Faculty of Engineering

Department of Textile Engineering

Report on

Effect of Yarn Count on Fabric Shade

Course code: TE-4214 Course title: Project (Thesis)

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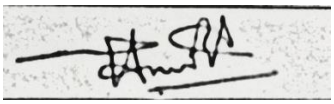
A project submitted in partial fulfillment of the requirements for the degree of **Bachelor of Science in Textile Engineering**

Advance in Wet Processing Technology

Spring-2021

LETTER OF APPROVAL

This project report prepared by **Sani Rahman Akash** (ID:181-23-5292) and **Monir Hossen** (ID:181-23-5225), 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. During the research period I found them sincere, hardworking and enthusiastic.



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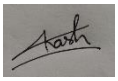
DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Tanvir Ahmed Chowdhury, Assistant Professor**, Department of Textile Engineering, Faculty of Engineering, Daffodil international University. We also declare that, neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.



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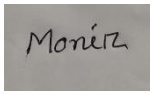

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ACKNOWLEDGEMENT

First, we are expressing our gratefulness to almighty **Allah** for his divine blessing makes us possible to complete this project successfully.

Special thanks to our honorable **Md. Mominur Rahman. Assistant Professor & Head In Charge, Textile Engineering Department, Daffodil International University** and We also fell thankful to **Md. Kamrul Islam. Lecturer, Department of Textile Engineering** for giving his continuous guideline, profound Knowledge and unmistakable fascination of our supervisor who encourages us to do this project. Without his support and direction, it would never be possible for us to make this report.

We are highly delighted to express our sincere gratitude to **Md. Jasim Uddin. Project Director, NZ Denim Ltd; Md. Zasim Uddin. General Manager, operation, NZ Denim Ltd; Md. Shah Jalal Uddin Bhuiyan Manager of HR, Admin and Compliance** for giving us permission to work in Lab and provide important data about our project. We would like to express our heartiest thanks to the entire staffs of **NZ Denim Ltd**. for their friendly co-operation, helpful support and cordial behavior.

We would like to acknowledge our sincere gratitude to all the teachers of the Department of Textile Engineering for their enormous support. Last but not the least hearty gratitude to our parents for their non-ending blessing, support and love without which finishing intern was almost impossible.

DEDICATION

We dedicate this project to our parents.

ABSTRACT

This study has been sorted on effect of denim yarn dyeing with vat dye in different ratio of Hydrose and Caustic Soda. In this thesis experiment we use two types of yarn Cotton yarn and Tencel yarn. Cotton is the most common plant fiber, which is typically spun into fine yarn for mechanical weaving or knitting in cloth. Typical Denim fabrics are woven from coarse, indigo-dyed Cotton yarn. And Tencel yarn is like other natural fibers. It's a cellulose –based fiber and can be used similarly to silk or mercerized cotton. It has smooth texture, soft and silky appearance.

Sodium Hydrosulphite named Hydrose in commercially is used as reducer for vat dye. Hydrose help to produce the insoluble dye to soluble dye by reduction process. Caustic Soda is used in textile dyeing as most dyeing processes require a control pH level in dye bath. Caustic Soda helps to maintain higher pH of 10.5-11.5 obtain ionized from of the dye. In Denim dyeing process the main dye is Indigo which also called Vat dye. Denim is a yarn dyeing process, warp yarn is mainly need to dye. In bulk production for accelerate this process a standard ratio of reducing agent and Caustic Soda is maintained for getting required output.

This research focuses on the shade variation of Cotton and Tencel dyed yarn with indigo dye in different ratio of Hydrose and Caustic soda and also evaluate the different properties of Cotton and Tencel yarn. Because dyeing auxiliaries make effect on material. Six bath was used for each process to achieve optimum output. After this process statistically analyze the result of all output. We are using blue (Indigo) in powder form.

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Chapter 1: Introduction

1.1 Introduction:

Dyeing is the act of chemically or physically altering a substrate such that the reflected light looks colored. Dyeing is a color transfer technique that imparts permanent and long-lasting color to a material, such as a completed textile or textile material (fibers and yarns). Any method, such as by hand or machine, is acceptable. Dyes come as powders, crystals, pastes, and liquid dispersions, and they completely dissolve in water. When the dye and the substance come into contact, the dye completely absorbs and colors the material. On the market, there are several varieties of dye staffs, each with its own brand name and maker. All dye staffs are classified according to their intended use. There are many kinds of dyes like acid, reactive, vat, indigo, direct etc.

GSM, Air Permeability, Pilling, loop length, EPI, PPI, Stitch density, Bursting Strength, and Shrinkage are all affected by the dyeing process. There are many different types of cloth that have various characteristics once they have been dyed. Some fabrics enhance their properties while others lose them. We'll look at GSM, EPI, PPI, stitch length, shrinkage, and abrasion resistance among all of these physical properties of knit fabric.

