Faculty of Engineering

Department of Textile Engineering

Project (Thesis) on

COMPARATIVE STUDY BETWEEN EXHAUST METHOD AND COLD-PAD BATCH (CPB) METHOD FOR DYEING 100% COTTON FABRIC

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Submitted By

K. M. Rounoque,	**ID: 181-23-5256**
Amit Kumar Sarkar,	**ID: 181-23-5267**
Reduanul Karim,	**ID: 181-23-5282**

Supervised By

Tanvir Ahmed Chowdhury

Assistant Professor

Department of Textile Engineering

Faculty of Engineering

Daffodil International University

This thesis is 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 sincerely 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 the award of any degree.

Name	**ID**	**Signature**
K. M. Rounoque	181-23-5256	
Amit Kumar Sarkar	181-23-5267	
Reduanul Karim	181-23-5282	Rizvi

LETTER OF APPROVAL

The project is prepared by **K. M. Rounoque;** ID: 181-23-5256, **Amit Kumar Sarkar;** ID: 181-23-5267 & **Reduanul Karim;** ID: 181-23-5282. This project is submitted in partial fulfillment of the requirements for the degree of BACHELOR OF SCIENCE IN TEXTILE ENGINEERING. The whole project is prepared under my supervision and guidelines. During the time of completing their project, the students were found sincere, punctual, and hard-working. I wish them every success in life.

TANVIR AHMED CHOWDHURY

ASSISTANT PROFESSOR

DEPARTMENT OF TEXTILE ENGINEERING

FACULTY OF ENGINEERING

DAFFODIL INTERNATIONAL UNIVERSITY

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Another man who was the best guidance and support for us was our supervisor **Md. Azad Hosen**, Assistant Manager, R&D. We are very much in the debt for his love and support towards us. Thanks would not be enough to show our gratitude and love to him.

Lastly, we must accept our Parents with due respect for their constant support, patients, and belief in our caliber which drives us in the successful completion of this report.

DEDICATION

This project is devoted to our beloved parents, honorable teachers, and fellow mates who always stand by us.

ABSTRACT

Dyeing is the operation of colorings or colors on cloth accouterments similar as filaments, yarns, and fabrics with the thing of achieving color with asked colorfastness. Dyeing is typically done in a special result containing colorings and particular chemical material. Color motes are fixed to the fiber by immersion, prolixity, or relating with temperature and time being crucial controlling factors. The bond between color patch and fiber may be strong or weak, depending on the color used. This paper shows the usual two methods of dying which are exhaust dyeing and CPB dying with their process difference. It also presents the results of different tests of the dyed fabric from these two dying methods. In this thesis, we use one type of single jersey fabric of the same construction for both dying processes. The dyed fabrics have been gone through different types of tests in the physical lab like; dimensional stability test, color fastness to- washing, rubbing, light, water, perspiration, ICI pilling resistance test. This thesis analyses the end lab results and presents if there is any difference in the dyed fabric to evaluate the overall better process for this type of single jersey.

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Chapter-1

INTRODUCTION

1.1. Dyeing

One of the most essential processes in the cloth sector is dyeing. Dyeing is a process of adding color into cloth accouterments either in fiber, yarns, or fabric stage. The natural color of fibers (natural yarns and fabric) is out-white or slate. So dyeing is an important process for perfecting the aesthetic and look of the cloth accouterments.

Dyeing is a value-added process and an essential part of cloth design.

A dyeing liquor is made in a dyeing bath (pane) with dyeing chemicals and accessories. The fabric or other form of cloth accouterments are dipped into or passed through the dyeing bath. Dyeing can be performed in hot and cold liquor. Colorful types of chemicals, liquor rate, and temperature are involved in dyeing. Pigmenting manufactories and small dyeing houses follow dyeing form to get demanded colors and shades of color in the cloth material or garments. As a single jersey fabric is made of cotton, we usually use reactive dye to dye the fabric. Reactive colorings combine directly with the fiber, performing in excellent colorfastness. The first ranges of reactive colorings for cellulose filaments were introduced in the mid-1950. Moment, a wide variety is available. It can be applied to fabric in two ways. Either by exhaust or CPB method.

1.1.1. Exhaust dyeing

Exhaust dyeing is one of the most popular dyeing styles. Utmost of the colorings could be used for exhaust dyeing of cloth material. The exhaust dyeing process is used for chief fiber dyeing. Yarn and fabric could be dyed by an exhaust dyeing system. Color result or color bath is produced by dissolving the dye according to the needed liquor rate. Also, Textile material is immersed in the color result. Originally the face of the fiber is dyed when colorings communicate with the fiber, also the colorings are entered in the core of the fiber. Proper temperature and time are maintained for prolixity and penetration of colorings patch in the fiber's core. During the process, kinetic and thermodynamic responses interact.

1.1.2. CPB (Cold Pad-Batch) dyeing

CPB dyeing is an advanced quality dyeing system for woven and knitted cellulosic filaments. The process reduces the use of swab, water, energy, dye, chemical and therefore significantly reduces the chemical attention of effluent. It's dispensable to say that it facilitates bacterial treatment effectively. CPB dyeing attempts the utmost cost-effective and profitable approach of dyeing the cotton with reactive colorings. The elimination of swab addition also supports the minimal energy and water consumption; hence rendering it more eco-friendly and obsession with color is also much advanced.

1.2. Objectives of the study

The objective of this study is to analyze both processes and differentiate them in many criteria such as pre-treatment, during dyeing, after treatment, time consumption, materials, product comparison, etc.

The broad objective of the study:

Comparative Study Between Exhaust Method and Cold-Pad Batch (CPB) Method for Dyeing 100% Cotton Fabric.

To achieve the broad objective we had to go through some processes which we can consider as our specific objectives:

- Analyses both exhaust and cold-pad batch (CPB) dyeing by production follow-up.
- To know the process difference between exhaust and cold-pad batch (CPB) dyeing.
- To know about the chemicals and machinery used for the processes.
- Compare the results of different tests on dyed fabrics of two processes.

Chapter-2

LITERATURE REVIEW

2.1 Dyeing process

Dyeing and printing processes are value-added treatments for utmost cloth accouterments. A dyeing process is commerce between a color and a fiber, as well as the movement of color into the internal part of the fiber. Generally, a dyeing process involves adsorption (transfer of colorings from the waterless result onto the fiber face) and prolixity (colorings diffused into the fiber). In addition to direct immersion, dyeing may also involve the rush of colorings inside the fiber (handbasket colorings) or chemical response with the fiber (reactive colorings). For cotton part dyeing reactive dye is mostly used.

Reactive color is the color that can reply with a fiber to form a covalent link, that's forming an endless attachment in the fiber and couldn't be removed by repeated treatment with scorching water under neutral conditions. Accordingly, the colorings come corridor of the fiber, leading to outstanding colorfastness to washing. Due to the advantages of full-color ranges, brilliance, high fastness, low cost, easy operation, etc., the reactive color came the predominant color for cotton dyeing and printing in cloth assiduity since it was constructed. Compared with direct color, reactive color is applied as easily as direct color but has veritably high situations of fastness, especially for wet fastness.

2.1.1. Objectives of dyeing

The primary idea of dyeing is to apply livery color to the substrate (fiber, yarn, or fabric) with needed colorfastness. Tie-dye and printing are the styles where the color is applied in a localized manner.

The main idea of dyeing are:

- To conduct color to cloth material slightly
- To achieve respectable continuity of the color to further treatment in product and normal use.
- To reproduce the needed shade from batch to batch
- To give and use an eco-friendly process
- Fixing the color in the shortest possible time.

2.1.2. Dye Selection

There are multitudinous factors involved in the selection of colorings for coloring a fabric in a particular shade. Some of these are as follows:

- The type of fiber to be dyed.
- The form of the cloth material and the degree of status needed- position dyeing is less critical for loose fibers, which are latterly blended than it's for fabric.
- The fastness parcels needed for any posterior manufacturing processes and the particular end-use.
- The dyeing system to be used, the overall cost, and the ministry available.
- The factual color needed by the client.

For dyeing cotton or cellulose fiber-made fabric, reactive dye is the most common dye that is used in the industries.

So, for our thesis work, we also choose Reactive dye for dyeing methods.

Textile dyeing can take place at different stages of the manufacturing of the cloth. There are colorful styles of cloth dyeing which are as follows:

- Fiber Stage Dyeing Method
- Yarn Stage Dyeing Method
- Fabric Stage Dyeing Method
- Garment Stage Dyeing Method

Fabric Stage Dyeing Method

In this system, color is applied to the fabric after its construction (woven or knitted). The fabric is submerged into the color bath to get the asked color. It's the most common system of dyeing used. The colorful styles used for this type of dyeing include spurt dyeing. Jig dyeing, pad dyeing, and ray dyeing.

Most of the industries follow the fabric stage dyeing method. It can be done generally in ow methods in the industries. One of them is the exhaust method and the other one is the cold-pad batch dyeing method.

2.1.3. Factors affecting the choice of dyeing methods in textile

The following is a list of factors that mandate the choice of conditions under which particular composites might best be dyed:

- Coloristic effect needed. Check is it a union, serve, tone-in-tone or what-additional? Ask the buyers what he wants and dye the fabric or any other cloth accouterments as per buyer conditions.
- Colorfastness is needed for the attendant dyeing. It's worth mentioning that – before starting a dying process in the cloth you must have to ask your buyer that, what type of colorfastness property he/ she wants. Use grayscale to measure the colorfastness of the sample that you have dyed and let the buyers be informed about it.
- Felicity of the dyeing for posterior finishing processes. Finishing is the pivotal point to consider. Every dyeing process might have a different finishing process. Check what kind of finish you can serve.
- Comity of colorings from different operation orders with one another. Blended fiber or Mix cloth requires particular and fiber-specific colorings to be duly. It's seen that; if you use the usual dye to make an amalgamated fiber or amalgamated fabric dyed, also some corridor of that fabric has been dyed and some other corridors haven't been dyed.
- Vacuity of particular types of batch, semi-continuous and nonstop dyeing equipment. However, accouterments, colorings, and batches; how would you dye? So, If you don't have the needed instruments.
- Cost of the colorings and chemicals involved. It does completely depend on the buyers and on the services you give. If your buyers want amalgamated dyeing with good colorfastness and good condition; also you might have to rush to buy good chemicals and good colorings. And most importantly; good services mean producing good products by using good accouterments. So it varies the cost.
- Economics of the overall process. The last thing one must have to consider; is Plutocrat. How about your budget? How important plutocrat do you want to spend to color these fabrics or filaments?

