Faculty of Engineering

Department of Textile Engineering

# Saturation Point Determination of Different Types of Reactive Dyes (Use Shade % 4 to 8)

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This Thesis submitted in partial fulfillment of the requirements for the degree of

**Bachelor of Science in Textile Engineering**

Advance in Wet Processing Technology

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# DECLARATION

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 **"Saturation Point Determination of Different Types of Reactive Dyes (Use Shade% 4 to 8)."** 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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# LETTER OF APPROVAL

This project report prepared by **Name: Sufal Sen**, (ID :), 173-23-369, **Name: Shabuj Kumer Sarker** (ID :), 173-23-376 is approved in Partial Fulfillment of the Requirement for the Degree of BACHELOR OF SCIENCE IN TEXTILE ENGINEERING. The said students have completed their project work under my supervision entitles with **"Saturation Point Determination of Different Types of Reactive Dyes (Use Shade% 4 to 8)"**. During the research period I found them sincere, hardworking and enthusiastic.

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# ACKNOWLEDGEMENT

At first we would like to express our heart-felt thanks to almighty ALLAH for his blessing to complete this Project Report successfully.

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# DEDICATION

"This Projects Report is dedicated to our dignified Parents and Teachers may they live long"

# ABSTRACT

In this study dyeing of 100% cotton knit fabrics were performed by using reactive dye at different shade percentages (2.0%, 4.0%, 6.0% & 8.0%).Exhaust dyeing method was applied in the experiments for 100% cotton knitted fabrics. Two types of knitted fabric samples (single Jersey & Interlock) were taken for this experiment. Scouring & bleaching was carried out at 98ºC for 45 minutes while dyeing was carried out at 60ºC for 60 minutes. Reflectance (%) of the dyed fabric samples were measured after dyeing. The color strength of a dyed fabric is usually expressed by its K/S value. The color strength (K/S) of the dyed samples were also measured from the reflectance (%).

# Contents

# Chapter One

# Introduction

## 1.1 Introduction

Reactive dyes are the most suitable dyestuff for the dyeing of cellulosic fibers considering it's fastness properties since this dye make strong covalent bond with cellulose. Shade means the depth of color on the weight of the fabric. Shade (%) influence the reflectance (%) of the dyed fabrics. Reflectance of the surface of a material is its effectiveness in reflecting radiant energy. It is known to us that when reflectance is more, absorbance is less and when reflectance is less, absorbance is more. Color strength (K/S) is most important parameter to test the quality measurement of a sample in terms of depth of the color dyed fabric. The aim of this research is to find out the color depth in dependence on concentration of reactive dyes. The American association of textile chemist and colorist has over thirty test method that evaluates different color fastness properties. These include, but aren't limited to rubbing, wash, light, crock, perspiration, abrasion, and heat. Manufacturers must know a cloth intended end use so on form processing decision which can produce a product of acceptable performance. Dyeing operation is performed by the reaction between fiber and dye. Somme dyes are water soluble and a couple of are insoluble some fiber have affinity to dye and a couple of fiber have no affinity to dye. So dyeing depend on both fiber and dyes chemical quality.

## 1.2 Objectives of the Study:

- To know about effect of color fastness to rubbing of reactive and direct dye for woven and knit fabric.
- To know about dyeing procedure of Reactive dye
- To know about dyeing procedure of direct dye.
- To know comparison rubbing fastness between reactive dye and direct 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 supported topic, But during this example 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 showed just possibility of result.

# Chapter Two

# Literature Review

## 2.1 Color fastness definition

Another name for color fastness is dye fastness. It refers to the resistance of textile colors to effects like color change or transfer during processing and use. The fastness grade, i.e., the degree of color fastness of cloth , is evaluated consistent with the discoloration of a sample and therefore the staining of the undyed lining fabric. During use, textiles are usually exposed to external factors like light, washing, ironing, sweat, friction, and chemical agents. Some printed and dyed textiles also are subjected to special finishing processes, like resin finishing, flame retardant finishing, sand-washing, and grinding. This demands that the colour of printed and dyed textiles relatively maintain a selected fastness, i.e. good color fastness performance.

## 2.2 Color Fastness

Property of a pigment or dye to retain its original hue, especially without fading, running, or changing when wetted, washed, cleaned; or stored under normal conditions when exposed to light, heat, or other influences.

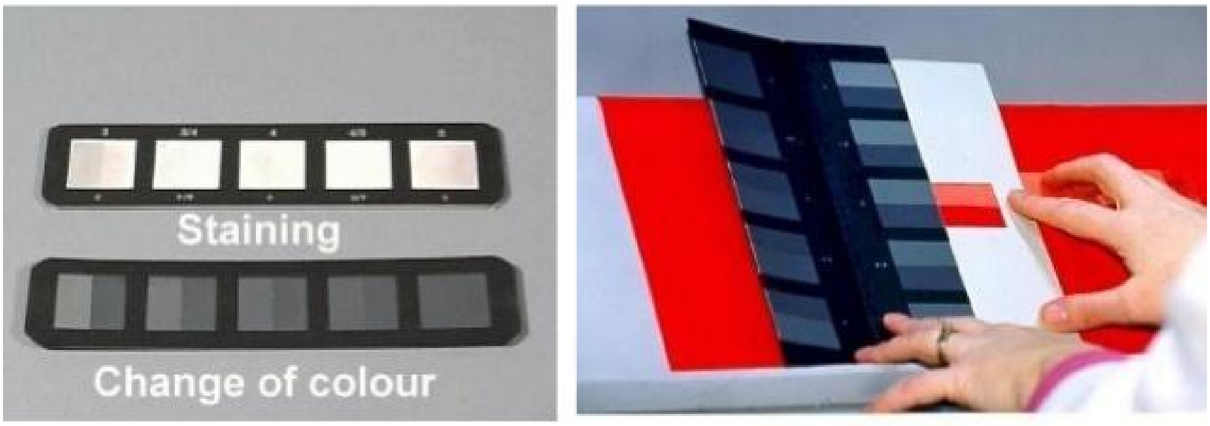



Figure 2.1: Colour Fatness of Dyed Goods

## 2.3 What is fastness of dye?

Colour fastness may be a term—used within the dyeing of textile materials that characterizes a material's colour's resistance to fading or running. Colour fastness is that the property of dyes and it's directly proportional to the binding force between photochromic dye and therefore the fiber.

## 2.4 Why is color fastness important?

Color fastness to perspiration test. the colour fastness to perspiration test determines the resistance of textile colors to human perspiration. A color fastness test for perspiration are particularly relevant for sports apparel and swimwear, which can presumably be exposed to heavy perspiration during use.

## 2.5 Which Colours are used in dyeing fast Colours?

The Fast Colour Bases are very widely utilized in Textile Industry. Dyeing with Naphthols Fast Bases are more economical even compared to Reactive Dyes. Maroon, Blue, Yellow obtained with these products aren't possible with the other Dyestuff.

## 2.6 Factors Affecting Color Fastness

• Fiber Type

• Class of Dye Used

• Dyeing or printing used

• Types of Finishing Treatments Used

• Action Of Laundering Detergents

## 2.7 Qualities of the Color Evaluator

**A special individual needed who:**

- Knows why color change
- Is skilled in colorfastness tests and knows their limitations.
- Possesses knowledge of dyes and pigments.
- Has the power to guage and report color changes.

## 2.8 Types of Colorfastness

- **Adversely affected by:**
    - Washing
    - Light
    - Crocking
    - Abrasion
    - Gases in Atmosphere
    - Frosting
    - Perspiration
    - Heat

## 2.9 Color fastness is usually assessed separately with respect to :

1. Changes in the color of the specimen being tested , that is color change
2. Staining of undyed material which is in contact with the specimen during the test, that is due to bleeding of color

## 2.10 Condition for preparation of Colorfastness to Washing

| **TEST** | Liquor | **Temp C** | **Time (min)** | Reproduces action of |
|---|---|---|---|---|
| C01 | 0.5% soap | 40 | 30 | Hand washing |
| C02 | 0.5% soap<br>0.2% soda ash | 50 | 45 | Repeated Hand washing |
| C03 | 0.5% soap<br>0.2% soda ash | 60 | 30 | Medium cellulosic wash<br>Severe wool wash |
| C04 | 0.5% soap<br>0.2% soda ash | 95 | 30 | Severe cellulosic wash |
| C05 | 0.5% soap<br>0.2% soda ash | 95 | 240 | Very Severe cellulosic wash |
| C06 | 4 g/l detergent + perborate | various | various | Domestic laundering |

## 2.11 Color fastness to rubbing

Rubbing fastness refers to the degree of color fading of dyed fabrics after rubbing. this will either be from dry rubbing or wet rubbing. The rubbing fastness is decided from the degree of a prespecified white cloth’s staining, and it's graded in 5 levels. The larger the worth , the higher the rubbing fastness.