We dyed yarn using vat dye in this report. We experimented with various yarn counts like 7 OE and 9 . Following the dyeing process, the shades of two yarns appeared in two different ways.

Essentially, vatting is a dyeing technique in which vat dye is treated with a reducing agent to make it soluble in alkali (solubilizing agent). The dye becomes soluble from its insoluble form after this procedure, and it may then be used on textile fabrics. Then, using various dyeing techniques, textile materials may be coloured using soluble vat dyes.

1.2 Sections of the denim manufacturing process:

Yarn store section

↓

Warping section

↓

Dyeing and sizing

↓

Weaving section

↓

Finishing section

↓

Inspection and Fabric store

1.3 Preparatory section:

Scouring

↓

Bleaching

↓

Dyeing (indigo, black, bottoming, topping etc.)

↓

Sizing (Not done in this experiment)

Chapter 2: Literature Review

2.1 Denim Fabrics:

Denim jeans have become an integral part of everyday life, so much so that most of us never stop to question where our favourite pair came from, how they were manufactured, nor their history.

Denim jeans have grown so ubiquitous that most of us don't think twice about where our favorite pair originated from, how they were made, or how long they've been around.

Despite the diversity of novel materials available, denim remains one of the most adaptable, durable and highly sough after textiles on the market. Jeans are universally popular, transcending gender, age, and social status, with most individuals possessing more pairs than there are days in the week. Their charm will never go out of style, but the design and fabric technologies used will continue to improve with the times.

New types of sustainable denim are now appearing as manufacturers respond to consumer demand for eco-friendly fabrics and environmentally friendly manufacturing processes.

2.2 Yarn used for denim:

Denim yarns are made from fibers with a staple length of less than 2.5 inches, they are often employed as short-staple spun yarns. Cotton fibers are usually more than one inch long. One of the most crucial pieces of yarn knowledge is the creation and production of denim by yarn size. Yarn is made using one of two standard spinning systems. They are the ring spinning end and the rotor spinning end, respectively.

There are many types of yarn used for denim fabric:

For warp yarn	For weft yarn
Open-end	Open-end
Ring spun	Lycra/ Spandex etc
Tencel etc	Polyester
	Polyester- lycra

2.3 Yarn count:

Textile yarn count is a number of represents the diameter or fineness of a yarn. The count is expressed either in terms of weight by length or length by weight. Commonly used yarn count for denim is given below:

Yarn type	**Yarn count**
Slub yarn Ring Yarn Rotor Yarn	For warp yarn: 6,7,8,9,10,12,14,16,20,30 For weft yarn: 6.7.8.9.10.12,14,16,20,30 (Slub + Normal) mixed.
Lycra yarn	10L40D, 16L40D etc.
Polyester	300D, 450D, 600D
Tencel yarn	10/1,12/1, 16/1, 24/1 etc.

2.4 Indigo or vat dye (C16 H10 N2 O2)

Indigo is a pigment derived from the leaves of indigo-bearing plants and is the world's oldest natural source of blue dye. Indigo has been used to color natural fabrics by humans for thousands of years, with traditions spanning countries and civilizations. Indigo dye was widely used in ancient Mesopotamia, Egypt, Britain, Mesoamerica, Peru, Iran, and West Africa. The earliest known indigo-dyed textile goes back 6,000 years and was discovered in Peru.

Because of its high value in trade, indigo was often referred to as blue gold. It was a major export and cash crop in South Carolina in the 1700s, playing a major role in plantation slavery there, along with cotton and rice. In 1865, German chemist Adolf von Baeyer introduced synthetic indigo, which was created in a lab and much less expensive to produce than naturally-grown indigo pigment. Most indigo dye made today is synthetic, constituting several thousand tons each year.

Any of a large class of water-insoluble dyes, such as indigo and anthraquinone derivatives, used primarily on cellulosic fibers. To impregnate the fiber, the dye is applied in a soluble, reduced form, which is then oxidized in the fiber back to its original insoluble form. Vat dyes are particularly resistant to light and washing. In most shades, brilliant colors can be obtained. Vat dyes originated in medieval Europe and were named after the vats used in the fermentation of indigo plants.

2.5 ORP:

For solubility, the oxidation-reduction potential (ORP) must be kept low enough to preserve the indigo dye in the reduced (leuco) form. The ORP of the bath might also have an impact on the final colour. The common ORP range is -760 to -860 millivolts, with the exact target ORP determined by the desired final shade. Some important things about ORP.