2.1.4. Different Types of Dyeing Methods or Processes:

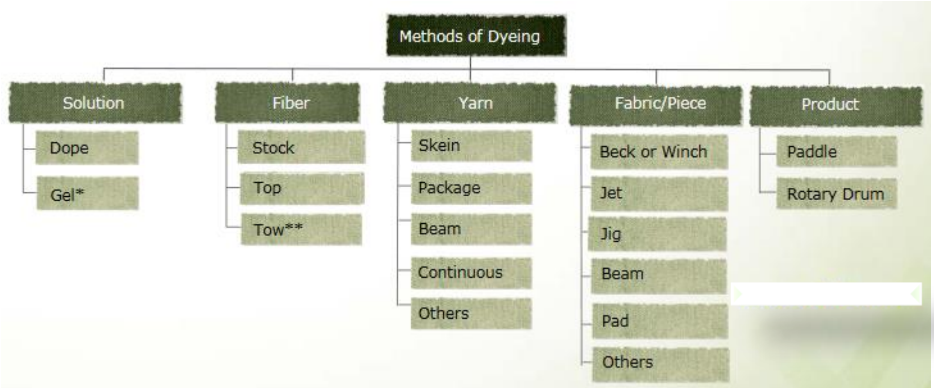


Figure 2.1.4: Different Types of Dyeing Methods.

2.1.5. Process flow chart of conventional cotton knit dyeing

The dyeing process is carried out with the help of colorings and chemicals. Different types are used for dyeing knit fabric. Cotton dyeing is the most important dyeing operation among all of the dyeing processes. From spinning to garments finished goods, a line of process is maintained.

Cotton fiber and its generated finished goods are more comfortable than other filaments products. Cotton knit fabric dyeing is carried out as the following:

Fabric entering
⬇
Fabric examination
⬇
Batching
⬇
Demineralization
⬇
Combing
⬇
Bleaching
⬇
Per-Oxide kills Wash
⬇
Neutralization
⬇
Dyeing
⬇
Neutralization after dyeing
⬇
Softening
⬇
Fixing
⬇
Dewatering/ Constricting
⬇
Drying
⬇
Steering / Condensing
⬇
Final Examination

It is the full wet processing way of knit dyeing. The pre-treatment, dyeing, after treatment, and finishing process is expressed together.

The most common two methods used in industries are Exhaust and Cold-Pad Batch methods. Now let's know about these methods.

2.2. Exhaust dyeing method

2.2.1. Introduction

Exhaust dyeing is one of the most popular dyeing styles. Utmost of the dyes could be used for exhaust dyeing of cloth material. The exhaust dyeing process is used for chief fiber dyeing. Yarn and fabric could be dyed by an exhaust dyeing system. Dye result or dye bath is produced by dissolving the dye according to the needed liquor rate. , Also Textile material is immersed in the color result. Originally the face of the fiber is dyed when dyes communicate with the fiber, also the colorings are entered in the core of the fiber. Proper temperature and time are maintained for prolixity and penetration of the colorings patch in the core of the fiber. During the process, kinetic and thermodynamic responses interact.

Figure 2.2.1: Exhaust dyeing.

2.2.2. Flow chart of Exhaust Dyeing

Pretreatment

Batch loaded

⬇

Demineralization (50˚C, 20 min; pH=4.5)

⬇

Scouring & bleaching (100˚C×40 min.)

⬇

Drain

⬇

Rinse

⬇

Drain

⬇

Neutralization with acid (50°C ×20 min)

⬇

Hot Wash with peroxide killer (60˚C, 20 min.)

⬇

Drain

⬇

Dyeing

Leveling agent & Salt (60° × 20 min; PH=6)

⬇

Color dosing (60°C×20 min.)

⬇

Run time = 10 min. (60°C)

⬇

Color migration (80°C × 20 min.)

⬇

Cooling (60°C)

⬇

Level Check

⬇

Soda dosing (60°C×30 min.)

⬇

Dyeing run (Dark shade:60°C×60 min; Medium shade: 60°C×40 min; Light shade: 60°C×30 min)

⬇

Dyeing sample check

⬇

(If Ok)

Drain

⬇

After-treatment

Rinse (with cold Water)

⬇

Neutralization after dyeing (50°C×20 min.)

⬇

Drain

⬇

Soaping (Hot wash)

⬇

Drain

⬇

Rinse

⬇

Add finishing chemical (60°C×20 min)

⬇

Drain

⬇

Unload

2.2.3. A basic process curve of Exhaust dyeing

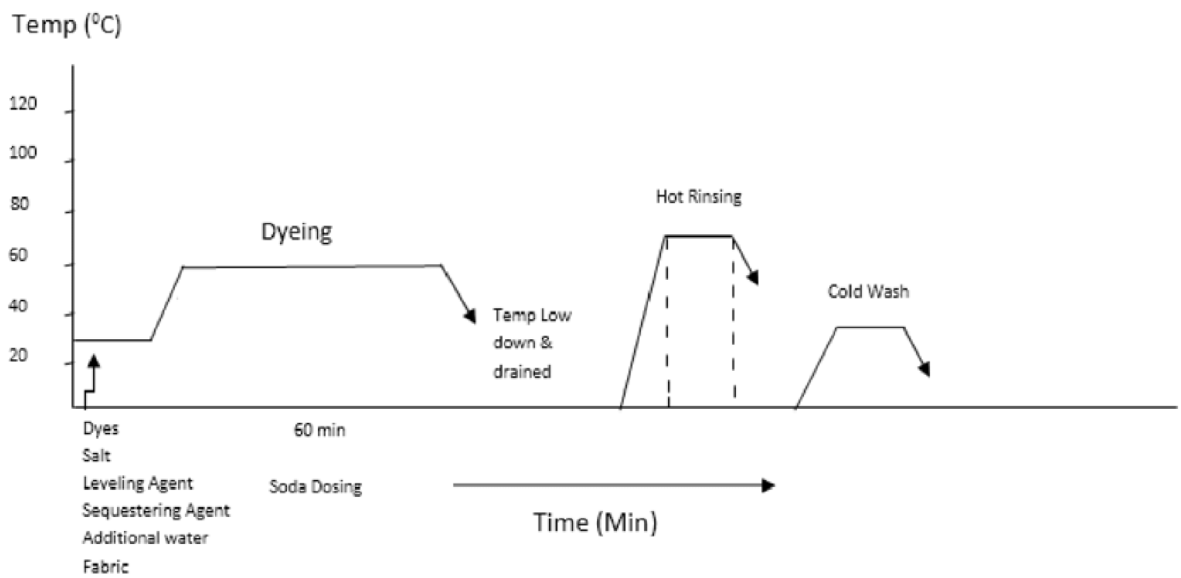


Figure 2.2.3: A basic process curve of Exhaust dyeing.

2.2.4. Advantages of exhaust dyeing

- Simple construction & thus provident to buy and operate.
- Suitable for all types of fabric especially lightweights.
- It imposes much lower pressure than Jigger so it's suitable for delicate fabrics.
- Combing effectiveness is high due to lesser mechanical action caused by the constant reformation of lengthways crowds.
- Tubular knitted fabrics are trolled & dyed expansive because of the low pressure.
- Creases are developed due to lesser mechanical action & low pressure.
- The dyed fabric is thicker with a fuller handle, more fabric cover & better crinkle recovery.

2.2.5. Disadvantages of exhaust dyeing

- The temperature varies in the different corridors. The heating unit is present only in one cube so when the fabric leaves that cube it cools & also enters. So, temperature-sensitive colorings it's a major debit.
- Inordinate movement may lead to undesirable felting in Hair fabrics.
- The fabric is desultorily piled & uneven dyeing may do unless suitable colorings & leveling agents are used.
- Due to the high liquor rate, color prostration is poor & a considerable quantum of color remains in the bath which hampers the frugality.
- Confirmation of running crimps during dyeing may not be removable indeed after stentering.
- Extension & distortion may do due to longitudinal pressure.
- Longer rope may beget trap at the bottom.

2.3. Cold pad batch dyeing (CPB

2.3.1. Introduction

Cold pad batch dyeing (CPB) is an indispensable system of reactive dyeing that uses smaller coffers. With CPB there's no need to apply heat during the process, and no swab or humectants are demanded, it's good practice to carry out color obsession in a heat-regulated room. The costs and the quality of a product define its success. The dyeing and posterior washing of knitwear in open range form is a complex process and is particularly applicable to these two parameters. Dyeing using the deep freeze pad batch (CPB) system is an established and dependable process for cotton fabric for carrying veritably good dyeing results with minimal use of coffers. The Schematic donation of Cold pad batch (CPB) dyeing of cotton knitted fabric is shown below:

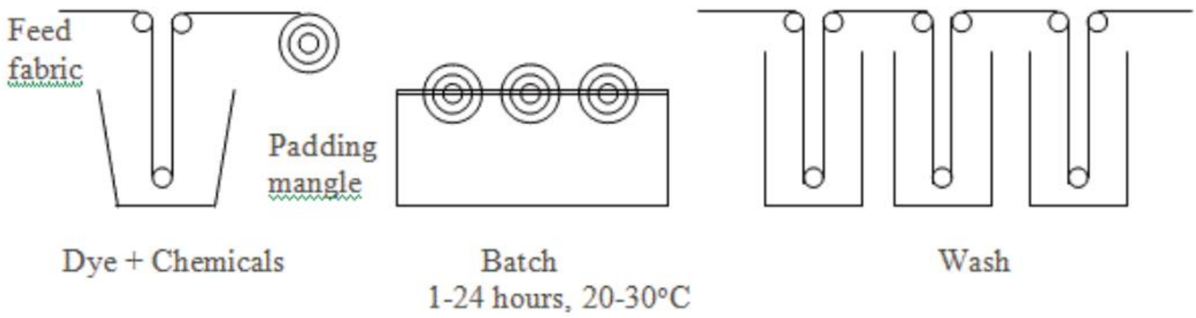


Figure 2.3.1.1: Schematic donation of Cold pad batch dyeing (CPB).

Figure 2.3.1.2: Cold Pad Batch Dyeing.

2.3.2. Flow chart of Cold Pad Batch Dyeing:

Batch Preparation
⬇
Slitting
⬇
Singeing
⬇
Scouring-Bleaching
⬇
Stenter Dry
⬇
Dye padding (CPB)
⬇
Rotating (8-24) hour
⬇
Washing
⬇
Compacting
⬇
Inspection
⬇
Delivery

The steps are:

1. The fabric is first padded in a padding murder with reactive color in presence of an alkali.
2. The padded fabric is rolled in a batch and the batches are wrapped by polyethylene wastes and stored in wet condition for 16-24 hours at 20-30 ^{o}c in a room.
3. During the storehouse period, the rolls may be kept sluggishly rotated to help seepage of the color liquor.
4. After storing time is finished fabric is washed in open- range washing machine to remove the unfixed color from the fabric face.

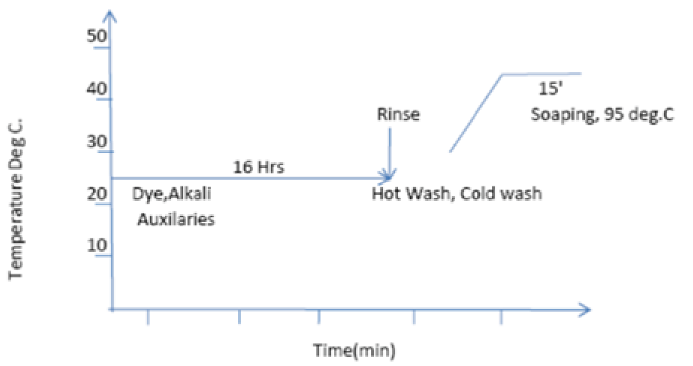


Figure 2.3.2: Process curve of cold pad batch dyeing.