## 2.12 Light fastness

Light fastness refers to the degree of discoloration of colored fabrics when exposed to sunlight. the colour Fastness to light test is completed by comparing the degree of fade of the sample after simulating sunlight with a typical color sample divided into eight grades; 8, because the resulting value, implies the simplest while 1 implies the worst lightfastness. In essence, for fabrics to stay in optimal condition, they ought to not be exposed to sunlight for long periods, and that they should also always be dried under shade, during a ventilated area.

## 2.13 Color Fastness to sublimation

This is the degree of sublimation dyed fabrics undergo in storage. The dye fastness of normal fabrics generally requires 3-4 grades during this category to satisfy wearing needs.

## 2.14 Washing Color Fastness

Washing or soaping fastness refers to the degree of the colour change of dyed fabric after washing with a washing liquid. Usually, a gray graded sample card is employed because the evaluation standard; that's , the colour difference between the first sample and therefore the faded sample is employed for judgment.

Washing fastness is graded into five levels; grade 5 is that the best while grade 1 is that the worst level of washing fastness.

Fabrics with poor washing fastness should be dry-cleaned. But if they need to be wet-washed, then other washing conditions may have to be tweaked and watched closely. as an example , the washing temperature shouldn't be relatively high, and therefore the washing time should be kept brief.

## 2.15 Color Fastness to perspiration

The Color Fastness to perspiration refers to the degree of color fading of a dyed fabric after small perspiration.

## 2.16 Ironing Color Fastness

Seeing that Color Fastness is a relatively broad topic, founded on a hatful of professional knowledge, it is important to know some basic concepts and tools to help you understand as you read.

## 2.17 Color Fastness test terms

**Discoloration**

In printing and dyeing textiles under specific environmental factors, certain activities and reactions within the textile may end in color chroma, hue, and brightness changes. This effect is mentioned as discoloration. a number of these occurrences within textiles include; when a part of the dye is separated from the fiber, or the luminescent group of the dye is destroyed, or a replacement luminescent group is generated.

**Staining**

Staining may be a phenomenon where a part of the dye on a bit of cloth is separated from its originally attached fiber and transferred to other lining fabrics when placed under various environmental factors, thereby staining the liner fabric.

For garments composed of parts with different colors, dyes sometimes migrate from one area of the material to a different , during storage and typically from dark parts to light parts. This phenomenon is different from sublimation because it's administered at temperatures below sublimation temperature, and it also occurs with non-sublimation dyes. we will see this within the migration of dyes in polyester and other chemical fiber fabrics, also as other raw materials.

The color transfer is especially thanks to two reasons: the primary is that the transfer of dyes, especially the floating color of dispersing and reactive dyes. These dyes may migrate and be released from the fiber, dyeing the fiber on another sample's surface. This usually happens with dark colors that dye light colors and stay the opposite sample's surface during a granular and embossed form. The second is that the fibers fall off under the action of friction and transfer from one sample to a different.

## 2.18 Common grading tools for Color Fastness

The Color Fastness of textiles is graded by discoloration and marking gray cards. the grey cards currently in use include AATCC gray cards, ISO gray cards, JIS gray cards and national standard GB gray cards. These gray cards are only slightly different within the grayscale.

The Color Fastness rating gray card may be a card characterized by a selected gradient increase or decreases. A color-changing gray card comprises one group of ordinary gray levels and another group of color-changing gray levels. the first gray levels remain unchanged throughout a test, while the second group of color-changing gray levels decreases gradually to make a discoloration contrast between the two .

**Color changing gray card**

This contrast card comprises one standard scale of gray and a decreasing scale of gray chroma. The grayscale rating for the colour change is decided using 5-grade levels and nine grades system with grade 5 representing the simplest Color Fastness and grade 1 representing the worst Color Fastness. the center levels are often assessed as half grade: grade 4-5, grade 4, and grade 3-4.

**Stained gray card**

This comprises of a typical scale of white with a corresponding group of accelerating gray chroma. There are five grades and nine grades system; grade 5 implies virtually no staining occurred. Hence great Color Fastness while grade 1 signifies the worst Color Fastness, and therefore the middle are often assessed as half grade, like grade 4-5, grade 4, and grade 3-4.

It are often seen from the above data that the so-called gradient decreasing method appears within the sort of 1:2:4:8:16. the grey card looks at the gradient level of the colour change, so you want to observe the gradient level of this alteration when grading in order that there'll be no such incident as only evaluating gray and black, but no other colors.

## 2.19 How to use the Color Fastness gray card correctly

The masking card is used in grading. Each hole is used for multi-fiber cloth staining evaluation, rubbing fastness staining evaluation and general staining evaluation (self-staining color evaluation, single fiber Cloth stain evaluation).

The use of masking cards is more conducive to focus on the samples that need to be graded while covering other areas to prevent other colors from affecting the vision.

When grading, the masking card needs to be linked together with the sample to be graded as it is, keeping the smallest gap to prevent the color of the backboard from being exposed, thereby affecting the vision. Make sure to use the masking card to cover the original sample and the sample's surroundings to be graded and keep it on the same level as the graded gray card.

## 2.20 Environmental requirements for Color Fastness ratings

The preferred general light is that the D65 light . Its service life tube is 2000 hours. Customers also can specify other light sources, like the F light , 84-P light , UV light , etc.

## 2.21 Dyes

That entire compound contains chromophore group and react with others material physically and chemically and when light reflects from that materials makes it colorfully is named dyes or dyestuff. Dyes are unsaturated complex compound.

## 2.22 Reactive dye

In general reactive dyes with an equivalent functional reactive group or groups have similar dyeing characteristics and may therefore be applied from an equivalent dye bath. Reactive dyes are usually classified consistent with the chemical reactivity of the characteristics reactive system. additionally substantively and fixation temperatures are parameters that help to characterized reactive dyes. the main reactive systems are listed in descending order of relative reactivity in batch wise dyeing under moderately alkaline condition, along side typical fixation temperatures.

A dye which is capable of reacting chemically with a substance to make a chemical bond or dye substrate linkage is understood as reactive dye. These dyes are mainly react with cellulosic fibres e.g. cotton, jute, bast, viscose, flax. It are often applied to protein fibre e.g. wool & silk These dyes are water soluble.

The general formula reactive dye can be written as follows:

**$D\text{-}S0_2\text{-}CH2\text{-}CH_2\text{-}OS03Na + OH\text{-}Cell = D\text{-}S02\text{-}CH2\text{-}CH2\text{-}0\text{-}Cell + NaHS03$**

Where, D= Dye part

Cell= Cellulose Polymer

## 2.23 Why it is called Reactive Dye

Reactive dyes react with the fibres. Mainly react with cellulose fibres, e.g. cotton, jute, bast fibres, viscose, flax. It are often applied to protein fibre e.g. wool & silk. Reactive dye contains reactive group & this reactive group makes covalent bonds with the fibres & becomes a part of the fibre.

## 2.24 History of Reactive dye

On the occasion of 100 years celebration of synthetic dye manufacturing, two chemists of ICL Company (UK) named Sttephen & Rattee tried to manufacture new dye stuff. Thus they succeed to create a replacement dye in 1956 which was named Reactive dye. This was manufactured for dyeing cellulosic fibres. the first three Reactive dyes were Procion Yellow R, Procion Brilliant Red 2B & Procion Blue 3G. for this effort hey were awarded trophy of the society of Dyes & Colorists for the year 1960. The dye to our country in mid 60's & became popular during 80's.

## 2.25 Properties of Reactive Dye

- Water soluble dyes
- Makes covalent bonds with the fibres
- a particular amount of dye is hydrolyzed during dyeing (10-60%)

- Dyeing is administered in alkaline condition (pH=11.5)
- Huge electrolyte is important for dyeing with reactive dyes
- Fastness (wash, light, rubbing, perspiration) properties are generally good.
- Easy applicable to cellulosic also as protein fibres (wool and silk)
- very fashionable & wide utilized in the wet processing industry in Bangladesh.
- Comparatively cheap
- All quite shade is found
- Dyeing method is straightforward

## 2.26 Reason of Popularity of Reactive dye

- Good wash fastness (4-5)
- excellent light fastness (6)
- Lower cost
- Simple dyeing method good reproducibility
- Low dyeing temperature
- Ability to supply bright shade
- Dye molecular composition
- Easily applicable to cellulose fibre ae well as protein
- all types of shade is found

## 2.27 Importance of Reactive Group Present in Reactive Dye

- Reactive group don't contribute color which is decided dy chromogen group
- The reactive group of vinyl sulphone group is a smaller amount than halogen group
- If number of reactive group increase, binding also increase depending ondye structure
- Reactive dye absorb up to 90%
- If the relative molecular mass of the reactive group increase, reactivity also increase
- Reactive of vinyl sulphone group increase with increase of pH & Temperature
- Sulphone group has more solubility but it's not stable
- Chlorine imparts medium reactive, but it's cheap

- Reactive of Fluorine is that the least & its rate of hydrolysis is additionally less

## 2.28 Name of Same Reactive Dyes with company and origin

| Trade Name | Company | Country |
|---|---|---|
| Cibacron | Cibageigy | Switzerland |
| Diamarene | Sandoz | Switzerland |
| Reactone | Cibageigy | Switzerland |
| Levafix | Bayer | Germany |
| Remazol | Hoechst | Germany |
| Livafix | Bayer | Germany |
| Priazin | BASF | Germany |
| Sumifix | --------- | Taiwan |
| Procion | ICI | UK |
| Cavalite | Dupont | USA |
| Mikacion | Mitshui Chemical Co. Ltd. | Japan |
| Uhopid | People's China | China |

Table-2.1: Reactive dyes, Company and Origin.