If ORP and ph becomes high then shade will be black

If ORP low and ph high then shade will be reddish

If ORP is high and ph low then shade will be black

If ORP is high then shade will black

If ORP low then shade will be red

If ph is high then shade will red

If ph is low then shade will black

If we use 1 kg of hydrose then 20 ORP increased

If we use 1 kg caustic soda then ph will increase 0.08

2.8 Grams per Liter (gpl):

An expression used to determine the amount of indigo in a vat. Higher gpl means the vat dye will be darker.

CHAPTER 3: Experimental Details.

3.1 Yarn that we have used:

In this experiment we have used 7 OE and 12 OE cotton yarn

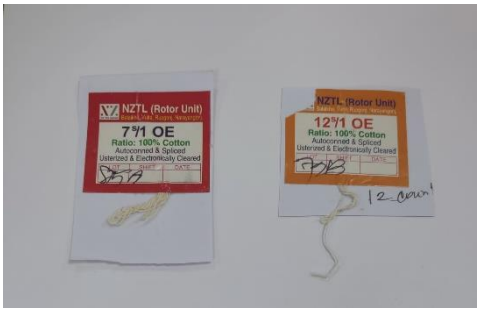

Fig 1: Cotton yarn

3.2 Chemical used for dyeing

Table 3.1: Recipe 1

Indigo	3 g/l
Hydrose	2.4 g/l
Caustic	1.5 g/l
Wetting agent	4 g/l
Sequestering agent (ADZ)	1 g/l
Water	1000

Table 3.2: ORP and PH of before and after dyeing

Before	After
ORP= 655.6	ORP= 572
PH= 11.7	PH= 10
G/L= 2.5	G/L =2.8

Table 3.3 Recipe 2

Indigo	3 g/l
Hydrose	1.8 g/l
Caustic	2.1 g/l
Wetting agent	4 g/l
Sequestering agent (ADZ)	1 g/l
Water	1000

Time (Immersion) :15 seconds (per bath)

Table 3.4: ORP and PH before and after dyeing

Before	After
ORP= 665	ORP= 632
PH=12.20	PH= 11.9
G/L= 2.9	G/L= 2.28

Fig 2: Spectrophotometer

Fig 3: ORP and pH test mc.

3.3 Spectrophotometer

Purpose: the sample solution and water.

A spectrophotometer is an instrument that measures the amount of light absorbed by a sample. Spectrophotometer techniques are mostly used to measure the concentration of solutes in solution by measuring the amount of the light that is absorbed by the solution in a cuvette place in the spectrophotometer.

3.4 Checking System of Spectrophotometer machine

1st have to select indigo (which sample I want to check)

After select target sample have to take 499ml water and 1 ml sample

Have to mix up sample water until dissolve

Put fresh water in the cell and put cell for zeroing (press and button)

Then put sample in the cell and press green button to take reading

3.5 Process path:

Yarn collection (Auto Conner)

↓

Lea making for experiment

↓

Scouring

↓

Washing

↓

Color dipping

↓

Washing

↓

Neutralization

↓

Washing

3.6 Collection of yarn:

Cotton yarn total 400 hundred cycle of 7 Ne and 12 Ne collected from the spinning section.

3.7 Process of Scouring:

Scouring is a technique for getting some textile textiles ready to use. Scouring removes soluble and insoluble pollutants present in textiles as natural, added, and unintentional contaminants, such as oils, waxes, fats, vegetable debris, and dirt. Scouring the fabrics to eliminate these contaminants prepares them for subsequent processes such as bleaching and dyeing. Despite the fact that "scouring" is a wide term, it is most usually linked with wool. In cotton, this is referred to as "boiling out." It is the process of eliminating foreign elements from cotton fibre, such as wax,

pectins, and minarel compounds. It will be tough to color cotton fiber if certain contaminants are present. The scouring procedure is carried out with caustic soda in this experiment.

3.8 Process of Washing:

After scouring process washing is done for remove extra chemical from the sample. Otherwise it creates difficulties when its dip in different bath.

3.9 Dipping in indigo colors:

It is a dyeing technique in which the yarn is dipped in a solution several times. This is the most important aspect of the experiment. To color the yarn, we use a slasher or sheet dyeing procedure. Slasher dyeing is a long-term dyeing method. In this dyeing method, the warp yarn is cut into sheets and dipped in several baths. The amount of time spent submerged or in the dip cycle is determined by the m/c speed. The dip cycle is 15 seconds if the machine runs at 25 meters per minute. We're working with powdered blue (Indigo). Even though indigo powder is blue, it does not turn blue until it is oxidized. An alkali bath is required to dissolve the powder. Indigo is insoluble in water, but it is soluble in an alkaline solution prepared with caustic soda. The finished product has a yellow-green hue. Indigo is mostly used to create color. As a result, the darker the hue, the more immersion – oxidation cycles there are.