2.3.3. CPB dyeing chemical ratio:

- Fabric: Dye = 1: 1 (Generally we take 40/50 liter extra).
  If the total dye liquor is 05.
- Then dyes will be 04 portions and chemical will be 01.
- Total Dye (05) = Dye (04) + Chemical (01).

2.2.4. Cold pad batch (CPB) dyeing process:

The ensuing process is followed-

- Colorings and auxiliaries grounded on the base form are ladened using a balance or with an electronic pipette.
- Weighted colorings are mixed with 500 ml of water and stirred for 2 min.
- According to the quality of the fabric padder Mathis is acclimated (generally 60 pick up). Then the sample, the fabric is set in the machine, and dyed liquor is poured in for padding.
- The coming step is to fix the color. The padded sample is put in a polythene bag for 5 min. Then a sample piece of that fabric is cut from the sample for rapid-fire obsession test by fryer oven. The sample is hung on a glass rod over the vassal containing about 50 ml of water and covering the sample and the vassal with a lid. At the power of 2 settings. The sample is fumed for 6 min.
- For the color obsession, there are two styles. In one system the padded fabric is wrapped for 8-24 hours with a polythene bag. In the other system which is the rapid-fire process, fryer woven is used. Then the dyeing piece should be kept in the fryer woven (power of 2) in plastic vassals with 50 ml of water for 6 min.
- Next the sample is washed grounded on the washing condition.
- Then the sample is dried using an iron.
- It's then set in the lightbox and audited for color matching.
- If the color match with the client sample then the trial ends and the sample is developed; if not also the form is acclimated and the trial continues following the same process until a sample match happens.

2.2.5. The impregnation processes

During impregnation the following parameters are important:

- Temperature and rate of rotation of the color liquor
- Squeeze line in the padder
- Absorbency of the fabric
- Fabric pressure

Still, there's nothing different in the way of a reproducible, controllable, If these introductory conditions are controlled rightly.

2.2.6. Machine Factors

An ultramodern CPB dyeing machine for knitwear should meet the following criteria:

- Centre unwinder (if fabric from batch)
- Member control comber for polarizing and feeding of knitwear
- Selvage uncurled in front of through and squeezing nip
- As numerous drives as possible
- Good availability and view

2.3.7. Advantages of Cold Pad Batch Dyeing

- Reduced water consumption (more so if counter-flow washing ranges are used).
- Less affluent with veritably low Swab content-suitable for recovering with a single-stage RO with further than 85 permeability.
- Reduced energy consumption, as it's done at room temperature.
- Advanced chance of color obsession.
- Excellent wet fastness parcels.
- No swab used – performing in easy color wash off and no swab being present in the effluent.
- Pre-dye checks can be carried out icing further fabric is dyed rightly.
- Productivity – one CPD machine can dye further fabric than a spurt machine.
- More suited to stretch fabrics and knits because it's easier to manage pressure control in a small machine.
- Fabrics are smoother so no need to bio polish.
- Fabrics are stronger than bio-polished fellows.

2.3.8. Limitations of CPB

- Compared to other reactive dyeing styles, similar to spurt dyeing, the disadvantages of CPB include:
- The dyed fabric product rate is low – requires at least 12hours of batching time for color obsession.
- Delicate to make emendations to out- shade batches so the pressure to get effects right first time.
- The process is not feasible unless high-quality ministry is used.
- Requires off-line bleaching and wash off which makes planning more complex.
- Requires an intermediate drying process after dulling.
- Requires fabrics to have fully invariant humidity and temperature throughout to achieve optimum results.
- Immaculately requires a bite for colorings and thermo- regulated room for color obsession.

2.4. Selection of fabric

For our thesis work, we choose single jersey knit fabric for conventional (exhaust) and CPB dyeing. We decided to go with the most common and available fabric of any industry. The construction and specification of the fabric are given below:

Single jersey:

Jersey fabric is a veritably common type of knit cloth that is made from cotton or cotton and synthetic mix. The common use of single jerseys is t-shirts and downtime coverlets. Single jersey is feeling warm, flexible, rubbery, and veritably separating, making it a popular choice for the layer worn closest to the body. Jersey fabric is also veritably soft and comfortable.

Single jersey characteristics:

- The fabric face and reverse are unique.
- The twist or move of texture happens at the edges.
- Texture caricatures are demonstrated in all felicitations unmistakably in the texture.
- Texture unwinding happens from either side is conceivable.
- Consistence of texture is around double the breadth of yarn employed.
- There's just a single arrangement of darned circles per course in the texture.

Single jersey features are:

- Feeling comfortable.
- Magnificent development, shape conservation, inconceivable serape capacity.
- Stupendous wrinkle rehabilitation.
- Shape conservation in knitwear is remarkable.
- Employed for both normally manufactured cowhide.
- Shoe uppers, Lycra gives 4-5 extend in shoes to give topmost solace to the wearer.
- Quality affecting high return in sewing Recuperation in the papers of apparel 100 Better protection from synthetic creations

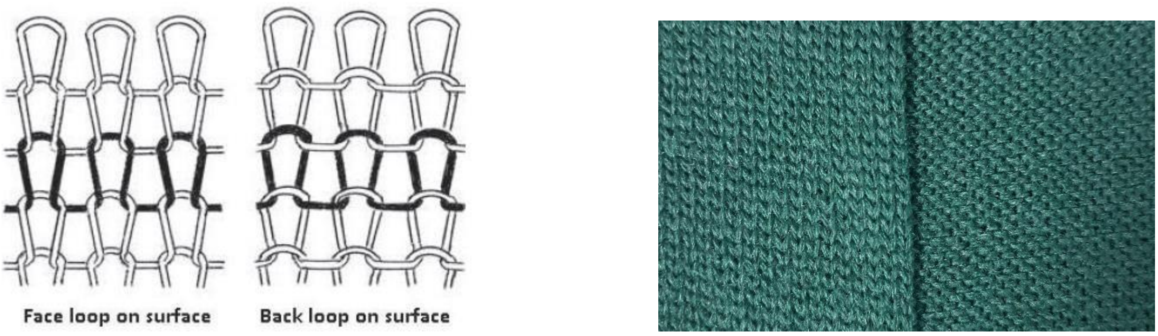


Figure 2.4: The structure of a single jersey.

2.5. Fabric parameters:

Knitting: It's a procedure of texture made by changing over yarn into circle structure and after that, these circles interlock/ intermesh/ interloped together which structure a structure is called weaving or sewed structure.

2.5.1. Weft knit stitches

It's the most well-known feathers utilized by the maker in producing material weaved particulars, for illustration, Shirts, and Socks. As far as shading designing, weft weave might be sewn with colorful yarns to produce a fascinating illustration plan. There aren't numerous feathers systems to deliver weft sew structure, Single pullover, Purl, and Rib are a portion of the procedure that has been utilized to produce weft sewed structure.

2.5.2. Course knit stitches

Twist sewed is created from a lot of twist yarn. It’s resembling weaved to one another down the length of the texture. Since weaved texture may have numerous grains, twist sewed is naturally done by machine.

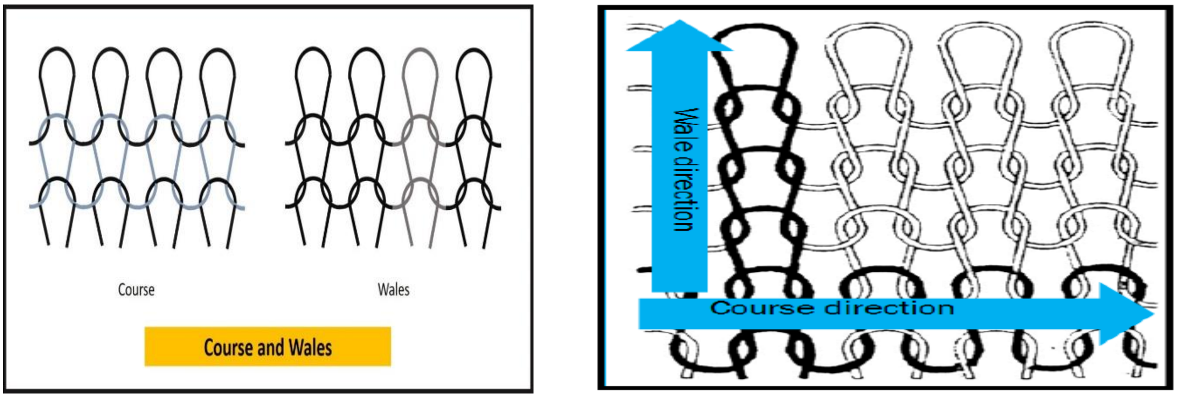


Figure 2.5. (1+2): Courses and wales.

2.5.3. Course per inch (CPI)

During the same knitting cycle and are measured in units of courses per inch. The courses determine the length of the fabric.

2.5.4. Wales per inch (WPI)

A monster is a perpendicular column of circles in the fabric which is produced by the same needle stitching at consecutive knitting cycles. The number of wales indicates the range of the fabric and they're measured in the unit of wales per inch.

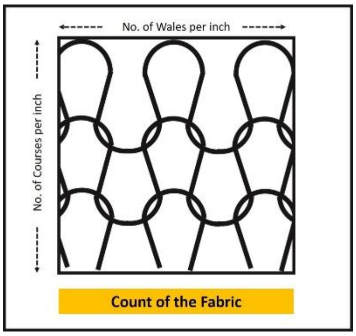


Figure 2.5. (3+4): Courses per inch and wales per inch.

2.5.5. Sewing or Stitch Length

A caricature is a perpendicular member of circles in the texture which is delivered by analogous needle sewing at progressive sewing cycles. The amounts of crests demonstrate the range of the texture and they're estimated in a unit of caricatures per inch.

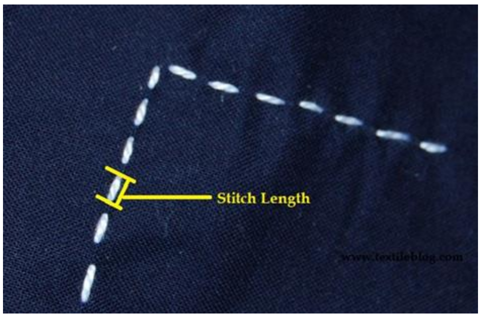


Figure 2.5.5: Stitch length.

2.5.6. GSM

GSM implies grams per forecourt cadence of any suture woven or non-woven fabric. It's critical to know the heaviness of any fabric before assembling and in the wake of getting the completed texture. It's introductory to quantify the heaviness of the texture to make sure about the completed cargo of the texture. This test can be done in colorful ways yet it's anything but delicate to know the heaviness of the texture by cutting the texture with a GSM shaper.