The trade names and manufacturers are more important ranges of these Reactive Dyes are shown in.

| Reactive Group | Fixation temperature (°c) | Relative reactivity |
|---|---|---|
| Dichlorotriazin | **30** | **1** |
| Difluorochloropyrimi | **40** | **2** |
| Dichloroquinoxaline | **50** | **3** |
| Monoflurotriazine | **60** | **3** |
| Vinylsulphone | **80** | **4** |
| Monochlorotriazine | **95** | **5** |
| Dichloro- and trichloro-pyrimidine | **95** | **6** |

1- Most reactive, 6- least reactive.

Table-2.2: Properties of major types of Reactive dye.

Symmetrical dye structures with two identical reactive group, e.g. two monochlorotriazine groups in procion H-E/H-EXL dyes, have led to products with better compatibility, more reproducible exhaustion and better fixation efficiency. More recently reactive dyes with two dissimilar reactive groups per molecule are developed, including the Sumifix Supra (NSK) range, during which each dye molecule features a monochlorotriazine and a sulphatoethylsulphone group attached. a replacement range of remazol reactive dyes is believed to be of an identical constitution.

In the past reactive dyes were usually classified as cold dyeing ( highly reactive) or hot dyeing ( moderately reactive). in additional recent times dyes are developed foe dyeing at intermediate temperatures or at long liquor ratios, also as by continuous methods.

## 2.29 Chemicals used in reactive dyeing

Common salt or Glauber's salt ( hydrated sodium sulphate) is employed in large quantities altogether batch wise dyeing. the selection depends on price and availability. In UK common salt is out there in very fine and pure from and is widely used. Common salt, being appreciably more soluble than Glauber's salt , is typically added to the dye bath within the dry state.

Where salt consumption is high. The installation of a saturator to supply brine may have advantages. Metering solid salt or brine to the dye bath eliminates repeated weighing's and reduces handling costs. As anhydrous sodium sulfate is difficult to dissolve, it's best slurried in extremely popular water followed by adding cold water with constant stirring. When using Glauber salt crystals account has got to be taken of the water of crystallization when calculating the number to be dispensed.

Soda ash is that the alkali most generally utilized in reactive dyeing' bicarbonate of soda and caustic soda also find application. These three alkalis, used either single or in binary mixtures, cover the pH range that's of interest in reactive dyeing. bicarbonate of soda is widely utilized in dyeing viscose with reactive dyes. In cotton dyeing it are often mixed with washing soda to supply intermediate pH values. Liquid buffer systems and alkali dosing agents in liquid form, like Alkaflo (Tanatex), are now available for multiproduct injection systems. Provided fabrics are well prepared, it's always unnecessary to feature wetting or leveling agent to the bath . However, the addition of selected antifoam agent can eliminate unwanted foaming in jet dyeing machines. Selected nonionic dispersing agents have proved useful in overcoming problems of aggregation of some reactive dyes. Certain turquoise and green reactive of the phthalocyanine type tend to point out this defect.

As reactive dyes are vulnerable to hydrolysis within the presence of moisture, they go to deteriorate unless carefully stored and handled. Cool , dry storage conditions are essential, and lids of drums and packages must be firmly replace after use. Dry scoops, scales and containers must be used when weighing. Care in handling is advisable and thus the utilization of dust-excluding respirators is usually recommended

**A. Depth of shade**

: ratio of weight of dye to weight of products dyed, usually expressed as percentage amount of dye owg. Depth of shade ( DOS ), in these terms, isn't really a really great way of comparing the darkness or intensity of color of finished fabrics, thanks to inherent differences within the hues of various dyes within a family, difference between dye families thanks to the character of the material . Dye manufacturer's shade cards are typically show one or two depth of shade for a specific dye, often between 1% and 4%, apart from black, which is usually 3% to six .

**B. Fixation:**

formation of the "final" bond between the dye and fibre. The bond type formed between the fibre and therefore the refore the dye varies with the sort of dye and the fibre. As examples, reactive dyes fix by covalent bonding while acid dyes fix by a spread of mechanisms like ionic bonding and hydrophobic forces. Disperse and vat dyes are fixed within the fibre largely by physical entrapment of insoluble dye within the fibre. The bond that causes final fixation isn't necessary an equivalent sort of bond is first made because the dye exhausts onto the fibre.

**C. Fixative:** in dyeing , a chemical that helps to enhance wash fastness of dyed fabric. Some sorts of dye don't bond strongly to fibres, and can wash out over time. substantive dye are notorious for this. Fixatives applied after dyeing can help, although some will degrade light fastness or cause shade change. Some fixative contain a small amount of formaldehyde, which is now regarded as carcinogenic. Much care is warranted in use of those fixatives, and garments should be thoroughly washed before being worn. Many of the newer fixatives work vary, but typically form large, relatively insoluble complexes with dye molecules inside the fibre. sodium carbonate is usually called a fixative for reactive dyes, but it actually creates the high-pH condition that allow the reactive dye to bond on to cellulose fibres, and isn't a fixative within the accepted sense.

**D. Hydrogen Peroxide:** H2aO2, normally as an answer in water. peroxide is extensively utilized in commercial bleaching of textiles, especially cellulose fibres and wool. it's effective and non -polluting. The peroxide sold in drug and grocery stores is a few 3% solution. Industrial strength peroxide could also be 35%, 50% or 70%. At these strengths it's quite dangerous to handle, and spills can cause fires. peroxide can behave as either an oxidation agent or reducer . it's a while used as an antichlor. washing soda and potassium monopersulphate are dry chemicals derived from peroxide .

# Chapter Three

# Material & Method

## 3.1 Materials

**Fabric specification**

- Fabric type: Cotton (100%)

This investigation has been carried out with single jersey of 100% cotton knitted fabric. The well scoured & bleached single jersey fabric was collected from sample dyeing machine of Orion Chem Laboratories.

All the required dyes & chemicals were taken from the dyes & chemicals store.

### 3.2 Methods:

**Dyeing of RFD (Ready For Dyed) fabrics**

A rapid sample dyeing machine of "Eco Dyer" was used for dyeing. Dyeing of single jersey & Interlock 100% cotton knitted fabric was done by using following recipe :

| | |
|---|---|
| Reactobond Deep Red LW | = X% |
| Salt ($Na_2SO_4$) | = X% |
| Soda ($Na_2CO_3$) | = X% |
| Anticreasing agent (JingenLub ACN) | = 1.0 g/L |

Levelling agent (Neucoblanc2013) = 1.0 g/L

Sequestering Agent (Jintexyeco SQ-117) = 0.6 g/L

Detergent (Jingen DT HLF-18) = 0.80g/L

Sample weight = 5gm

Time = 60 min

Temperature = 60°C

M:L = 1:7

pH = 10.5-11

## 3.3 Usage of Salt & Soda

Table 3.1: Usage of Salt & Soda according to shade percentage

| Shade (%) | Salt (g/L) | Soda (g/L) |
|---|---|---|
| 2.0 | 40 | 12 |
| 4.0 | 60 | 20 |
| 6.0 | 70 | 20 |
| 8.0 | 80 | 20 |

## 3.4 Dyeing curve

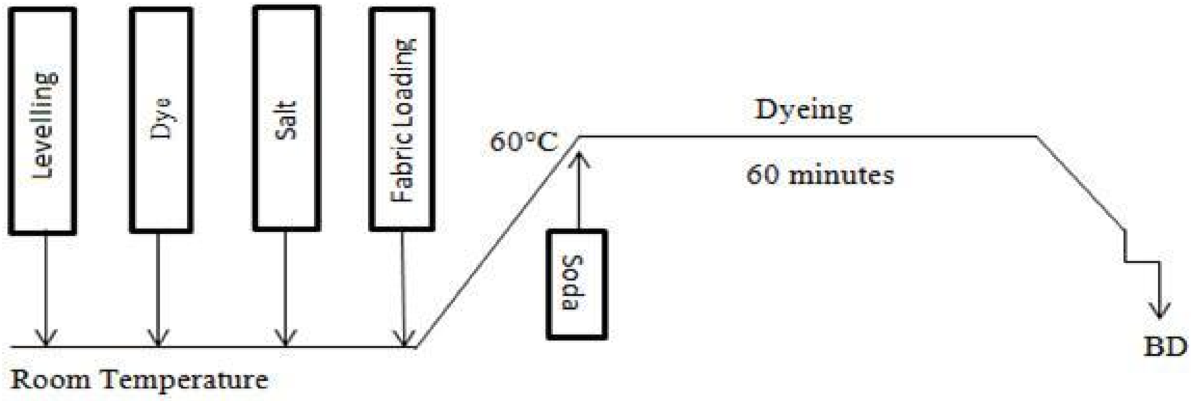



Figure 3.1: Dyeing curve

## 3.5 After-treatment

After dyeing cold wash is performed for 2/3 times and normal hot wash is performed for 2/3 times followed by neutralization with acetic acid & rinsing.

