 mm thickness) and solvent compo- sition 2-methyl propanol-butanol water (4:3:3) at a room temperature of 28°C in TLC chamber for 9h. The Rf value calculated is shown in Table II. [13]

pH

The pH of dye-bath during exhaust dyeing method was widely taken into consideration. Here, we first used the neutral pH and gradually increased to alkali by dosing the Na2CO_3/NaOH to a pH of 11.5 to differentiate the probable exhaustion in both cases. Both SES and MCT groups functioned as the reactive sites. However, we recommend a dying process for this type of dye exhaust dyeing method set at 60°C with a control dye-bath ph.

Color measurement

The (%R) percent reflectance of the dyed material was measured at different wavelengths in the visible region (400- 700 nm) using a ACS-600 color control system. The K/S value at l max was calculated using the Kubelka-Munk equation $K/S = (I-R)^2/2R$ Table II. Shade evaluation The hue over the knitted cotton fabric. [14]

Table II: Analytical data and dyeing performance of compound Vlla-j. [16]

Compound	Rf value			Primary exhaustion	Secondary exhaustion	Fixation yield	Relative fixation yield
Vlla	0.78	485	3.0	35	77	57	74
Vllb	0.68	495	4.8	38	69	61	88
Vllc	0.45	520	6.5	42	78	65	84
Vlld	0.80	490	8.2	56	75	62	82
Vlle	0.73	505	7.8	40	79	61	77
Vllf	0.69	540	2.3	51	80	67	84
Vllg	0.76	575	4.6	44	78	66	85
Vllh	0.66	497	5.2	35	82	69	84
Vlli	0.72	575	7.2	47	85	65	76
Vllj	0.55	495	7.8	38	65	52	80
Vllk	0.83	556	3.2	49	78	49	63
VllI	0.80	565	6.8	42	83	62	75

Table-III: Color shade and fastness properties of compound Vlla-j. [16]

Compound	Color of crystal	Shade	Light fastness	Wash fastness	Rubbing Fastness	
					Dry	Wet
Vlla-j	Brown black	Light brown	6	5	55	
	Violet-black	Red-violet	5-6	5	5	5
	Violet-black	Brill.-violet	6	5	55	
	Bluish black	Brill. Blue	6	5	.5	5
	Bluish black	Blue-green	6	4-5	55	
	Blue	Blue	5-6	5	55	
	Violet-black	Brill. Blue	6	5	55	
	Blue	Violet	6	5	55	
	Violet-black	Blue	6	5	55	
	Violet-black	Red-violet	5-6	5	5	4-5
	Bluish black	Blue-violet	6	5	5	5
	Bluish	Brill. blue	6	5	55	

Chapter: 03

Material & Method

3.1 Material

3.1.1 Fabric Specification

Industrial Scoured & Bleached samples were collected from CRYSTAL COMPOSIT LTD.

Parameter	100% Cotton fabric
Types	S/J Knitting
GSM	135
Count	38 Ne
WPI	50
CPI	40

3.1.2 Dyes & Chemicals

Serial	Chemical Names	Commercial Names
1	Reactive Dye (Red)	Red 3BX
2	Soda	Caustic Soda
3	Salt	Glauber salt
4	Acetic Acid	n/a