2.5.7. Yarn count

Yarn count is numerical regard that conveyed its fineness or tastelessness. It likewise communicates if the yarn is thick or slim. Yam includes can be estimated in multitudinous frame still more frequently than not use two frames. They're circular frames and direct frames. Estimating yarn check of any texture is significant as GSM texture plan, texture type relies upon yarn census.

Chapter-3

EXPERIMENTAL DETAILS

3.1 Materials at a glance

This section will be mainly explained by focusing on two main factors. The first one is the material used and the other one is the process details of the method.

Experimental grey fabric specification:

Fabric type	Fabric composition	Grey fabric Stitch length (mm)		Grey fabric GSM (gm)	Grey fabric Diameter		Yarn count (Ne)	
		Exh.	CPB		Exh.	CPB	Exh	CPB
Single jersey	100% Cotton	2.80	2.65	160	70	76	28's	28's

Table 3: Experimental grey fabric specification.

Experimental methods of dyeing:

- Exhaust dyeing
- Cold-Pad Batch (CPB) dyeing

Experimental tests the finished fabric has been gone through:

- Dimensional stability to washing
- Colorfastness to washing
- Colorfastness to Rubbing
- Colorfastness to Light
- Colorfastness to Water
- Colorfastness to Perspiration (Acid)
- Colorfastness to Perspiration (Alkali)
- ICI Pilling resistance

Test results by:

Physical Lab
Impress-Newtex Composite Textiles Ltd.
(3rd party lab quality with certification by BAB).

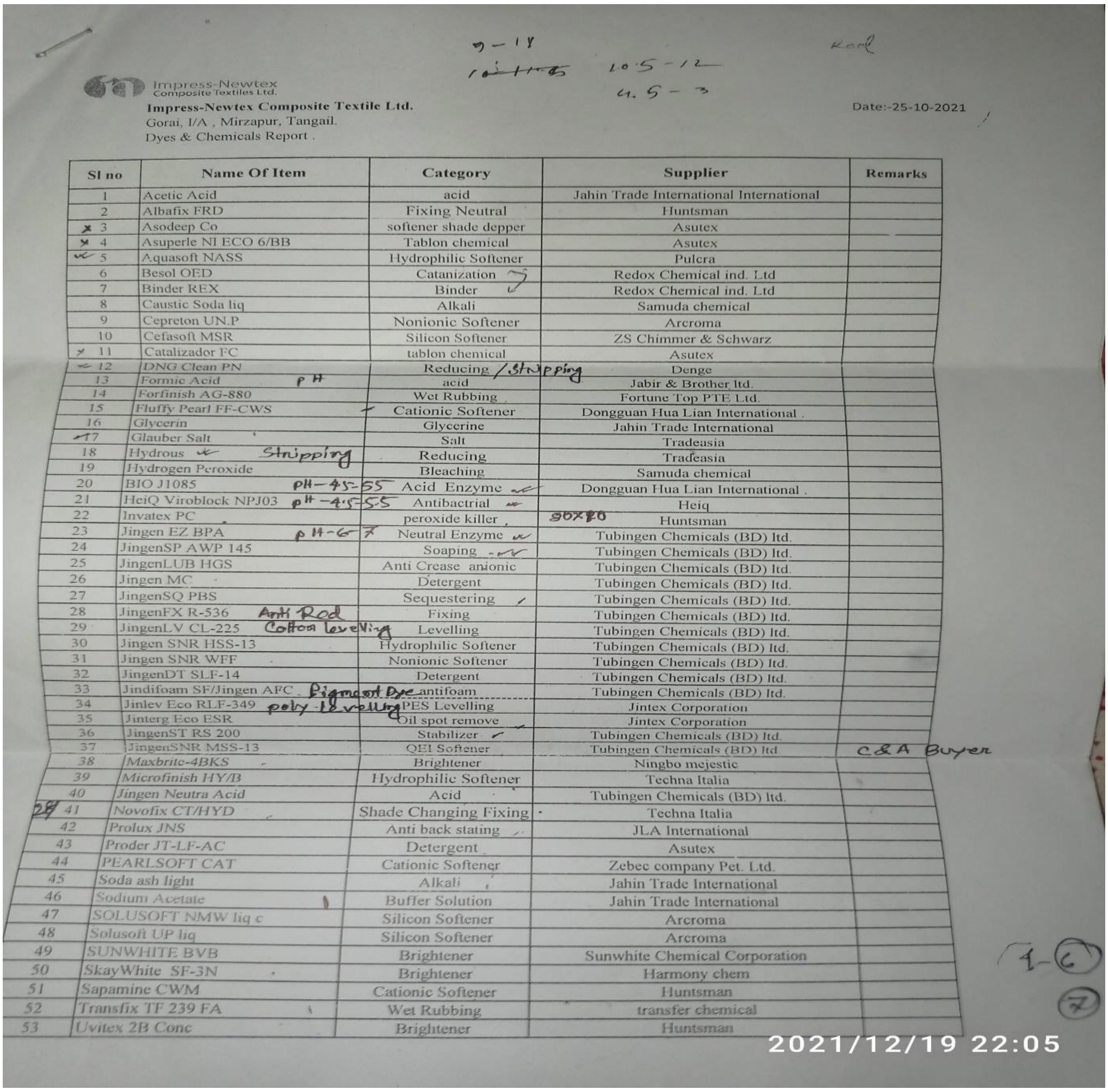
We will present this whole thesis work through this chapter which will be divided into two main parts. One is the materials and the other one is a method. Every action or process detail with its component will be discussed through these two sub-chapters.

Here, all the materials and machines will be mentioned according to their working stages and functions for both the exhaust and cold-pad batch (CPB) dyeing process.

It will focus on:

1. Machine used in the process.
2. Dyes and chemicals used.
3. Functions of the dyes and chemicals in different stages.

List of Raw materials (dyes & chemicals) used for dyeing:



Impress-Newtex Composite Textiles Ltd.
Impress-Newtex Composite Textile Ltd.
Gorai, I/A , Mirzapur, Tangail.
Dyes & Chemicals Report .

Date:-25-10-2021

Sl no	Name Of Item	Category	Supplier	Remarks
1	Acetic Acid	acid	Jahin Trade International International	
2	Albafix FRD	Fixing Neutral	Huntsman	
3	Asodeep Co	softener shade depper	Asutex	
4	Asuperle NI ECO 6/BB	Tablon chemical	Asutex	
5	Aquasoft NASS	Hydrophilic Softener	Pulcra	
6	Besol OED	Catanization	Redox Chemical ind. Ltd	
7	Binder REX	Binder	Redox Chemical ind. Ltd	
8	Caustic Soda liq	Alkali	Samuda chemical	
9	Cepreton UN.P	Nonionic Softener	Arcroma	
10	Cefasoft MSR	Silicon Softener	ZS Chimmer & Schwarz	
11	Catalizador FC	tablon chemical	Asutex	
12	DNG Clean PN	Reducing	Denge	
13	Formic Acid	acid	Jabir & Brother ltd.	
14	Forfinish AG-880	Wet Rubbing	Fortune Top PTE Ltd.	
15	Fluffy Pearl FF-CWS	Cationic Softener	Dongguan Hua Lian International .	
16	Glycerin	Glycerine	Jahin Trade International	
17	Glauber Salt	Salt	Tradeasia	
18	Hydrous	Reducing	Tradeasia	
19	Hydrogen Peroxide	Bleaching	Samuda chemical	
20	BIO J1085	Acid Enzyme	Dongguan Hua Lian International .	
21	HeiQ Viroblock NPJ03	Antibactrial	Heiq	
22	Invatex PC	peroxide killer	Huntsman	
23	Jingen EZ BPA	Neutral Enzyme	Tubingen Chemicals (BD) ltd.	
24	JingenSP AWP 145	Soaping	Tubingen Chemicals (BD) ltd.	
25	JingenLUB HGS	Anti Crease anionic	Tubingen Chemicals (BD) ltd.	
26	Jingen MC	Detergent	Tubingen Chemicals (BD) ltd.	
27	JingenSQ PBS	Sequestering	Tubingen Chemicals (BD) ltd.	
28	JingenFX R-536	Fixing	Tubingen Chemicals (BD) ltd.	
29	JingenLV CL-225	Levelling	Tubingen Chemicals (BD) ltd.	
30	Jingen SNR HSS-13	Hydrophilic Softener	Tubingen Chemicals (BD) ltd.	
31	Jingen SNR WFF	Nonionic Softener	Tubingen Chemicals (BD) ltd.	
32	JingenDT SLF-14	Detergent	Tubingen Chemicals (BD) ltd.	
33	Jindifoam SF/Jingen AFC	antifoam	Tubingen Chemicals (BD) ltd.	
34	Jinlev Eco RLF-349	PES Levelling	Jintex Corporation	
35	Jinterg Eco ESR	Oil spot remove	Jintex Corporation	
36	JingenST RS 200	Stabilizer	Tubingen Chemicals (BD) ltd.	
37	JingenSNR MSS-13	QEI Softener	Tubingen Chemicals (BD) ltd	C&A Buyer
38	Maxbrite-4BKS	Brightener	Ningbo mejestic	
39	Microfinish HY/B	Hydrophilic Softener	Techna Italia	
40	Jingen Neutra Acid	Acid	Tubingen Chemicals (BD) ltd.	
41	Novofix CT/HYD	Shade Changing Fixing	Techna Italia	
42	Prolux JNS	Anti back stating	JLA International	
43	Proder JT-LF-AC	Detergent	Asutex	
44	PEARLSOFT CAT	Cationic Softener	Zebec company Pet. Ltd.	
45	Soda ash light	Alkali	Jahin Trade International	
46	Sodium Acetate	Buffer Solution	Jahin Trade International	
47	SOLUSOFT NMW liq c	Silicon Softener	Arcroma	
48	Solusoft UP liq	Silicon Softener	Arcroma	
49	SUNWHITE BVB	Brightener	Sunwhite Chemical Corporation	
50	SkayWhite SF-3N	Brightener	Harmony chem	
51	Sapamine CWM	Cationic Softener	Huntsman	
52	Transfix TF 239 FA	Wet Rubbing	transfer chemical	
53	Uvitex 2B Conc	Brightener	Huntsman	