After hydro dyed samples were dried at "Rapid" hydro machine for 3 minute & the maximum temperature of the machine was 14*0°C*.

## 3.6 Measurement of reflectance (%) & color strength (K/S)

Reflectance (%) of the dyed fabric samples were measured by using Data color 650 TM spectrophotometer. Strength of any colorant (dyestuff / pigment) is related to absorption property. Kubelka–Munk theory gives us the following relation between reflectance and absorbance:

$$\mathbf{K/S = [\{(1-R)^2 / 2R\}]}$$

Where R is the reflectance, K is absorbance and S is the scattering. By using the above equation color strength of different samples were measured.

# Chapter 4

# Result and discussion

## 4.0 Color fastness Data analysis

| Sample name | Shade % | Rubbing fastness (ISO 105-X 12) | | Wash fastness (ISO methods of ISO 105-co3) | | Perspiration fastness (ISO 105-E04:2013 | |
|---|---|---|---|---|---|---|---|
| | | Dry | wet | Acidic | Basic | Acid | Alkali |
| 100% Cotton knitted fabric | 2% | 4 | 3/4 | 3/4 | 3/4 | 3-4 | 2-3 |
| | 4% | ¾ | 3 | 3 | 3 | 4 | 3 |
| | 6% | 3 | 4 | 4 | 4/5 | 3-4 | 2-3 |
| | 8% | 4 | 4 | 3 | 5 | 4 | 3 |

## 4.1 Data analysis and Finding

- Evaluation of reflectance (%) & color strength (K/S) of single jersey fabrics for React bond Deep Red LW :

  The reflectance (%) of single jersey dyed fabric samples were evaluated.

  The following table shows the reflectance (%) and color strength (K/S) values of single jersey fabric samples for different shade (%).

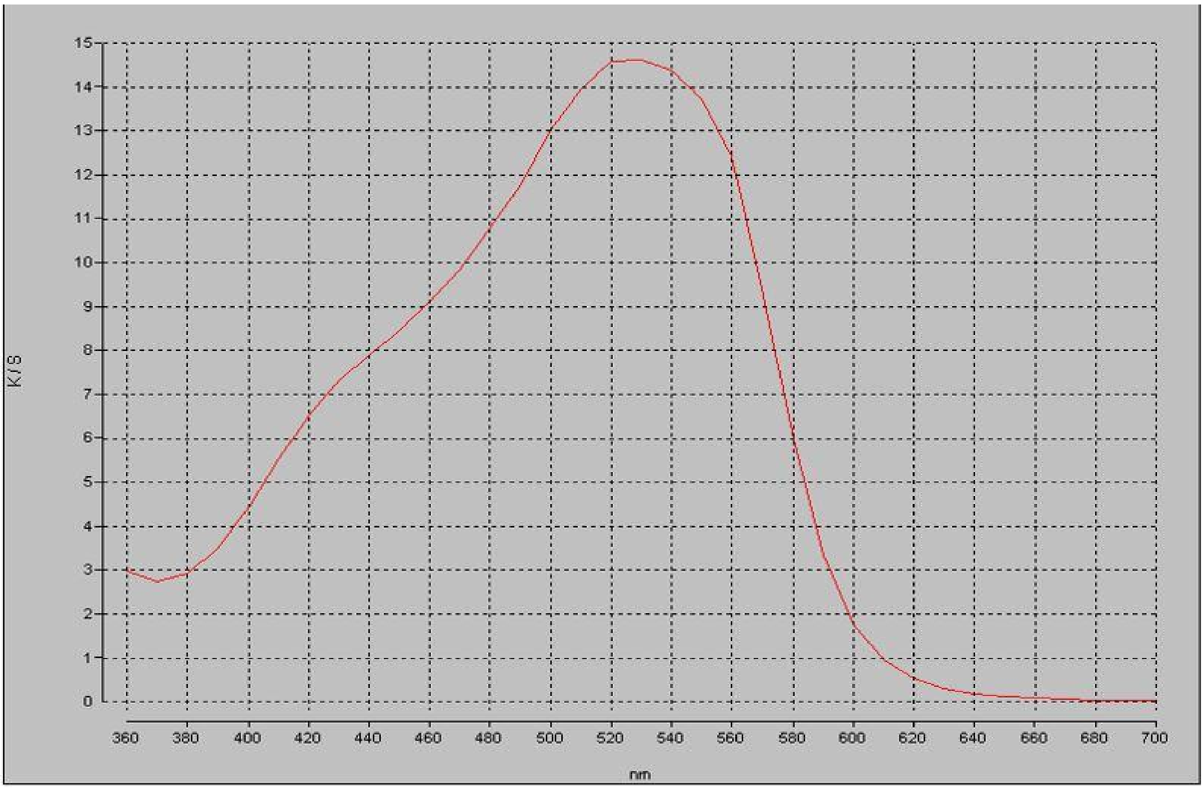
  For 2.0% shade (%) the reflectance (%) was 3.20% and the color strength (K/S) value was 14.60. For higher shade (%) i.e. 4%, the reflectance (%) and color strength (K/S) was lower i.e. 2.08% and 23.10 respectively.

## 4.2 Analysis of reflectance (%) & color strength (K/S) For R. Deep Red LW

| Fabric Type | Used Dyes | Shade (%) | Reflectance (%) | Color Strength (K/S) |
|---|---|---|---|---|
| Interlock | Reactobond Deep Red LW | 2.0 % | 3.20 | 14.60 |
| | | 4.0 % | 2.08 | 23.10 |
| | | 6.0 % | 2.08 | 23.10 |

The following table shows that the increasing of shade (%), the reflectance (%) is decreasing where the color strength (K/S) is increasing.

### 4.2.1 Reactobond Deep Red LW= 2.0%

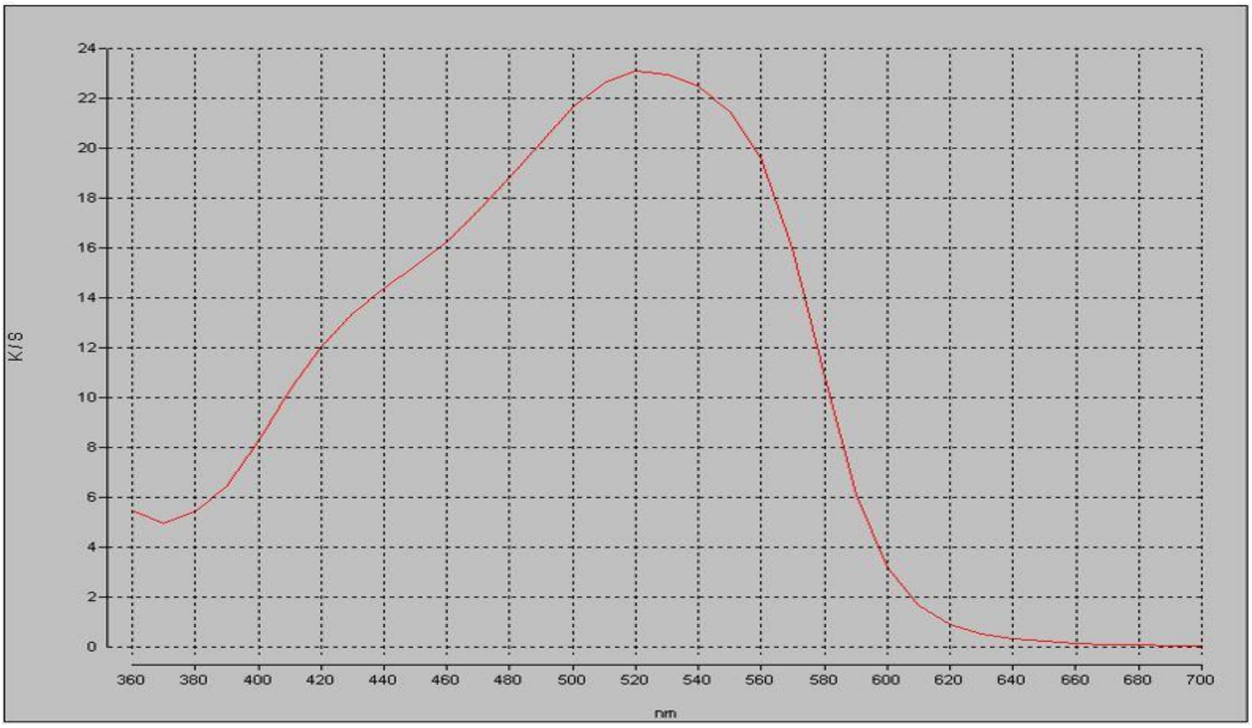



**Standard: %R**
**Rb.Deep Red LW=2%**

%R / %T Plot | K/S (Absorb.)