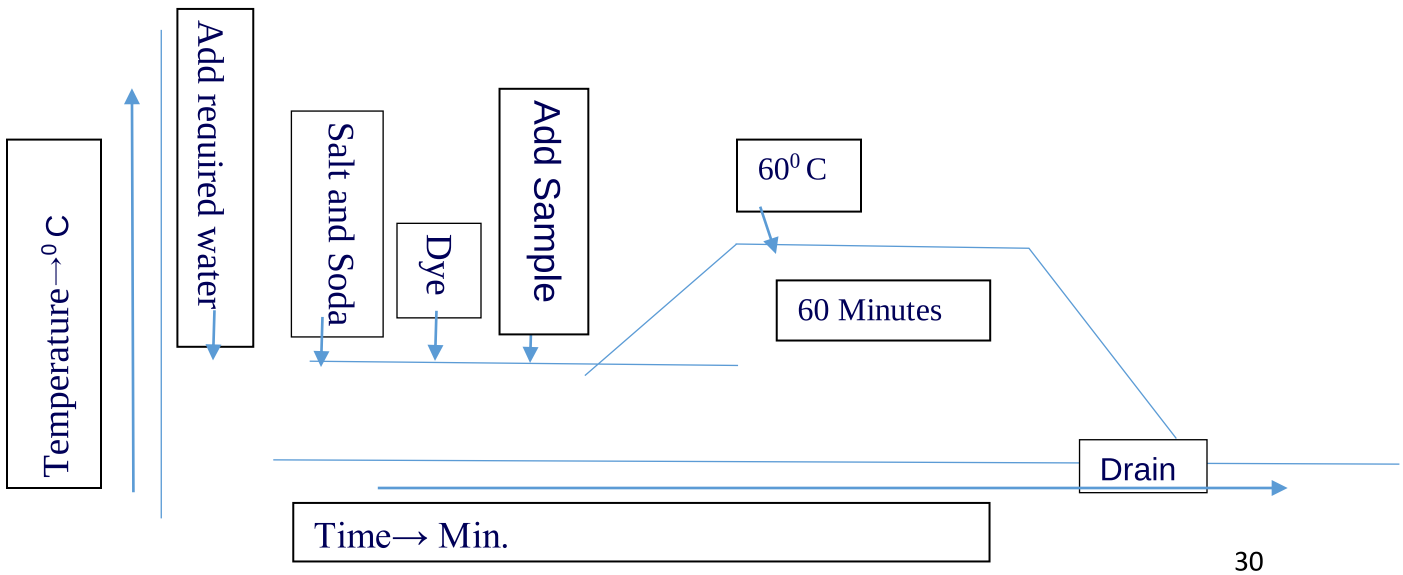
3.2 Method

3.2.1 Dyeing methods (recipe, curve and procedure)

Recipe for dyeing **100% Cotton** fabric by **Reactive dye** for **2% (Red)** shade. [17]

Serial	Chemicals	Amounts
1	Red 3BX	2%
2	Soda	12 g/l
3	Salt	50 g/l
4	Sample Weight	5 gm
5	M:L	1:50
6	pH	11.5

Process Curve: [17]



Dyeing procedure: [17]

100% Cotton fabric with bi-functional and mono-functional **reactive dye** for **2% shade**. [17]

At first we collect the pre-treated 100% Cotton fabric sample from the industry lab store.

↓

Then we measure and add the dyes, and chemicals to the pot

↓

Then we add required amount of water

↓

After that we add the sample to the pot with dyes, chemicals & water

↓

Then we seal the pot and we set the pot to the sample dyeing machine and set the machine time and temperature

↓

Then dyed the sample at 60^0 C Temp. For 30 min.