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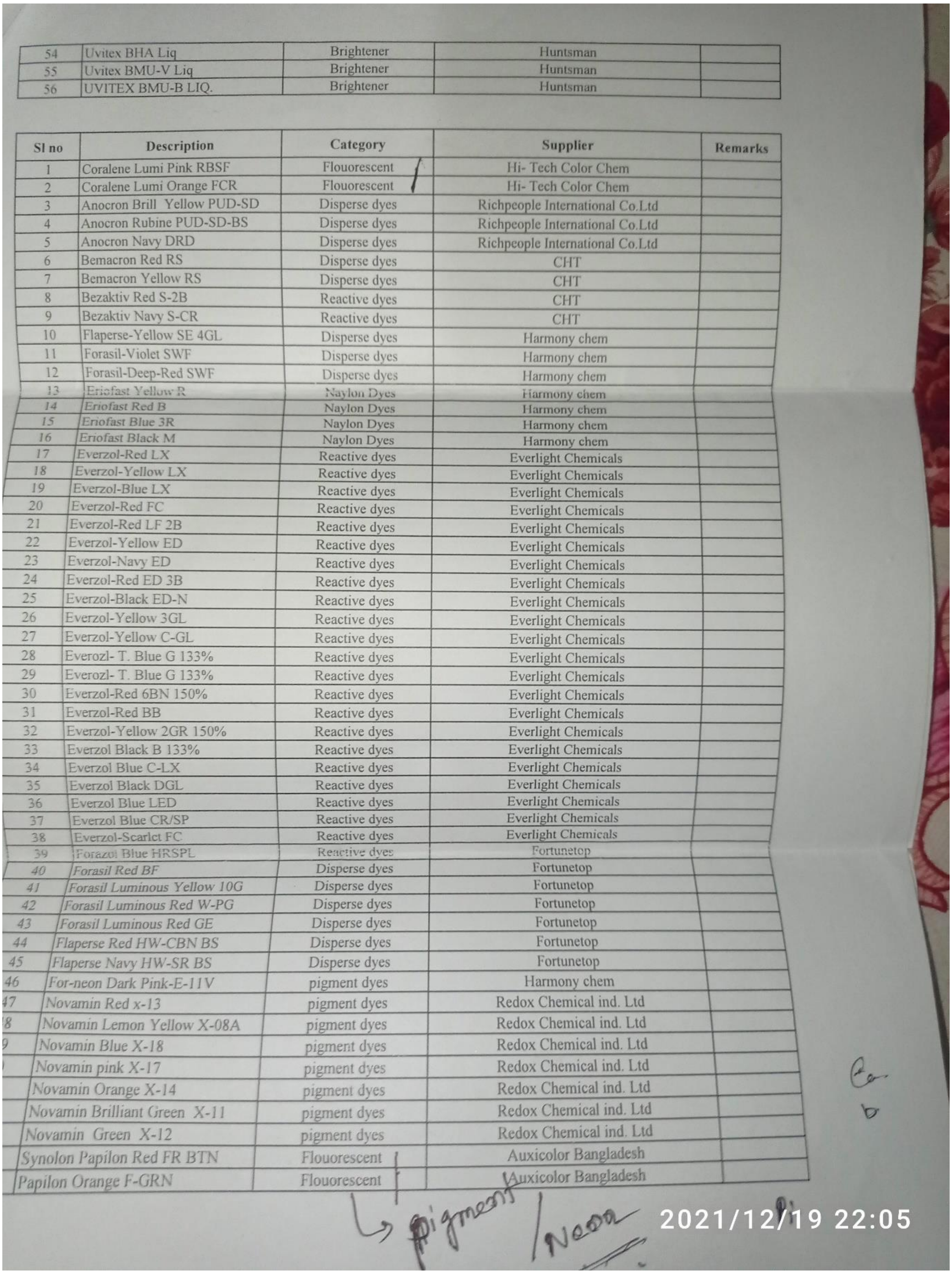
Figure 3.1: Raw materials used for dyeing.



54	Uvitex BHA Liq	Brightener	Huntsman	
55	Uvitex BMU-V Liq	Brightener	Huntsman	
56	UVITEX BMU-B LIQ.	Brightener	Huntsman	

Sl no	Description	Category	Supplier	Remarks
1	Coralene Lumi Pink RBSF	Flouorescent	Hi- Tech Color Chem	
2	Coralene Lumi Orange FCR	Flouorescent	Hi- Tech Color Chem	
3	Anocron Brill Yellow PUD-SD	Disperse dyes	Richpeople International Co.Ltd	
4	Anocron Rubine PUD-SD-BS	Disperse dyes	Richpeople International Co.Ltd	
5	Anocron Navy DRD	Disperse dyes	Richpeople International Co.Ltd	
6	Bemacron Red RS	Disperse dyes	CHT	
7	Bemacron Yellow RS	Disperse dyes	CHT	
8	Bezaktiv Red S-2B	Reactive dyes	CHT	
9	Bezaktiv Navy S-CR	Reactive dyes	CHT	
10	Flaperse-Yellow SE 4GL	Disperse dyes	Harmony chem	
11	Forasil-Violet SWF	Disperse dyes	Harmony chem	
12	Forasil-Deep-Red SWF	Disperse dyes	Harmony chem	
13	Eriofast Yellow R	Naylon Dyes	Harmony chem	
14	Eriofast Red B	Naylon Dyes	Harmony chem	
15	Eriofast Blue 3R	Naylon Dyes	Harmony chem	
16	Eriofast Black M	Naylon Dyes	Harmony chem	
17	Everzol-Red LX	Reactive dyes	Everlight Chemicals	
18	Everzol-Yellow LX	Reactive dyes	Everlight Chemicals	
19	Everzol-Blue LX	Reactive dyes	Everlight Chemicals	
20	Everzol-Red FC	Reactive dyes	Everlight Chemicals	
21	Everzol-Red LF 2B	Reactive dyes	Everlight Chemicals	
22	Everzol-Yellow ED	Reactive dyes	Everlight Chemicals	
23	Everzol-Navy ED	Reactive dyes	Everlight Chemicals	
24	Everzol-Red ED 3B	Reactive dyes	Everlight Chemicals	
25	Everzol-Black ED-N	Reactive dyes	Everlight Chemicals	
26	Everzol-Yellow 3GL	Reactive dyes	Everlight Chemicals	
27	Everzol-Yellow C-GL	Reactive dyes	Everlight Chemicals	
28	Everozl- T. Blue G 133%	Reactive dyes	Everlight Chemicals	
29	Everozl- T. Blue G 133%	Reactive dyes	Everlight Chemicals	
30	Everzol-Red 6BN 150%	Reactive dyes	Everlight Chemicals	
31	Everzol-Red BB	Reactive dyes	Everlight Chemicals	
32	Everzol-Yellow 2GR 150%	Reactive dyes	Everlight Chemicals	
33	Everzol Black B 133%	Reactive dyes	Everlight Chemicals	
34	Everzol Blue C-LX	Reactive dyes	Everlight Chemicals	
35	Everzol Black DGL	Reactive dyes	Everlight Chemicals	
36	Everzol Blue LED	Reactive dyes	Everlight Chemicals	
37	Everzol Blue CR/SP	Reactive dyes	Everlight Chemicals	
38	Everzol-Scarlet FC	Reactive dyes	Everlight Chemicals	
39	Forazol Blue HRSPL	Reactive dyes	Fortunetop	
40	Forasil Red BF	Disperse dyes	Fortunetop	
41	Forasil Luminous Yellow 10G	Disperse dyes	Fortunetop	
42	Forasil Luminous Red W-PG	Disperse dyes	Fortunetop	
43	Forasil Luminous Red GE	Disperse dyes	Fortunetop	
44	Flaperse Red HW-CBN BS	Disperse dyes	Fortunetop	
45	Flaperse Navy HW-SR BS	Disperse dyes	Fortunetop	
46	For-neon Dark Pink-E-11V	pigment dyes	Harmony chem	
47	Novamin Red x-13	pigment dyes	Redox Chemical ind. Ltd	
8	Novamin Lemon Yellow X-08A	pigment dyes	Redox Chemical ind. Ltd	
9	Novamin Blue X-18	pigment dyes	Redox Chemical ind. Ltd	
	Novamin pink X-17	pigment dyes	Redox Chemical ind. Ltd	
	Novamin Orange X-14	pigment dyes	Redox Chemical ind. Ltd	
	Novamin Brilliant Green X-11	pigment dyes	Redox Chemical ind. Ltd	
	Novamin Green X-12	pigment dyes	Redox Chemical ind. Ltd	
	Synolon Papilon Red FR BTN	Flouorescent	Auxicolor Bangladesh	
	Papilon Orange F-GRN	Flouorescent	Auxicolor Bangladesh	

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Figure 3.1: Raw materials used for dyeing.

56	Avitera Red SE	Reactive dyes	Huntsman	
57	Avitera Gold SE	Reactive dyes	Huntsman	
58	Novacron Navy S-G	Reactive dyes	Huntsman	
59	Novacron Navy S-G	Reactive dyes	Huntsman	
60	Novacron Navy EC-BN	Reactive dyes	Huntsman	
61	Imcozin Turquise KX- G	Reactive dyes	Tootal quality resources	
62	Livafix Brill Yellow CA	Reactive dyes	Dystar	
63	Reactobond Brill Blue BB	Reactive dyes	MEGHMANI DYES AND IND. LLP	
64	Reactobond Deep Red LW	Reactive dyes	MEGHMANI DYES AND IND. LLP	
65	Reactobond Deep Yellow LW	Reactive dyes	MEGHMANI DYES AND IND. LLP	
66	Reactobond Orange 2RX	Reactive dyes	MEGHMANI DYES AND IND. LLP	
67	Reactobond Black KGD	Reactive dyes	MEGHMANI DYES AND IND. LLP	
68	Reactobond Orange MD	Reactive dyes	MEGHMANI DYES AND IND. LLP	
69	Reactobond Red-MD	Reactive dyes	MEGHMANI DYES AND IND. LLP	
70	Reactobond Yellow-MD	Reactive dyes	MEGHMANI DYES AND IND. LLP	
71	Reactobond Blue MD	Reactive dyes	MEGHMANI DYES AND IND. LLP	
72	Reactobond Red-2GX	Reactive dyes	MEGHMANI DYES AND IND. LLP	
73	Remazol Red RR	Reactive dyes	Dystar	
74	Remazol Green 6BT	Reactive dyes	Dystar	
75	Rifalon Red ACE	Disperse dyes	Fabpro specilites	
76	Rifalon Yellow ACE	Disperse dyes	Fabpro specilites	
77	Rifalon Blue ACE	Disperse dyes	Fabpro specilites	
78	Secilene Brilliant Blue 2GN	Disperse dyes	Fortunetop	
79	Secilene Deep Black HXF	Disperse dyes	Fortunetop	
80	Secilene Navy HSF-N	Disperse dyes	Fortunetop	
81	Secilene Red HSF-N	Disperse dyes	Fortunetop	
82	Secilene G.Yellow SWF-N	Disperse dyes	Fortunetop	
83	Suncron Red RD-E BS	Reactive dyes	Nafiza Enteprise	
84	Suncron Yellow RD-E BS	Reactive dyes	Nafiza Enteprise	
85	Suncron Blue RD-E BS	Reactive dyes	Nafiza Enteprise	
86	Starfix Orange ED	Disperse dyes	Fabpro specilites	
87	Suncron-Black SFWN	Disperse dyes	OHYOUNG Inc.	
88	Suncron-Red SFW	Disperse dyes	OHYOUNG Inc.	
89	Suncron Red-S-BFW	Disperse dyes	OHYOUNG Inc.	
90	Suncron Yellow SFW	Disperse dyes	OHYOUNG Inc.	
91	Suncron G.Yellow S-3FW	Disperse dyes	OHYOUNG Inc.	
92	Suncron-N-Blue-SE-SFO 300%	Disperse dyes	OHYOUNG Inc.	
93	Suncron-N-Blue-SF-WN	Disperse dyes	OHYOUNG Inc.	
94	Suncron Blue E-FBL	Disperse dyes	OHYOUNG Inc.	
95	Suncron-Blue-T-FW	Disperse dyes	OHYOUNG Inc.	
96	Suncron-T-Blue-SF-W ECO	Disperse dyes	OHYOUNG Inc.	
97	Suncron Brill Violet R	Disperse dyes	OHYOUNG Inc.	
98	Sunfix Blue SPR 150%	Disperse dyes	OHYOUNG Inc.	
99	Sunfix Blue SS R	Disperse dyes	OHYOUNG Inc.	
100	Sunfix Red SPR	Disperse dyes	OHYOUNG Inc.	
101	Sunfix Dk Blue SS	Disperse dyes	OHYOUNG Inc.	
102	Sunzol Blue RS 150%	Disperse dyes	OHYOUNG Inc.	
103	Sunzol Blue GRB	Disperse dyes	OHYOUNG Inc.	