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 9.27 | 7.69 | 6.68 | 6.03 | 5.65 | 5.30 |
| 460-510 nm | 4.96 | 4.63 | 4.25 | 3.93 | 3.57 | 3.35 |
| 520-570 nm | 3.21 | 3.20 | 3.26 | 3.40 | 3.73 | 4.81 |
| 580-630 nm | 7.18 | 11.66 | 18.67 | 27.48 | 36.94 | 46.02 |
| 640-690 nm | 54.05 | 60.84 | 66.18 | 70.37 | 73.72 | 75.87 |
| 700 nm | 77.85 | | | | | |

### 4.2.2 Reactobond Deep Red LW= 4.0%

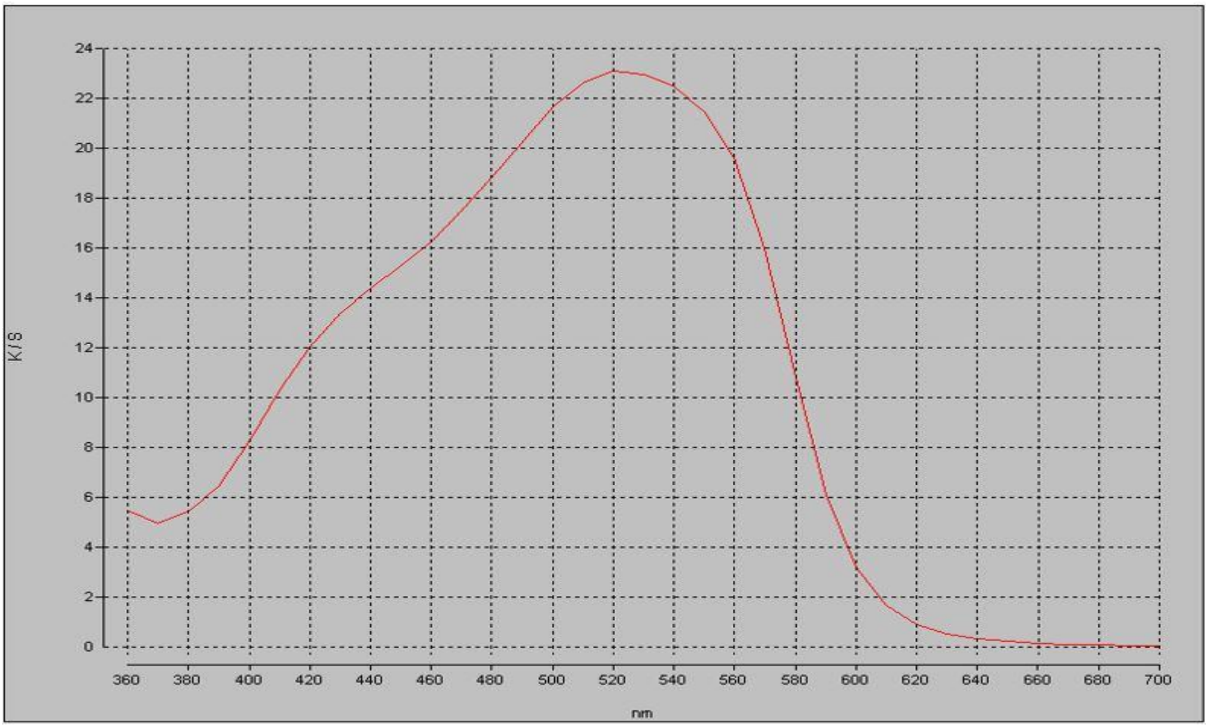



**Standard: %R**
**Rb.Deep Red LW=4%**

%R / %T Plot    K/S (Absorb.)

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 5.40 | 4.42 | 3.84 | 3.47 | 3.26 | 3.07 |
| 460-510 nm | 2.90 | 2.71 | 2.52 | 2.36 | 2.21 | 2.12 |
| 520-570 nm | 2.08 | 2.09 | 2.13 | 2.23 | 2.43 | 2.94 |
| 580-630 nm | 4.25 | 7.06 | 12.13 | 19.30 | 27.82 | 36.44 |
| 640-690 nm | 44.38 | 51.37 | 57.21 | 62.12 | 66.22 | 68.93 |
| 700 nm | 71.67 | | | | | |

### 4.2.3 Reactobond Deep Red LW= 6.0%




**Standard: %R** %R / %T Plot K/S (Absorb.)

**Rb.Deep Red LW= 6%.**

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 2.39 | 2.35 | 2.34 | 2.30 | 2.23 | 2.20 |
| 460-510 nm | 2.18 | 2.14 | 2.11 | 2.09 | 2.09 | 2.09 |
| 520-570 nm | 2.07 | 2.04 | 1.99 | 1.95 | 1.88 | 1.80 |
| 580-630 nm | 1.76 | 1.74 | 1.75 | 1.79 | 1.84 | 1.92 |
| 640-690 nm | 2.07 | 2.37 | 2.93 | 4.14 | 6.32 | 9.19 |
| 700 nm | 14.26 | | | | | |

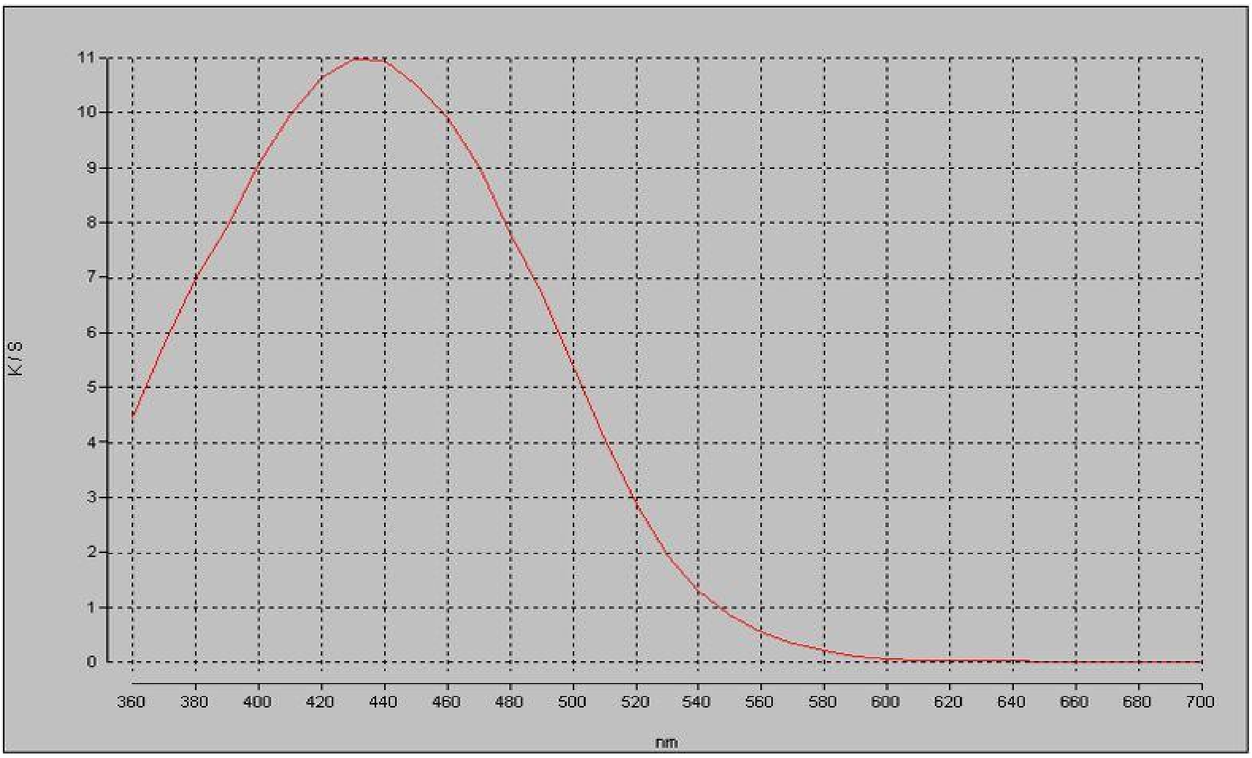
### 4.2.4 Sample Attachment (Red)

## 4.3 Analysis of reflectance (%) & color strength (K/S) For R. Ultra Yellow RGB

| Fabric Type | Used Dyes | Shade (%) | Reflectance (%) | Color Strength (K/S) |
|---|---|---|---|---|
| Single Jersy | Reactobond Ultra Yellow RGB | 2.0 % | 4.18 | 11.00 |
| | | 4.0 % | 2.76 | 17.05 |
| | | 0.6 % | 2.50 | 20.05 |

The following table shows that the increasing of shade (%), the reflectance (%) is decreasing where the color strength (K/S) is increasing.