Fig 4: Powder Indigo

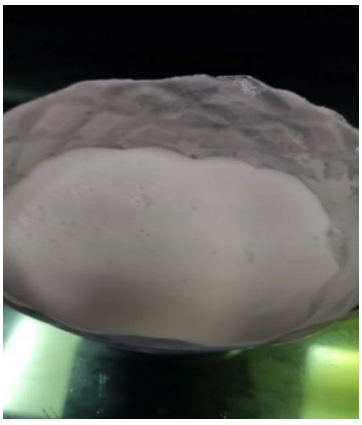

Fig 5: Hydrose (C. name: BSF)

Fig 6: Seq. agent (C. name: Marla ADZ)

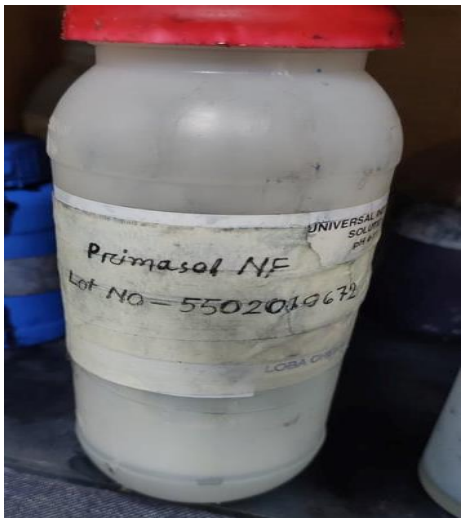

Fig 7: **Wetting agent (C. name: Primasol NF)**

Fig 8: Dye bath (Before Dye mixing)

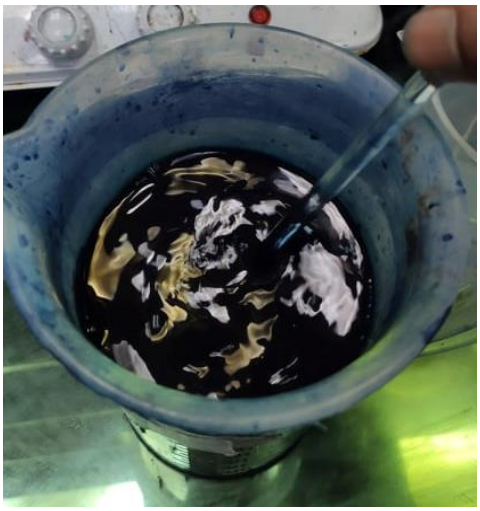

Fig 9: Dye bath (After dye mixing)

3.10 Reduction process:

Reduction is the gain of hydrogen. Indigo is a unique dye when compared to other dyes. Indigo demands that excess oxygen be removed from the vat liquid, allowing the indigo color molecule to physically bond to the fiber. Bath indigo attaches poorly to the fiber when the yarn is soaked in it. The fiber in the vat is not blue at this moment. It's called leuco indigo and it has a yellow-green appearance.

3.11 Oxidation process:

Oxidation is the loss of hydrogen. When indigo-colored fiber is withdrawn from the vat, it undergoes oxidation. The oxygen in the air reconverts the weakly bound indigo dye molecule, allowing it to bind to the fiber. And by making a strong link, the indigo blue hue is able to emerge. It's as though magic happens when the yellow-green fiber gradually turns blue.

3.12 Neutralization:

A neutralization reaction is a chemical reaction in which an acid and a base combine quantitatively to generate a salt and water as products. A chemical reaction in which alkali and acids combine to generate a neutral solution is known as neutralization. Indigo dye is made in an alkaline environment with a pH of 11 to 12. As a result, oxalic acid and peroxide were utilized to neutralize the acid.

Fig 10: Neutralization bath

3.13 Neutralization Recipe:

- Oxalic Acid : 1.15 gpl
- Peroxide : 2.3 gpl
- Water : 1000 ml

Chapter 4: Result and Discussion

4.1 Result

Table 3.5: Sample of 7 count before & after dyeing

Before	After
	

Table 3.6: Sample yarn of 12 Count before & after dyeing

Before	After
	

4.2 Discussion:

Table 3.7: Shade variation analysis of these two yarns:

7 count	12 count
1. Yarn dyed in recipe 1 becomes reddish tone. 2. Yarn dyed in recipe 2 becomes greenish tone.	1. Yarn dyed in recipe 1 becomes reddish tone. 2. Yarn dyed in recipe 2 becomes greenish tone.

7 Ne yarn is coarser than 12 Ne yarn. So that hairiness is more in 7 Ne yarn. We made the recipe 2 times. In recipe 1 we have used more hydrose and less caustic than recipe 2. And in recipe 2 we have used less hydrose and more caustic than recipe 1. After dyeing we have noticed that 7 Ne yarn absorbed more deep color than 12 Ne yarn. So that's the shade variation that we are looking for. So if we use less count of yarn then the yarn will absorb more color. And higher count of yarn will absorb less color from the same solution.