Figure 3.1: Raw materials used for dyeing.

3.1.2 Materials for Exhaust dyeing Method

3.1.2.1. Experimental grey fabric sample

Figure 3.1.2.1: Experimental grey fabric sample.

3.1.2.2. Chemicals used in Exhaust dyeing

Chemicals used in different stages of exhaust dyeing: (Recipe)

Production 171852 / 148340

Customer ID	Quality Number	Recipe Number	Process	Fabric Width	Fabric Weight
Hurley	26	9558	REACTIVE MD LYCRA	157 cm	1494 kg
Batch Number	**Machine**		**Yarn Lot**	**Quality**	
148340	24 ATHENA 3A/D 1800H			S/J GSM 160	
Order Number	**Double Rope**	**Aquachron Type**	**GSM / GLM**	**Color**	
128-0002	NO		160 / 251	OBSIDIAN	

FORM NO.: INCTL-F-DYE-01 REVISION NO.: 00 REVISION NO. DATE: 08-01-2012

59 **AD.PRETREATMENT (AB. MID)** Che. Lot		DLR: 5.0	Liquor: 7470.0 l		Addition
Preparation 1					
Proder JTLF AC(127226)	Detergent	0.6000 g/l	4.482	kg	Scouring-Bleaching
Jingen SQ PBS (PJT0058014020S)	Sequestering agent	0.5000 g/l	3.735	kg	
Jingen LUB HGS (PJT059022020F)	Anti-Crease Anionic	1.000 g/l	7.470	kg	
Caustic Soda (21-007367)	Alkali	1.800 g/l	13.446	kg	
JingenSTRS 200 (PJT022020T)	Stabilizer	0.2700 g/l	2.017	kg	
Hyd. Peroxide(50%)(106000394))	Bleach agent	1.800 g/l	13.446	kg	
Preparation 2					
Jin.Neutra Acid (NR21401001S)	Acid	1.200 g/l	8.964	kg	
INVATEX PC(900	H_2O_2 Killer	0.2400 g/l	1.793	kg	
Preparation 3					
BIO J1085(62106241)	Acid Enzyme	0.5000 %	7.470	kg	Bio-Polishing
JINGEN EZ BPA (DUP090A07021S)	Neutral Enzyme	0.5000 %	7.470	kg	
61 **REACTIVE (M-D)** Che. Lot		DLR: 5.0	Liquor: 7470.0 l		Addition
Preparation 7					
JingenLV CL-225(PJT03B011020S)	Levelling agent	1.000 g/l	7.470	kg	Dyeing
Jingen LUB HGS (PJT059022020F)	Anti-Crease anionic	0.5000 g/l	3.735	kg	
Preparation 8 Dyestuff					
REA					
Everzol Yellow 2GR(B6201515)	Reactive Dyes	0.8800 %	13147.2	g	
Everzol Red 6BN (B6401508)		1.160 %	17330.4	g	
Everzol Navy-ED (B2621532)		1.800 %	26892.0	g	
Preparation 9					
Glauber Salt(1020003)	Salt	55.000 g/l	410.850	kg	
Soda ash light (006)	Alkali	7.000 g/l	52.290	kg	
60 **AD.Wash off (m-d)** Che. Lot		DLR: 5.0	Liquor: 7470.0 l		Addition
Preparation 10					
Jin.Neutra Acid (NR21401001S)	Acid	1.000 g/l	7.470	kg	After-Treatment
Jingen SP AWP 145 (KBA0233001)	Soaping	0.8000 g/l	5.976	kg	
Preparation 11					
Jin.Neutra Acid (NR21401001S)	Acid	0.1000 g/l	0.7470	kg	
Pearl Soft Cat(PC/012021)	Cationic Softener	0.2500 g/l	1.867	kg	
Cost Che. Lot		DLR: 5.0	Liquor: 7470.0 l		Addition
Total Recipe Cost/Kg (BDT)		28.6833685	28.683	1	

02.11.21

Prepared By:	Issued By (Store):	Checked By (Dyeing):	02-Nov-21 3:25:05 PM

Figure 3.1.2.2: Recipe of Exhaust dyeing with chemical & dye quantity.

3.1.2.3. Functions of chemicals in different stages of exhaust dyeing

Stage	Chemical	Functions
Scouring & Bleaching	Detergent	Emulsify oils, fat and waxes, expel oil borne - stains, suspend materials after they have been expelled
	Sequestering agent	Evacuates hardness of water, Neutralize calcium and magnesium particles and some substantial metal particles in water
	Anti-crease agent	Reduces the disunion between fibers and fibers-dyeing tank that prevents crimps or scrapes, due to its soothing and softening goods
	Caustic soda	Kill acidic issue, waxes, oil, dust evacuate, Also go about as a swelling operator
	Stabilizer	To control the decomposition of H_2O_2
	H_2O_2	Utilized as blanching operators. Expels shaded contaminations, Whiten the texture
	Jin.Neutra acid	Used for an acid wash.
	H_2O_2 killer	used for removing the residual hydrogen peroxide from fabric blends
Bio-polishing	Acid enzyme	For the modification of the surface of cellulosic fabrics to reduce the hairiness and increase the resistance to pilling
	Anti-crease agent	Reduces the disunion between fibers and fibers-dyeing tank that prevents crimps or scrapes, due to its soothing and softening goods
Dyeing	Leveling agent	Work on the color patch and help in fixing the color patches slightly which enables to gain invariant shade
	Anti-crease agent	Reduces the disunion between fibers and fibers-dyeing tank that prevents crimps or scrapes, due to its soothing and softening goods
	Everzol Yellow 2GR	Reactive dyes: During dyeing, the reactive group of this color forms a covalent bond with fiber polymer and becomes an integral corridor of the fiber.
	Everzol Red 6BN	
	Everzol Navy-ED	
	Glauber salt	Work as an electrolyte, perfecting the affinity of the dye towards the fiber accelerating the commerce of the dye, and reducing its solubility
	Soda ash light	Changes the pH of the fiber-reactive color and cellulose fiber so that the color reacts with the fiber, making an endless connection that holds the color to the fiber

After treatment	Jin.Neutra acid	Used for an acid wash.
	Jingen SP AWP (soaping)	Used for a normal wash of dyed fabric.
	Pearl Soft Cat (cationic softener)	Handling can be bettered by after-treatment with a cationic softener.

Table 3.1.2.3: Functions of chemicals in different stages of exhaust dyeing.

3.1.2.4. Specification of the machine used in exhaust dyeing

- Machine No : 21
- Origin : China
- Brand : Tonjong
- Body : Stainless steel
- Heating rate : 4°C/ min
- Cooling rate : 4°C/min
- Maximum working temperature : 135°C
- Maximum working pressure : 3.2 Bar
- Control : Manual + Automatic