### 4.3.1 Reactobond Ultra Yellow RGB= 2.0%




**Standard: %R**

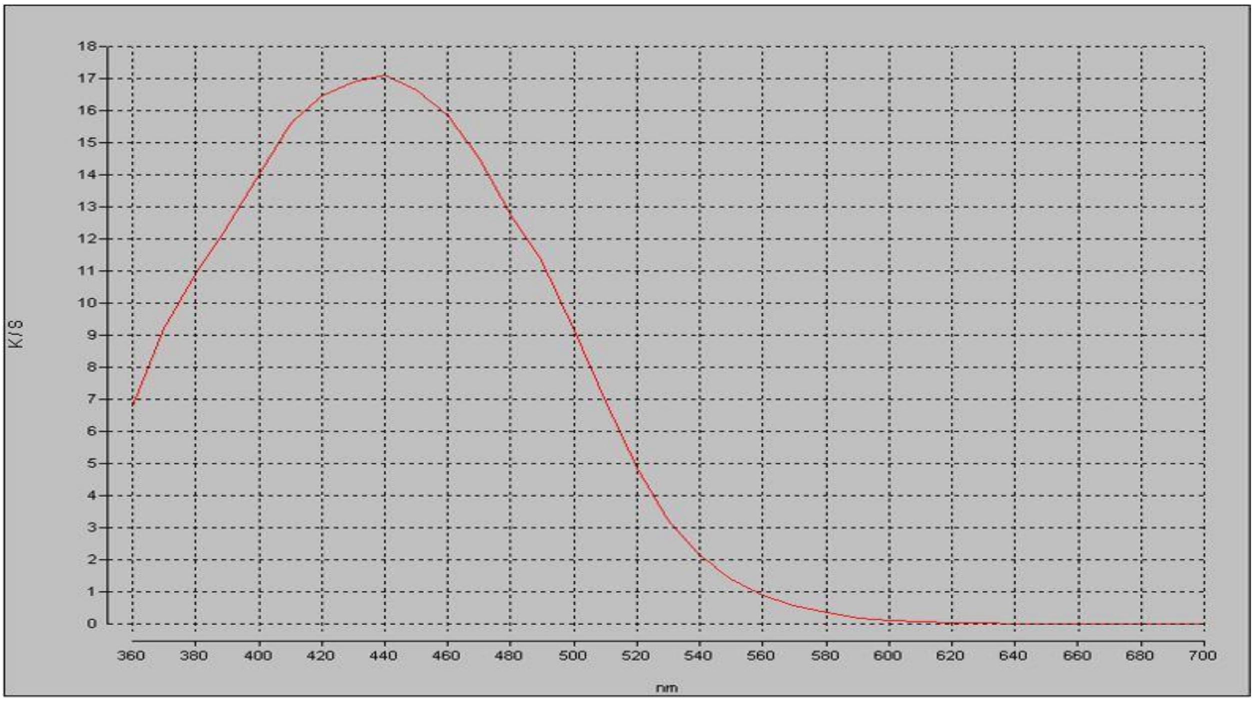
**Rb.Ul.Yellow RGB=2%**

%R / %T Plot

K/S (Absorb.)

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 4.97 | 4.57 | 4.31 | 4.18 | 4.20 | 4.35 |
| 460-510 nm | 4.60 | 5.00 | 5.70 | 6.53 | 7.90 | 10.03 |
| 520-570 nm | 13.12 | 17.51 | 22.73 | 29.03 | 36.24 | 44.21 |
| 580-630 nm | 52.82 | 61.63 | 69.17 | 74.62 | 78.14 | 80.13 |
| 640-690 nm | 81.40 | 82.36 | 82.77 | 83.18 | 83.42 | 83.50 |
| 700 nm | 83.66 | | | | | |

## 4.3.2 Reactobond Ultra Yellow RGB= 4.0%

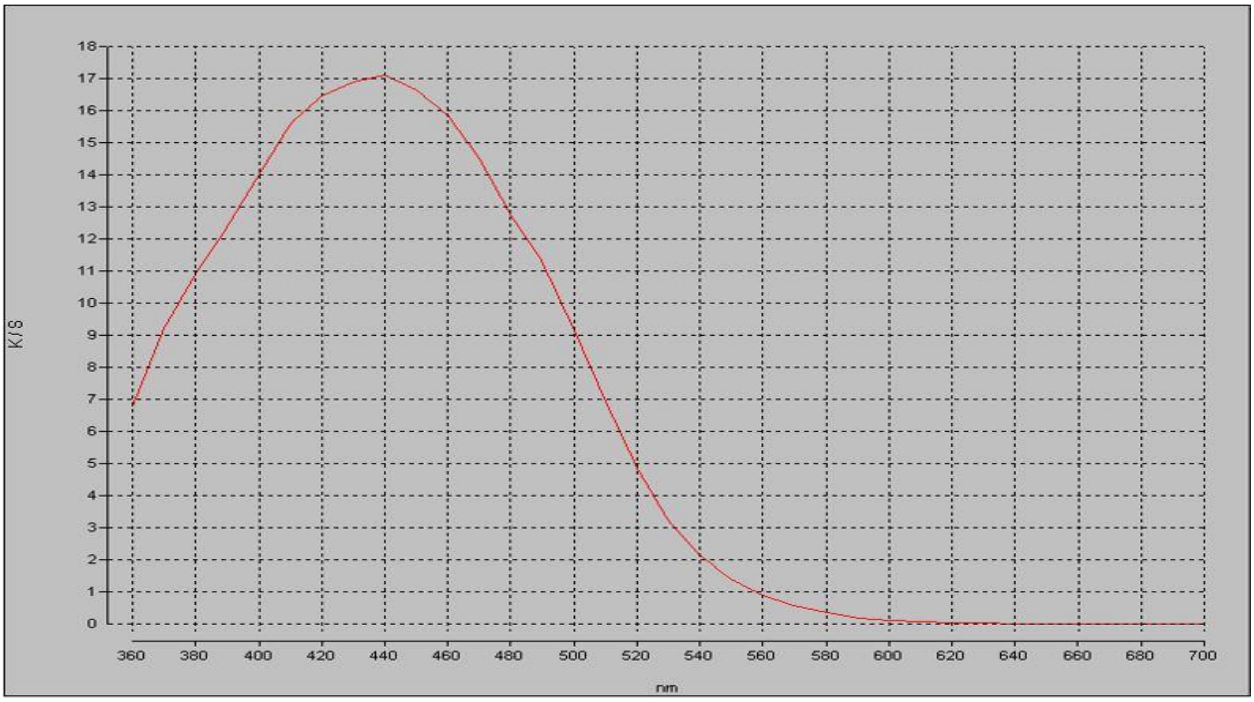



**Standard: %R** [%R / %T Plot] [K/S (Absorb.)]

**Rb.Ul.Yellow RGB=4%**

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 3.32 | 3.01 | 2.87 | 2.80 | 2.76 | 2.84 |
| 460-510 nm | 2.97 | 3.22 | 3.63 | 4.06 | 4.95 | 6.34 |
| 520-570 nm | 8.59 | 11.97 | 16.37 | 21.98 | 28.65 | 36.11 |
| 580-630 nm | 44.37 | 53.48 | 62.35 | 69.60 | 74.82 | 78.02 |
| 640-690 nm | 80.06 | 81.50 | 82.24 | 82.80 | 83.18 | 83.37 |
| 700 nm | 83.62 | | | | | |

### 4.3.4 Reactobond Ultra Yellow RGB= 6.0%




**Standard: %R** %R / %T Plot K/S (Absorb.)
**Rb.Ul.Yellow RGB=6%**

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 3.32 | 3.01 | 2.87 | 2.80 | 2.50 | 2.84 |
| 460-510 nm | 2.97 | 3.22 | 3.63 | 4.06 | 4.95 | 6.34 |
| 520-570 nm | 8.59 | 11.97 | 16.37 | 21.98 | 28.65 | 36.11 |
| 580-630 nm | 44.37 | 53.48 | 62.35 | 69.60 | 74.82 | 78.02 |
| 640-690 nm | 80.06 | 81.50 | 82.24 | 82.80 | 83.18 | 83.37 |
| 700 nm | 83.62 | | | | | |