Chapter 5: Conclusion

5.1 Conclusion

In fabric, shade variation, or shading, is recognized as a key concern. In most quality assurance managers' inspection procedures, checking fabric color deviations is a critical step. The shade effect was overserved in this investigation after the cotton yarn dying procedure was completed. We employed mostly two dyeing recipes in this experiment. We were able to see the difference in shade fluctuation. The tint of yarn was reddish + greenish toned after following the first formula, which was truly typical. They retain shade in the denim yarn dying process by modifying the formula. Both pH and g/L of bath solution both played an impact in the alterations in yarn shade ORP. It's critical to the denim industry's success. As a result, they monitor the ORP, pH, and g/L levels throughout the manufacturing process. It helps to have good technology, high-quality inks and dyes, and the right fiber content and fabric quality, but it doesn't ensure perfect success. The technique that came before it should be properly scrutinized. The smaller the change, the more care you take.

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Faculty of Engineering Department of Textile Engineering Report on Effect of Yarn Count on Fabric Shade Course code: TE-4214 Course title: Project (Thesis) Submitted by: Student's Name Student's ID Sani Rahman Akash 181-23-5292 Monir Hossen 181-23-5225 Supervised by: Tanvir Ahmed Chowdhury Assistant Professor Department of Textile Engineering Daffodil International University A project submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Textile Engineering Advance in Wet Processing Technology Spring-2021 I|Page LETTER OF APPROVAL This project report prepared by Sani Rahman Akash (ID:181-23-5292) and Monir Hossen (ID:181-23-5225), 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. During the research period I found them sincere, hardworking and enthusiastic. TANVIR AHMED CHOWDHURY ASSISTANT PROFESSOR DEPARTMENT OF TEXTILE ENGINEERING FACULTY OF ENGINEERING DAFFODIL INTERNATIONAL UNIVERSITY ii|Page DECLARATION We hereby declare that, this project has been done by us under the supervision of Tanvir Ahmed Chowdhury, Assistant Professor, Department of Textile Engineering, Faculty of Engineering, Daffodil international University. We also declare that, neither this project nor any part of this