3.1.3. Materials for cold-pad batch (CPB) dyeing method

3.1.3.1. Experimental grey fabric sample

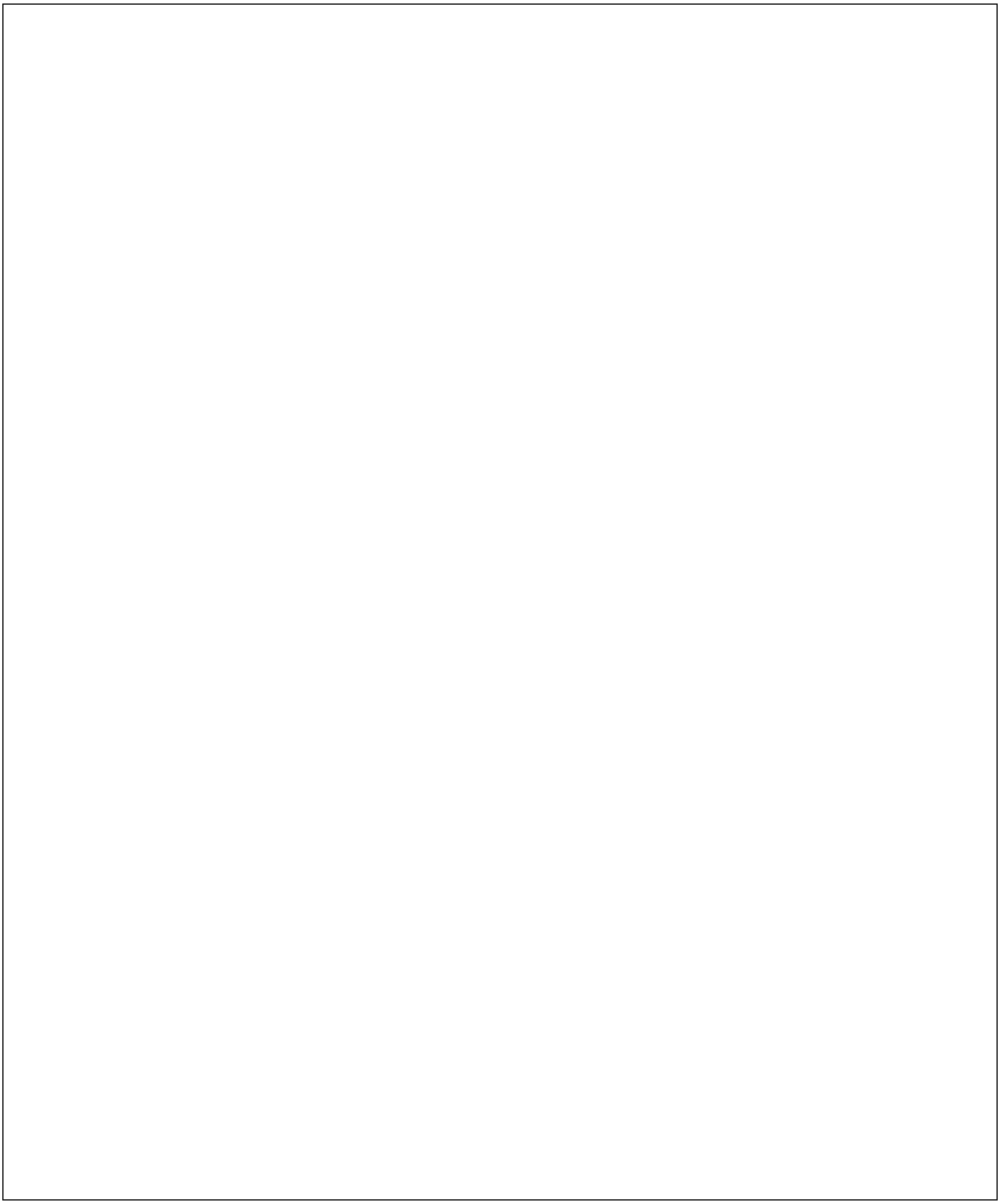
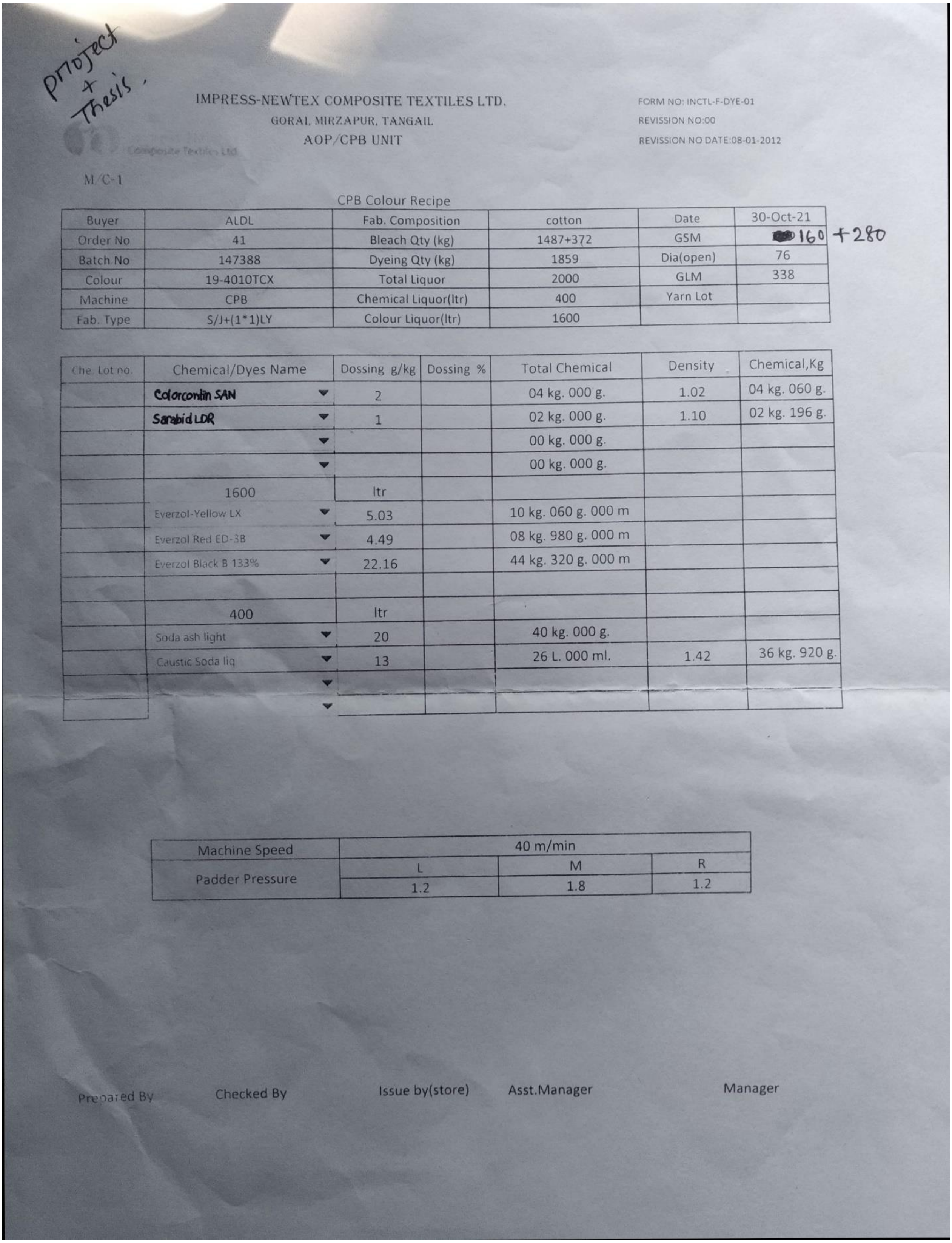


Figure 3.1.3.1: Experimental grey fabric sample.

3.1.3.2. Chemicals used in CPB dyeing process (only during dyeing)

Chemicals used for dyeing: (Recipe)



project + Thesis,

IMPRESS-NEWTEX COMPOSITE TEXTILES LTD.
GORAI, MIRZAPUR, TANGAIL
AOP/CPB UNIT

FORM NO: INCTL-F-DYE-01
REVISSION NO:00
REVISSION NO DATE:08-01-2012

M/C-1

CPB Colour Recipe

Buyer	ALDL	Fab. Composition	cotton	Date	30-Oct-21
Order No	41	Bleach Qty (kg)	1487+372	GSM	160 +280
Batch No	147388	Dyeing Qty (kg)	1859	Dia(open)	76
Colour	19-4010TCX	Total Liquor	2000	GLM	338
Machine	CPB	Chemical Liquor(ltr)	400	Yarn Lot	
Fab. Type	S/J+(1*1)LY	Colour Liquor(ltr)	1600		

Che. Lot no.	Chemical/Dyes Name	Dossing g/kg	Dossing %	Total Chemical	Density	Chemical,Kg
	Colorcontin SAN	2		04 kg. 000 g.	1.02	04 kg. 060 g.
	Sarabid LDR	1		02 kg. 000 g.	1.10	02 kg. 196 g.
				00 kg. 000 g.		
				00 kg. 000 g.		
	1600	ltr				
	Everzol-Yellow LX	5.03		10 kg. 060 g. 000 m		
	Everzol Red ED-3B	4.49		08 kg. 980 g. 000 m		
	Everzol Black B 133%	22.16		44 kg. 320 g. 000 m		
	400	ltr				
	Soda ash light	20		40 kg. 000 g.		
	Caustic Soda liq	13		26 L. 000 ml.	1.42	36 kg. 920 g.

Machine Speed	40 m/min		
Padder Pressure	L	M	R
	1.2	1.8	1.2

Prepared By   Checked By   Issue by(store)   Asst.Manager   Manager

Figure 3.1.3.2: Recipe CPB dyeing with chemical & dye quantity.

3.1.3.3. Chemicals used in different stages of CPB dyeing & their function:

Stage	Chemical	Functions
Scouring & bleaching	Sequestering agent (Jingen SQ PBS)	Neutralize the metal ion on the fabric surface
	Wetting agent (Proder JTLF AC)	Helps to wet the fabric properly
	Caustic soda	Scouring and bleaching.
	Sequestering agent	
	H_2O_2	
	H_2O_2 Stabilizer (JingenSTRS 200)	
	Wetting agent	
	Acetic acid	1. pH control by neutralizing the fabric. 2. Killing the rest of H_2O_2.
Dyeing	Colorcontin SAN	Work as a wetting agent for better dyeing performance
	Sarabid LDR	A dispersing agent with sequestering and leveling properties for perfecting the solubility of reactive dyestuffs
	Everzol Yellow LX	Reactive dyes: During dyeing, the reactive group of this color forms a covalent bond with fiber polymer and becomes an integral corridor of the fiber.
	Everzol Red ED-3B	
	Everzol Black B 133%	
	Caustic soda liquid	Caustic soda is added to the solution to maintain the pH levels during the dyeing processes.
	Soda ash light	Changes the pH of the fiber-reactive color and cellulose fiber so that the color reacts with the fiber, making an endless connection that holds the color to the fiber.
Washing	Acetic acid	pH control (5.0)
	Detergent / Soap	Hot wash
Stenting	Cefasoft MSR (silicon softener)	Improve the hand feel of the fabric
	Albafix FRD (fixer)	Improve the fixation of dye with the fabric

Table 3.1.3.3: Functions of chemicals during CPB dyeing.

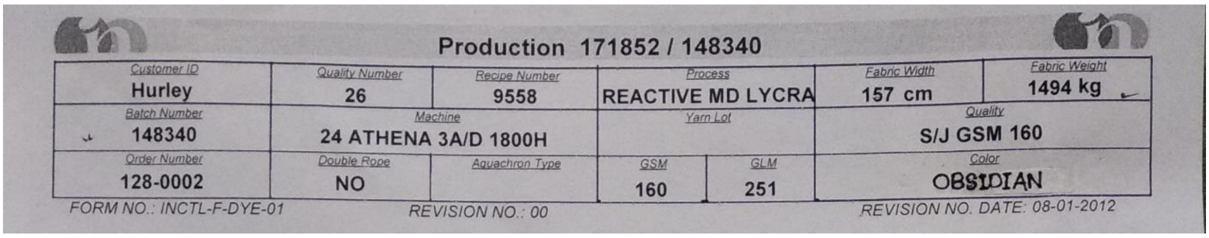
3.1.3.4. Specification of the machine used in CPB dyeing

- Country of Origin : Made in India
- Shape : Bhatt Bros
- Automation Grade : Automatic
- Voltage : 440 V
- Padder Model : FHDH -180
- Dia. Of Cylinder : 180mm
- Length : 900 mm
- Height : 1450mm
- Maximum Liner Pressure : 50 Kg/CML
- Roller width : (1800 - 3600) mm
- Machine speed : (15 - 70) m/min
- Driving control mode : PLC, Frequency conversion AC drive
- Fabrics weight scope : (100 - 450) g/m2
- Dosing pump : 1: 4
- Fabric delivery type : Center batching

3.2. Methods of Exhaust and Cold-Pad Batch (CPB) dyeing processes

This sub-chapter will describe the whole process of two dyeing processes. From the pre-treatment to finishing, every stage will be elaborated step by step in detail.

3.2.1. Process details of exhaust dyeing method



Production 171852 / 148340

Customer ID	Hurley
Quality Number	26
Recipe Number	9558
Process	REACTIVE MD LYCRA
Fabric Width	157 cm
Fabric Weight	1494 kg
Batch Number	148340
Machine	24 ATHENA 3A/D 1800H
Yarn Lot	
Quality	S/J GSM 160
Order Number	128-0002
Double Rope	NO
Aquachron Type	
GSM	160
GLM	251
Color	OBSIDIAN

FORM NO.: INCTL-F-DYE-01 REVISION NO.: 00 REVISION NO. DATE: 08-01-2012

Figure 3.2.1: Batch details of Exhaust dyeing

3.2.1.1: Dyeing

As the total dyeing process is done in the machine. But from time to time observation and chemical insert timetable gives a clear idea about the stages of dying exhaust machine. The stages are :

1. Scouring & bleaching
2. Bio-polishing
3. Dyeing
4. After treatment

Step 01: Scouring & Bleaching

Fabric load with required water

⬇

Temperature rising to 98°C

⬇

Liquid Chemical injection

⬇

Caustic soda dosing (05 min)

⬇

Run for 50 min

⬇

Steam up at 80°C

⬇

Cold wash for 10 min

⬇

PC hot wash at 80°C for 10 min with H_2O_2 killer

⬇

Cold wash for 10 min

Step 02: Bio-polishing

Take required water
⬇
Temperature rise to 55°C
⬇
Enzymes inject
⬇
Run for 1 hour
⬇
Hot wash at 80/70 °C for 10 min
⬇
Cold wash for 05 min
⬇
Water drain

Step 03: Dyeing

Required water
⬇
Leveling and anti-crease agent inject
⬇
Salt dosing for 5 min
⬇
Dye dosing for 30/35 min
⬇
Run for 10/15 min at 60°C
⬇
Then soda dosing for 40 min at 60°C
⬇
Run for 10 min
⬇
Shade check (color steam/running shed)

The shade was ok.