### 4.3.4 Sample Attachment (Yellow)

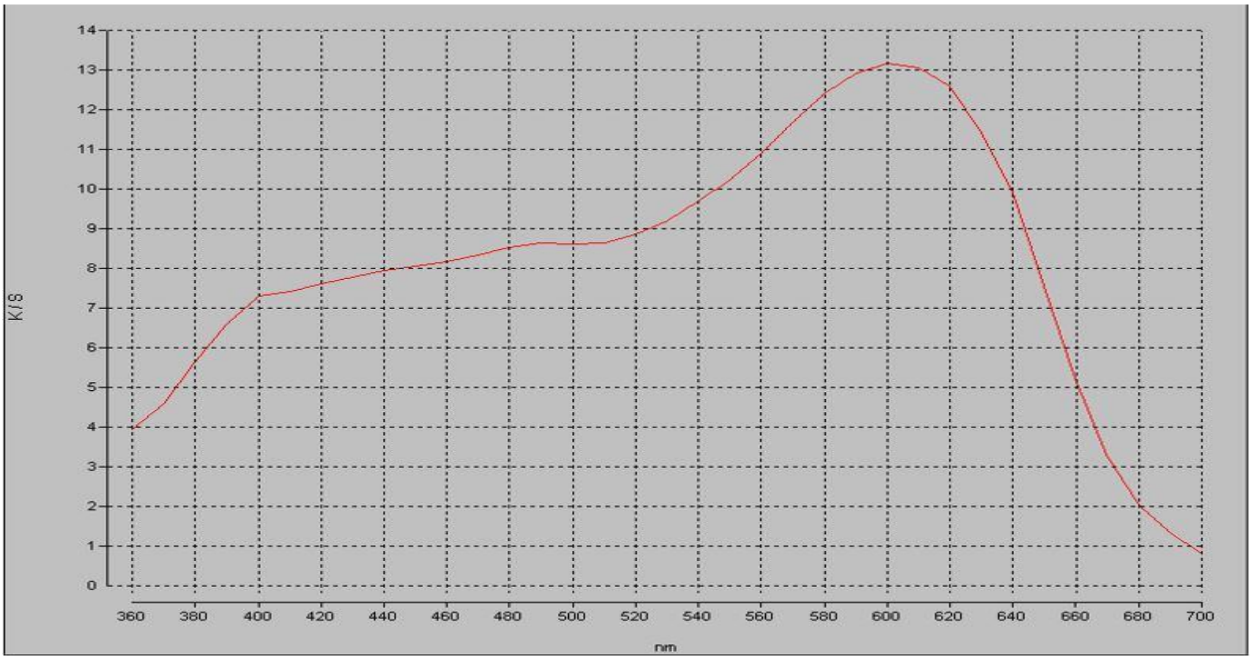
### 4.4 Analysis of reflectance (%) & color strength (K/S) For Reactobond Black DN

| Fabric Type | Used Dyes | Shade (%) | Reflectance (%) | Color Strength (K/S) |
|---|---|---|---|---|
| Interlock | Reactobond Black DN | 2.0 % | 3.53 | 13.10 |
| | | 4.0 % | 2.28 | 20.90 |
| | | 6.0% | 1.95 | 25.85 |

| | | | | |
|---|---|---|---|---|
| | | 8.0 % | 1.74 | 27.80 |

The following table shows that the increasing of shade (%), the reflectance (%) is decreasing where the color strength (K/S) is increasing

### 4.4.1 Reactobond Black DN = 2.0%

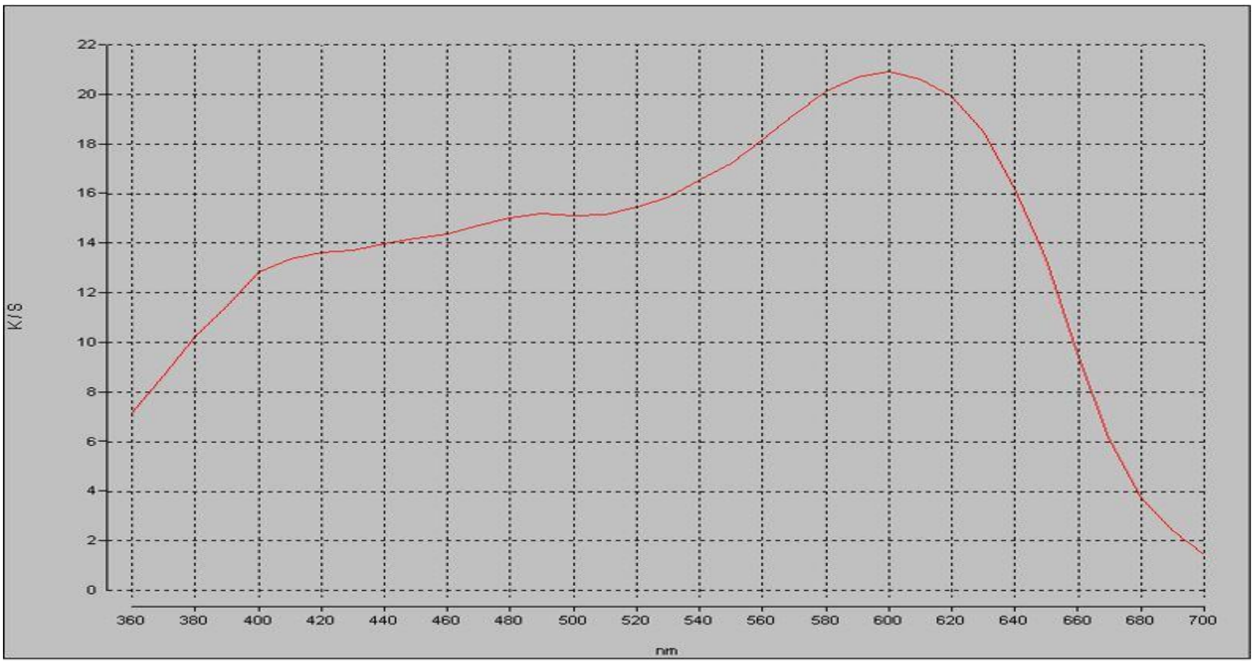



**Standard: %R**
**Rb.Black DN=2%.**

%R / %T Plot    K/S (Absorb.)

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 6.03 | 5.95 | 5.82 | 5.72 | 5.61 | 5.53 |
| 460-510 nm | 5.47 | 5.36 | 5.25 | 5.20 | 5.21 | 5.20 |
| 520-570 nm | 5.08 | 4.92 | 4.68 | 4.47 | 4.22 | 3.95 |
| 580-630 nm | 3.73 | 3.60 | 3.53 | 3.56 | 3.69 | 4.04 |
| 640-690 nm | 4.59 | 5.85 | 8.10 | 11.73 | 16.95 | 22.43 |
| 700 nm | 30.11 | | | | | |

### 4.4.2 Reactobond Black DN = 4.0%

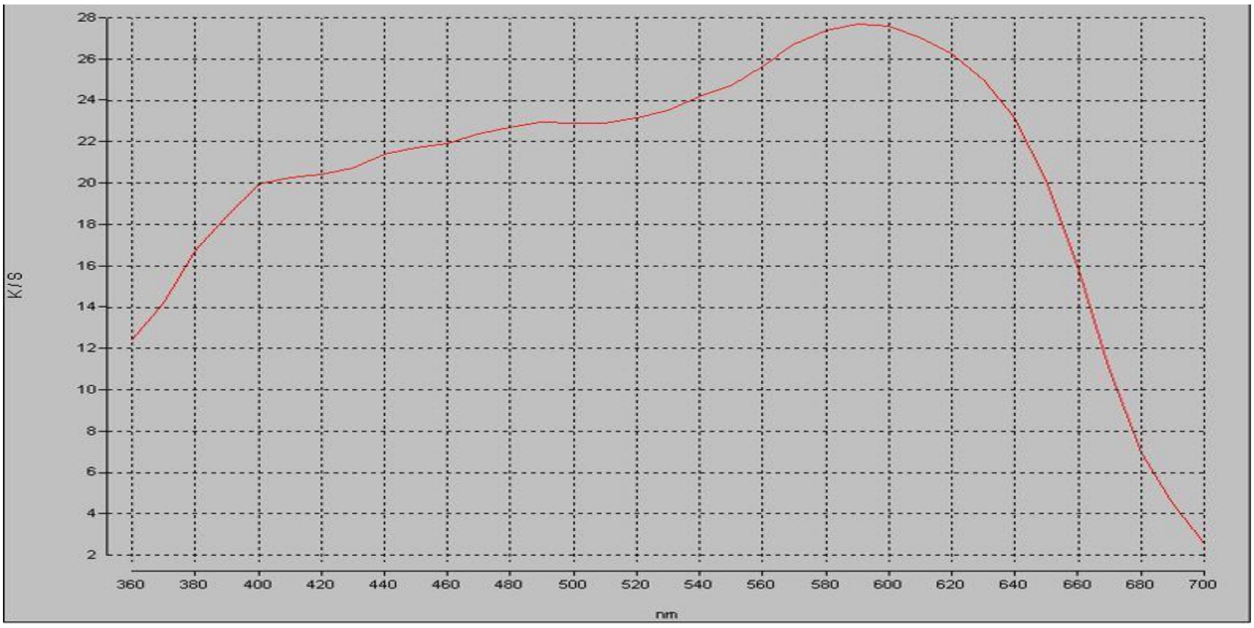



**Standard: %R**
**Rb.Black DN=4%.**

%R / %T Plot    K/S (Absorb.)