↓

Drain the dye bath

↓

Wash the sample

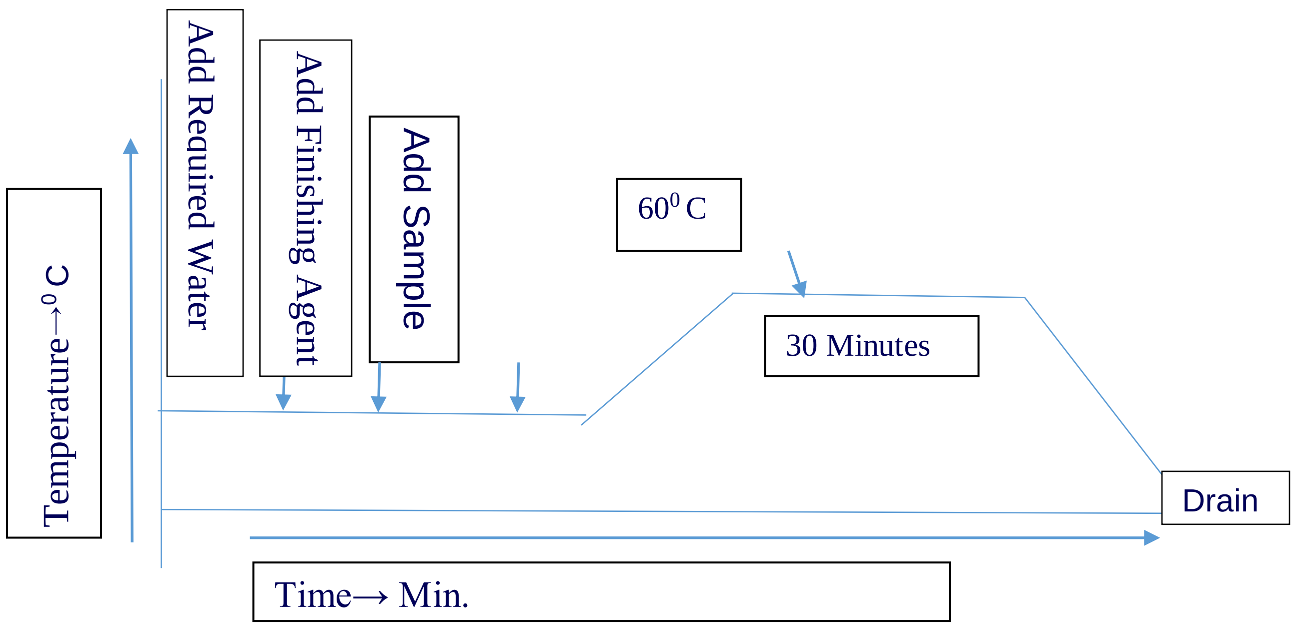
↓

Dry the sample

3.2.2 Finishing method with recipe, curve and procedure. [17]

Serial	Chemicals	Amounts
1	Ludox PE 40(Silicone based organic polymer as Strength Improver)	2% (recommended by the supplier)
2	M:L	1:50
3	Temperature	60^0 C
4	Time	30Min.
5	pH	5.5

Process Curve: [17]



Procedure: [18]

At first we took the dyed fabric at 100% Cotton sample

↓

Then we calculate and add Finishing Agent to the pot

↓

Then we add required amount of water

↓

After that we add the sample to the pot with Finishing Agent & Water

↓

Then we seal the pot and we set the pot to the sample dyeing machine and set the machine time and temperature

↓

Then finished the sample at 60^0 C Temp. For 30 min.

↓

Drain the bath

↓

Wash the sample

↓

Dry the sample

3.2.3 Test Method.

3.2.3.1 Spectral analysis. [18]

We found the reflectance% values, color strength (K/S), L*, a*, b*, c* values by using spectrophotometer. And we measured the color strength (K/S) values of dyed sample by using equation no (1):

$K/S=(1-R)^2/2R$………………………… (1)

Here,

R= Reflectance

K= Absorption

S= Scattering co-efficient

Change in color strength was calculated by the equation no (2)

$$\textbf{Color Strength Change (\%)} = \frac{\frac{K}{S}(\text{before}) - \frac{K}{S}(\text{after})}{\frac{K}{S}(\text{before})} \times 100 \ldots\ldots\ldots\ldots(2)$$

3.2.3.2. Color Fastness to wash test

ISO-105-C03 was obtained to wash all the samples.

Chapter: 04

Result & Discussion

4.1Color Strength. [19]

K/S Value for 100% cotton

Shade %	**K/S value of 100% Cotton fabric**		**K/S Change %**
2%	Before Finishing	After Finishing	0.03 % Increase
	9.70	9.73	

Discussion:

We found R_{min} 540nm for both cotton dyed fabric with 2% (Red) shade. If we compare Cotton, we can see that the reflectance value in before finishing sample is more than after finishing sample. We know that reflectance value become more when the shade percentance become lighter & reflectance value become lower when the shade percentance become deeper. There is no remarkable change in color strength in both cotton fabrics after applying bi-functional and mono-functional dye. [19]

Colorimetric properties. [20]

Comparison of colorimetric values of 100% cotton (Red) shade.