project has been submitted elsewhere for award of any degree or diploma. Sani Rahman Akash ID: 181-23-5292 Department of TE Daffodil International University Monir Hossen ID: 181-23-5225 Department of TE Daffodil International University iii | P a g e ACKNOWLEDGEMENT First, we are expressing our gratefulness to almighty Allah for his divine blessing makes us possible to complete this project successfully. Special thanks to our honorable Md. Mominur Rahman. Assistant Professor & Head In Charge, Textile Engineering Department, Daffodil International University and We also fell thankful to Md. Kamrul Islam. Lecturer, Department of Textile Engineering for giving his continuous guideline, profound Knowledge and unmistakable fascination of our supervisor who encourages us to do this project. Without his support and direction, it would never be possible for us to make this report. We are highly delighted to express our sincere gratitude to Md. Jasim Uddin. Project Director, NZ Denim Ltd; Md. Zasim Uddin. General Manager, operation, NZ Denim Ltd; Md. Shah Jalal Uddin Bhuiyan Manager of HR, Admin and Compliance for giving us permission to work in Lab and provide important data about our project. We would like to express our heartiest thanks to the entire staffs of NZ Denim Ltd. for their friendly co-operation, helpful support and cordial behavior. We would like to acknowledge our sincere gratitude to all the teachers of the Department of Textile Engineering for their enormous support. Last but not the least hearty gratitude to our parents for their non-ending blessing, support and love without which finishing intern was almost impossible. iv|Page DEDICATION We dedicate this project to our parents. ABSTRACT This study has been sorted on effect of denim yarn dyeing with vat dye in different ratio of Hydrose and Caustic Soda. In this thesis experiment we use two types of yarn Cotton yarn and Tencel yarn. Cotton is the most common plant fiber, which is typically spun into fine yarn for mechanical weaving or knitting in cloth. Typical Denim fabrics are woven from coarse, indigo-dyed Cotton yarn. And Tencel yarn is like other natural fibers. It's a cellulose –based fiber and can be used similarly to silk or mercerized cotton. It has smooth texture, soft and silky appearance. Sodium Hydrosulphite named Hydrose in commercially is used as reducer for vat dye. Hydrose help to produce the insoluble dye to soluble dye by reduction process. Caustic Soda is used in textile dyeing as most dyeing processes require a control pH level in dye bath. Caustic Soda helps to maintain higher pH of 10.5-11.5 obtain ionized from of the dye. In Denim dyeing process the main dye is Indigo which also called Vat dye. Denim is a yarn dyeing process, warp yarn is mainly need to dye. In bulk production for accelerate this process a standard ratio of reducing agent and Caustic Soda is maintained for getting required output. This research focuses on the shade variation of Cotton and Tencel dyed yarn with indigo dye in different ratio of Hydrose and Caustic soda and also evaluate the different properties of Cotton and Tencel yarn. Because dyeing auxiliaries make effect on material. Six bath was used for each process to achieve optimum output. After this process statistically analyze the result of all output. We are using blue (Indigo) in powder form. Table of Contents Contents Page number Letter of approval .....
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Introduction: Dyeing is the act of chemically or physically altering a substrate such that
the reflected light looks colored. Dyeing is a color transfer technique that imparts
permanent and long-lasting color to a material, such as a completed textile or textile
material (fibers and yarns). Any method, such as by hand or machine, is acceptable.
Dyes come as powders, crystals, pastes, and liquid dispersions, and they completely
dissolve in water. When the dye and the substance come into contact, the dye completely
absorbs and colors the material. On the market, there are several varieties of dye staffs,
each with its own brand name and maker. All dye staffs are classified according to their
intended use. There are many kinds of dyes like acid, reactive, vat, indigo, direct etc.
GSM, Air Permeability, Pilling, loop length, EPI, PPI, Stitch density, Bursting Strength, and
Shrinkage are all affected by the dyeing process. There are many different types of cloth
that have various characteristics once they have been dyed. Some fabrics enhance their
properties while others lose them. We'll look at GSM, EPI, PPI, stitch length, shrinkage,
and abrasion resistance among all of these physical properties of knit fabric. We dyed
yarn using vat dye in this report. We experimented with various yarn counts like 7 OE
and 9 . Following the dyeing process, the shades of two yarns appeared in two different
ways. Essentially, vatting is a dyeing technique in which vat dye is treated with a
reducing agent to make it soluble in alkali (solubilizing agent). The dye becomes soluble
from its insoluble form after this procedure, and it may then be used on textile fabrics.
Then, using various dyeing techniques, textile materials may be coloured using soluble
vat dyes. 1.2 Sections of the denim manufacturing process: Yarn store section ↓ Warping
section ↓ Dyeing and sizing ↓ Weaving section ↓ Finishing section ↓ Inspection and Fabric
store 1.3 Preparatory section: Scouring ↓ Bleaching ↓ Dyeing (indigo, black, bottoming,
topping etc.) ↓ Sizing (Not done in this experiment) Chapter 2: Literature Review 2.1
Denim Fabrics: Denim jeans have become an integral part of everyday life, so much so
that most of us never stop to question where our favourite pair came from, how they
were manufactured, nor their history. Denim jeans have grown so ubiquitous that most
of us don't think twice about where our favorite pair originated from, how they were
made, or how long they've been around. Despite the diversity of novel materials
available, denim remains one of the most adaptable, durable and highly sough after
textiles on the market. Jeans are universally popular, transcending gender, age, and
social status, with most individuals possessing more pairs than there are days in the
week. Their charm will never go out of style, but the design and fabric technologies used
will continue to improve with the times. New types of sustainable denim are now
appearing as manufacturers respond to consumer demand for eco-friendly fabrics and
environmentally friendly manufacturing processes. 2.2 Yarn used for denim: Denim
yarns are made from fibers with a staple length of less than 2.5 inches, they are often
employed as short-staple spun yarns. Cotton fibers are usually more than one inch long.
One of the most crucial pieces of yarn knowledge is the creation and production of