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 3.62 | 3.48 | 3.42 | 3.41 | 3.35 | 3.29 |
| 460-510 nm | 3.25 | 3.19 | 3.13 | 3.09 | 3.10 | 3.10 |
| 520-570 nm | 3.04 | 2.97 | 2.85 | 2.75 | 2.61 | 2.48 |
| 580-630 nm | 2.37 | 2.31 | 2.28 | 2.32 | 2.39 | 2.56 |
| 640-690 nm | 2.91 | 3.49 | 4.75 | 7.02 | 10.69 | 14.95 |
| 700 nm | 21.49 | | | | | |

### 4.4.3 Reactobond Black DN = 6.0%

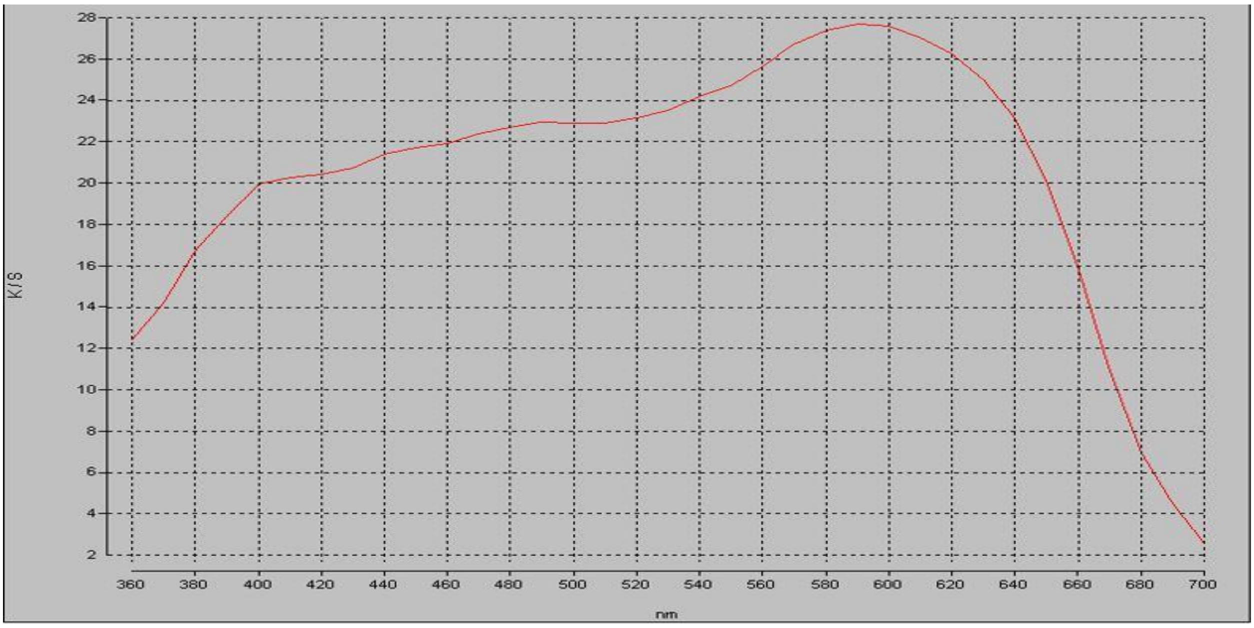



**Standard: %R**
**Rb.Black DN=6%.**

%R / %T Plot K/S (Absorb.)

| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 2.39 | 2.35 | 2.34 | 2.30 | 2.23 | 2.20 |
| 460-510 nm | 2.18 | 2.14 | 2.11 | 2.09 | 2.09 | 2.09 |
| 520-570 nm | 2.07 | 2.04 | 1.99 | 1.95 | 1.88 | 1.80 |
| 580-630 nm | 1.76 | 1.74 | 1.75 | 1.79 | 1.84 | 1.95 |
| 640-690 nm | 2.07 | 2.37 | 2.93 | 4.14 | 6.32 | 9.19 |
| 700 nm | 14.26 | | | | | |

### 4.4.4 Reactobond Black DN = 8.0%




**Standard: %R**
**Rb.Black DN=8%.**

%R / %T Plot    K/S (Absorb.)

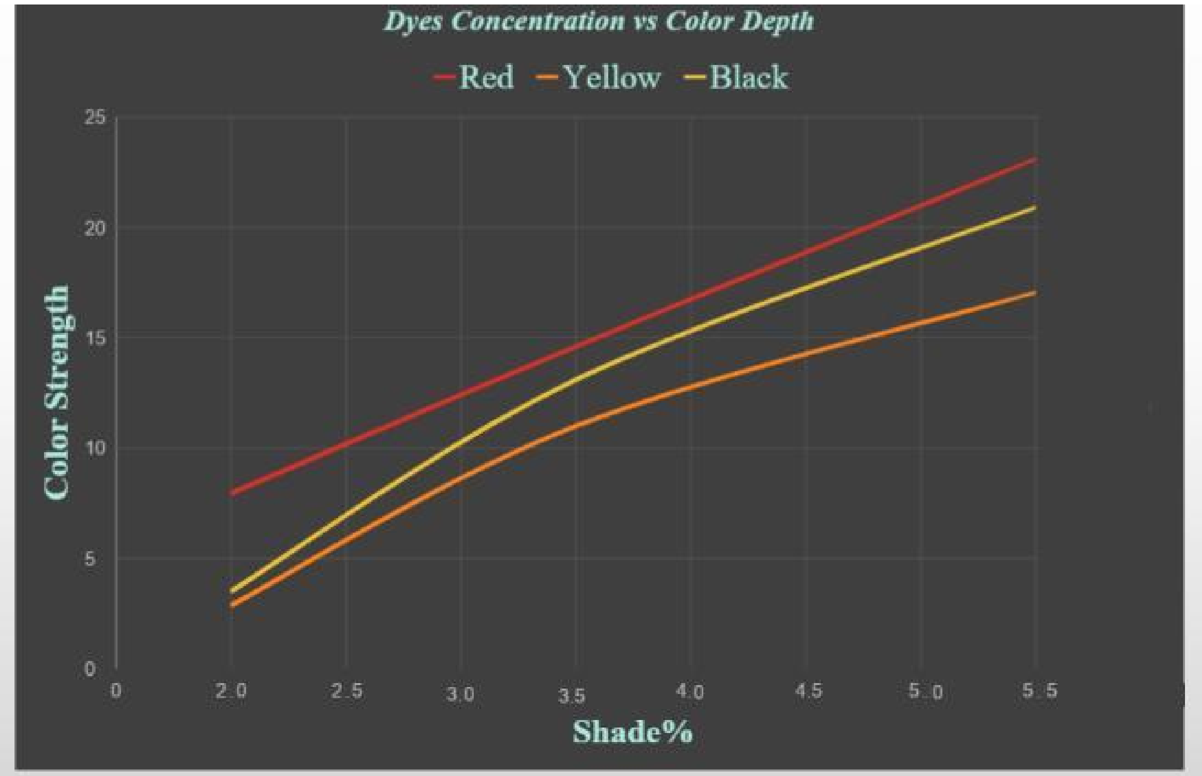
| | | | | | | |
|---|---|---|---|---|---|---|
| 400-450 nm | 2.39 | 2.35 | 2.34 | 2.30 | 2.23 | 2.20 |
| 460-510 nm | 2.18 | 2.14 | 2.11 | 2.09 | 2.09 | 2.09 |
| 520-570 nm | 2.07 | 2.04 | 1.99 | 1.95 | 1.88 | 1.80 |
| 580-630 nm | 1.76 | 1.74 | 1.75 | 1.79 | 1.84 | 1.92 |
| 640-690 nm | 2.07 | 2.37 | 2.93 | 4.14 | 6.32 | 9.19 |
| 700 nm | 14.26 | | | | | |

### 4.4.5 Sample Attachment (Black)

## 4.5 Analysis of Color Depth (%) & Color Strength (K/S)

| Dyes | Shade% | Reflectance% | Color Strength |
|---|---|---|---|
| Reactobond Deep Red LW | 2.0% | 3.20 | 14.60 |
| | 4.0% | 2.08 | 23.10 |
| | 6.0 % | 2.08 | 23.10 |
| Reactobond Ultra Yellow RGB | 2.0% | 4.18 | 11.00 |
| | 4.0% | 2.76 | 17.05 |
| | 0.6 % | 2.50 | 20.05 |
| Reactobond Black DN | 2.0% | 3.53 | 13.10 |
| | 4.0% | 2.28 | 20.90 |
| | 6.0% | 1.95 | 25.85 |
| | 8.0 % | 1.74 | 27.80 |

## 4.6 Graphical representation of Color Depth (%) & Color Strength (K/S)



# Chapter 5

# Conclusion

## 5.1 Conclusion

Reflectance (%) of a dyed fabric is greatly influenced by shade (%) of that dyed fabric. At the same time reflectance (%) also influenced by the absorption properties of a dyed fabric. When shade (%) is higher, the absorption of dye by the substrate is also higher which results in lower reflectance (%) value. At the same time when shade (%) is lower, the absorption of dye by the substrate is also lower which results in higher reflectance (%) value.

Color strength (K/S) of the dyed fabric also influenced by the increase of reflectance (%) value. In this research a relation was found among shade (%) & reflectance (%) & Color Strength (K/S).When shade (%) increase, reflectance (%) is decreasing & color strength that means color depth (K/S) is increasing.

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