Light Source		**100% Cotton fabric**
D 65	$\Delta L (L_{after\ finish} - L_{before\ finish})$	0.74 L
	$\Delta a^* (a_{after\ finish} - a_{before\ finish})$	1.44 R
	$\Delta b^* (b_{after\ finish} - b_{before\ finish})$	0.25 Y
	$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$	0.63

Discussion:

Here we can see that 100% cotton fabric the wash fastness is better after applying bi-functional and mono-functional dye than before finished sample. [20]

4.2 Color Fastness to Wash test:

100% Cotton & 100% Viscose fabric color fastness to wash for 2% (Red) shade. [21]

Sample	Color Change	Grading Scale (Staining)					
		Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
Before Finish (Cotton)	4	4/5	4	4/5	3/4	4/5	3/4
After Finish (Cotton)	4/5	3/4	4/5	3/4	4/5	4/5	4
Before Finish (Viscose)	4/5	4	4/5	4/5	4	3/4	3
After Finish (Viscose)	4/5	4/5	4/5	3/4	4	4/5	3/4

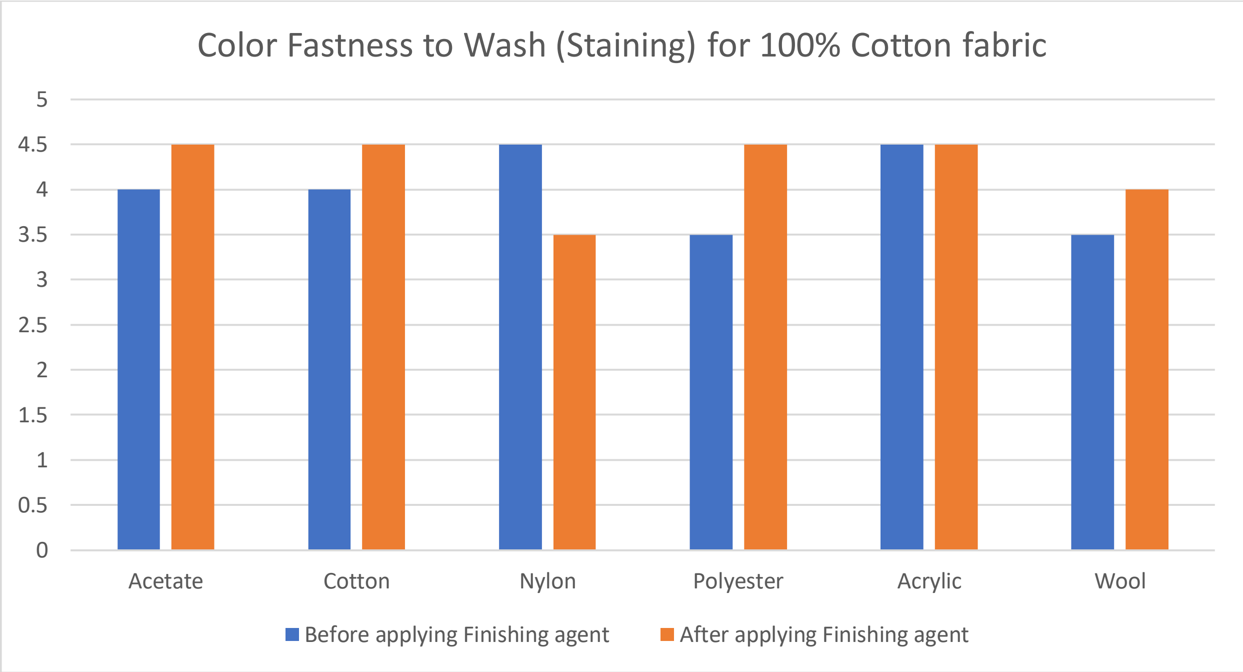


Figure: Bar diagram grade of washing fastness (Staining) result for 100% Cotton fabric. [21]

Discussion:

Here we can say that the color fastness to wash for both sample is good. 100% cotton fabric fastness is better than before finished. And for color fastness to wash (staining) in 100% cotton is increased. [21]

Chapter: 05

Conclusion

Outcomes:

- **Spectral analysis:**
  - ✓ K/S value very little increase in cotton fabric & little decrease in after applying finishing agent.
  - ✓ Colorimetric value indicate that cotton batch fabric are lighter, reddish & yellowish than standard sample. But color difference value in both sample are acceptable
- **Color Fastness to wash test:** After applying finishing agent the wash fastness (color change & Staining) of viscose fabric is better than cotton fabric.

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