denim by yarn size. Yarn is made using one of two standard spinning systems. They are the ring spinning end and the rotor spinning end, respectively. There are many types of yarn used for denim fabric: For warp yarn For weft yarn Open-end Open-end Ring spun Lycra/ Spandex etc Tencel etc Polyester Polyester- lycra 2.3 Yarn count: Textile yarn count is a number of represents the diameter or fineness of a yarn. The count is expressed either in terms of weight by length or length by weight. Commonly used yarn count for denim is given below: Yarn type Yarn count Slub yarn For warp yarn: 6,7,8,9,10,12,14,16,20,30 Ring Yarn For weft yarn: 6.7.8.9.10.12,14,16,20,30 Rotor Yarn (Slub + Normal) mixed. Lycra yarn 10L40D, 16L40D etc. Polyester 300D, 450D, 600D Tencel yarn 10/1,12/1, 16/1, 24/1 etc. 2.4 Indigo or vat dye (C16 H10 N2 O2) Indigo is a pigment derived from the leaves of indigo-bearing plants and is the world's oldest natural source of blue dye. Indigo has been used to color natural fabrics by humans for thousands of years, with traditions spanning countries and civilizations. Indigo dye was widely used in ancient Mesopotamia, Egypt, Britain, Mesoamerica, Peru, Iran, and West Africa. The earliest known indigo-dyed textile goes back 6,000 years and was discovered in Peru. Because of its high value in trade, indigo was often referred to as blue gold. It was a major export and cash crop in South Carolina in the 1700s, playing a major role in plantation slavery there, along with cotton and rice. In 1865, German chemist Adolf von Baeyer introduced synthetic indigo, which was created in a lab and much less expensive to produce than naturally-grown indigo pigment. Most indigo dye made today is synthetic, constituting several thousand tons each year. Any of a large class of water-insoluble dyes, such as indigo and anthraquinone derivatives, used primarily on cellulosic fibers. To impregnate the fiber, the dye is applied in a soluble, reduced form, which is then oxidized in the fiber back to its original insoluble form. Vat dyes are particularly resistant to light and washing. In most shades, brilliant colors can be obtained. Vat dyes originated in medieval Europe and were named after the vats used in the fermentation of indigo plants. 2.5 ORP: For solubility, the oxidation-reduction potential (ORP) must be kept low enough to preserve the indigo dye in the reduced (leuco) form. The ORP of the bath might also have an impact on the final colour. The common ORP range is -760 to -860 millivolts, with the exact target ORP determined by the desired final shade. Some important things about ORP. If ORP and ph becomes high then shade will be black If ORP low and ph high then shade will be reddish If ORP is high and ph low then shade will be black If ORP is high then shade will black If ORP low then shade will be red If ph is high then shade will red If ph is low then shade will black If we use 1 kg of hydrose then 20 ORP increased If we use 1 kg caustic soda then ph will increase 0.08 2.8 Grams per Liter (gpl): An expression used to determine the amount of indigo in a vat. Higher gpl means the vat dye will be darker. CHAPTER 3: Experimental Details. 3.1 Yarn that we have used: In this experiment we have used 7 OE and 12 OE cotton yarn Fig 1: Cotton yarn 3.2 Chemical used for dyeing Table 3.1: Recipe 1 Indigo 3 g/l Hydrose 2.4 g/l Caustic 1.5 g/l Wetting agent 4 g/l Sequestering agent (ADZ) 1 g/l Water 1000 Table 3.2: ORP and PH of before and after dyeing Before After ORP= 655.6 ORP= 572 PH= 11.7 PH= 10 G/L= 2.5 G/L =2.8 Table 3.3 Recipe 2 Indigo 3 g/l Hydrose 1.8 g/l Caustic 2.1 g/l Wetting agent 4 g/l Sequestering agent (ADZ) 1 g/l Water 1000 Time (Immersion) :15 seconds (per bath) Table 3.4: ORP and PH before and after dyeing Before After ORP= 665 ORP= 632 PH=12.20 PH= 11.9 G/L= 2.9 G/L= 2.28 Fig 2: Spectrophotometer Fig 3: ORP and pH test mc. 3.3 Spectrophotometer Purpose: the sample solution and water. A spectrophotometer is an instrument that measures the amount of light absorbed by a sample. Spectrophotometer techniques are mostly used to measure the concentration of solutes in solution by measuring the amount of the light that is absorbed by the solution in a cuvette place in the spectrophotometer. 3.4 Checking System of Spectrophotometer machine 1st have to select indigo (which sample I want to check) After select target sample have to take 499ml water and 1 ml sample Have to mix up sample water until dissolve Put fresh water in the cell and put cell for zeroing (press and button) Then put sample in the cell and press green button to take reading 3.5 Process path: Yarn collection (Auto Conner) ↓ Lea making for experiment ↓ Scouring ↓ Washing ↓ Color dipping ↓ Washing ↓ Neutralization ↓ Washing 3.6 Collection of yarn: Cotton yarn total 400 hundred cycle of 7 Ne and 12 Ne collected from the spinning section. 3.7 Process of Scouring: Scouring is a technique for getting some textile textiles ready to use. Scouring removes soluble and insoluble pollutants present in textiles as natural, added, and unintentional contaminants, such as oils, waxes, fats, vegetable debris, and dirt. Scouring the fabrics to eliminate these contaminants prepares them for subsequent processes such as bleaching and dyeing. Despite the fact that "scouring" is a wide term, it is most usually linked with wool. In cotton, this is referred to as "boiling out." It is the process of eliminating foreign elements from cotton fibre, such as wax,

pectins, and minarel compounds. It will be tough to color cotton fiber if certain contaminants are present. The scouring procedure is carried out with caustic soda in this experiment. 3.8 Process of Washing: After scouring process washing is done for remove extra chemical from the sample. Otherwise it creates difficulties when its dip in different bath. 3.9 Dipping in indigo colors: It is a dyeing technique in which the yarn is dipped in a solution several times. This is the most important aspect of the experiment. To color the yarn, we use a slasher or sheet dyeing procedure. Slasher dyeing is a long-term dyeing method. In this dyeing method, the warp yarn is cut into sheets and dipped in several baths. The amount of time spent submerged or in the dip cycle is determined by the m/c speed. The dip cycle is 15 seconds if the machine runs at 25 meters per minute. We're working with powdered blue (Indigo). Even though indigo powder is blue, it does not turn blue until it is oxidized. An alkali bath is required to dissolve the powder. Indigo is insoluble in water, but it is soluble in an alkaline solution prepared with caustic soda. The finished product has a yellow-green hue. Indigo is mostly used to create color. As a result, the darker the hue, the more immersion – oxidation cycles there are. Fig 4: Powder Indigo Fig 5: Hydrose (C. name: BSF) Fig 6: Seq. agent (C. name: Marla ADZ) Fig 7: Wetting agent (C. name: Primasol NF) Fig 8: Dye bath (Before Dye mixing) Fig 9: Dye bath (After dye mixing) 3.10 Reduction process: Reduction is the gain of hydrogen. Indigo is a unique dye when compared to other dyes. Indigo demands that excess oxygen be removed from the vat liquid, allowing the indigo color molecule to physically bond to the fiber. Bath indigo attaches poorly to the fiber when the yarn is soaked in it. The fiber in the vat is not blue at this moment. It's called leuco indigo and it has a yellow-green appearance. 3.11 Oxidation process: Oxidation is the loss of hydrogen. When indigo-colored fiber is withdrawn from the vat, it undergoes oxidation. The oxygen in the air reconverts the weakly bound indigo dye molecule, allowing it to bind to the fiber. And by making a strong link, the indigo blue hue is able to emerge. It's as though magic happens when the yellow-green fiber gradually turns blue. 3.12 Neutralization: A neutralization reaction is a chemical reaction in which an acid and a base combine quantitatively to generate a salt and water as products. A chemical reaction in which alkali and acids combine to generate a neutral solution is known as neutralization. Indigo dye is made in an alkaline environment with a pH of 11 to 12. As a result, oxalic acid and peroxide were utilized to neutralize the acid. Fig 10: Neutralization bath 3.13 Neutralization Recipe: • Oxalic Acid : 1.15 gpl • Peroxide : 2.3 gpl • Water : 1000 ml Chapter 4: Result and Discussion 4.1 Result Table 3.5: Sample of 7 count before & after dyeing Before After Table 3.6: Sample yarn of 12 Count before & after dyeing Before After 4.2 Discussion: Table 3.7: Shade variation analysis of these two yarns: 7 count 12 count 1. Yarn dyed in recipe 1 becomes reddish tone. 2. Yarn dyed in recipe 2 becomes greenish tone. 1. Yarn dyed in recipe 1 becomes reddish tone. 2. Yarn dyed in recipe 2 becomes greenish tone. 7 Ne yarn is coarser than 12 Ne yarn. So that hairiness is more in 7 Ne yarn. We made the recipe 2 times. In recipe 1 we have used more hydrose and less caustic than recipe 2. And in recipe 2 we have used less hydrose and more caustic than recipe 1. After dyeing we have noticed that 7 Ne yarn absorbed more deep color than 12 Ne yarn. So that's the shade variation that we are looking for. So if we use less count of yarn then the yarn will absorb more color. And higher count of yarn will absorb less color from the same solution. Chapter 5: Conclusion 5.1 Conclusion In fabric, shade variation, or shading, is recognized as a key concern. In most quality assurance managers' inspection procedures, checking fabric color deviations is a critical step. The shade effect was overserved in this investigation after the cotton yarn dying procedure was completed. We employed mostly two dyeing recipes in this experiment. We were able to see the difference in shade fluctuation. The tint of yarn was reddish + greenish toned after following the first formula, which was truly typical. They retain shade in the denim yarn dying process by modifying the formula. Both pH and g/L of bath solution both played an impact in the alterations in yarn shade ORP. It's critical to the denim industry's success. As a result, they monitor the ORP, pH, and g/L levels throughout the manufacturing process. It helps to have good technology, high-quality inks and dyes, and the right fiber content and fabric quality, but it doesn't ensure perfect success. The technique that came before it should be properly scrutinized. The smaller the change, the more care you take. Reference [1] https://textilelearner.net/fabric-shade-variation-in-dyeing/ [2] https://textilemerchandising.com/tag/how-to-reduce-shade- [3] variation-in-garments/ http://article.sapub.org/10.5923.j.clothing.20170401.02.htm [4] l https://www.onlineclothingstudy.com/2013/10/9-step- [5] guide-to-eliminate-fabric-shade.html https://www.denimsandjeans.com/denim/manufacturing- process/cross-shade-variation-csv-in-indigo-dyeing-causes- [6] and-solutions/2328 https://leanstitch.com/fabric-parameters-that-affect- garment-production/ ©Daffodil

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