⬇
Color wash at 50°C
⬇
Water drain

Step 04: After-treatment

Required water
⬇
Temperature rise to 50°C
⬇
Acid wash for 10 min
⬇
Cold wash for 05 min
⬇
Water drain and taking
⬇
Hot wash (acid neutralization) at 80°C for20 min
⬇
Cold wash for 20 min
⬇
Water drain and again take
⬇
Temperature rise to 40°C
⬇
Softener dosing for 5/7 min
⬇
Run for 10/15 min
⬇
Fabric unload

Finishing section (open width finish)

3.2.1.2. Slitting & de-watering machine

Machine speed (m/min)	60
Over Feed %	2%
Pre padder pressure	1.0 kg
Post padder pressure	1.0 kg

Table 3.2.1.2: Dewatering machine parameters.

3.2.1.3. Stenter machine

Machine speed (m/min)	25
Over Feed %	25%
Set width	180
Temperature	140°C
1st/2nd padder pressure	2.0 kg
After GSM	150/155

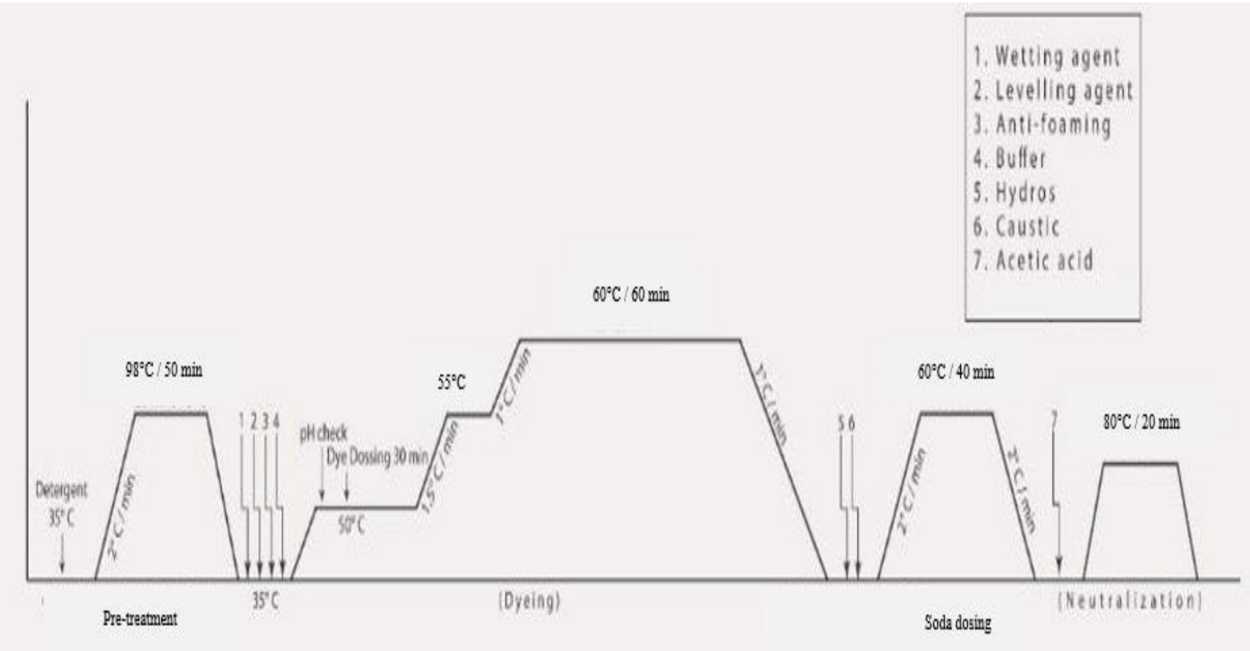
Table 3.2.1.3: Stenter machine parameters

3.2.1.4. Compactor machine

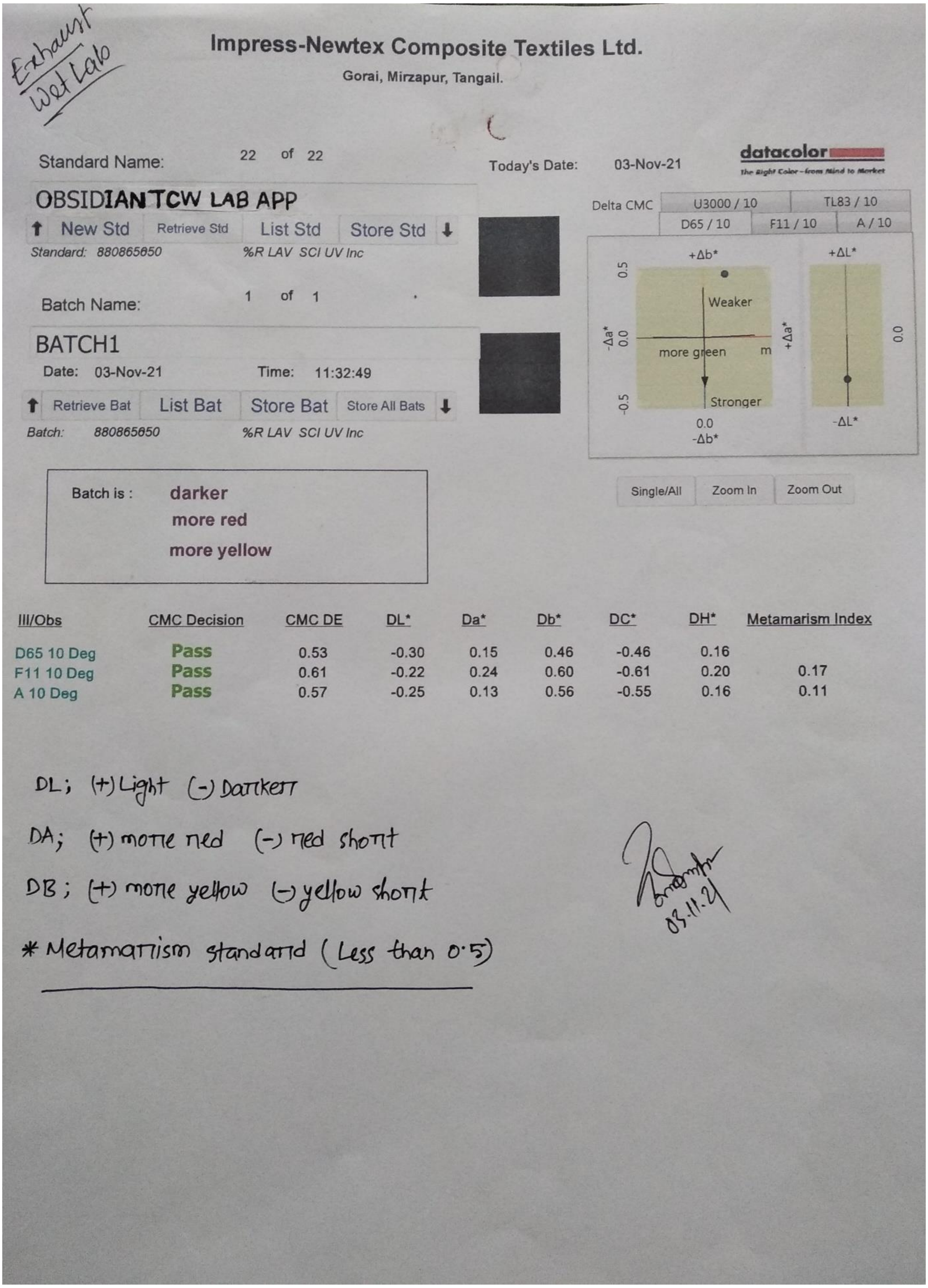
Machine speed (m/min)	24
Over Feed %	40%
Set width	175
Temperature	130°C
Pressure/steam	Normal
After GSM	155/158
After width	171

Table 3.2.1.4: Compactor machine parameters.

3.2.1.5. Process curve of Exhaust dyeing



3.2.1.6. Wet lab result



Exhaust Wet Lab

Impress-Newtex Composite Textiles Ltd.

Gorai, Mirzapur, Tangail.

Standard Name: 22 of 22

Today's Date: 03-Nov-21

datacolor

OBSIDIAN TCW LAB APP

New Std | Retrieve Std | List Std | Store Std

Standard: 880865650 %R LAV SCI UV Inc

Batch Name: 1 of 1

BATCH1

Date: 03-Nov-21 Time: 11:32:49

Retrieve Bat | List Bat | Store Bat | Store All Bats

Batch: 880865650 %R LAV SCI UV Inc

Delta CMC | U3000 / 10 | TL83 / 10 | D65 / 10 | F11 / 10 | A / 10

Batch is : darker

more red

more yellow

Single/All | Zoom In | Zoom Out

Ill/Obs	CMC Decision	CMC DE	DL*	Da*	Db*	DC*	DH*	Metamarism Index
D65 10 Deg	Pass	0.53	-0.30	0.15	0.46	-0.46	0.16	
F11 10 Deg	Pass	0.61	-0.22	0.24	0.60	-0.61	0.20	0.17
A 10 Deg	Pass	0.57	-0.25	0.13	0.56	-0.55	0.16	0.11

DL; (+) Light (-) Darker

DA; (+) more red (-) red short

DB; (+) more yellow (-) yellow short

* Metamarism standard (Less than 0.5)

03.11.21

Figure 3.2.1.6: Wet lab report.

3.2.1.7. Exhaust method dyed sample

Figure 3.2.1.7: Exhaust method dyed sample.

3.2.2. Cold-Pad Batch (CPB) dyeing method

3.2.2.1. Singeing

Fabric GSM	160
Quantity (kg)	1487
rated	16
Temperature	120°C
Machine roller rpm	70
Process	Both side
Time	01 hour 10min (approximate)

Table 3.2.2.1: Singeing machine parameters.

3.2.2.2. Scouring & bleaching

The machine has 05 chambers. Described below:

Chamber no.	Chamber name	Process / Work	Chemicals	Time & Temp.
01	Wetting Chamber	1. Neutralize the metal ion on the fabric surface. 2. Helps to wet the fabric properly.	1. Sequestering agent (Jingen SQ PBS 0.5g/l) 2. Wetting agent (Proder JTLF AC 0.5g/l)	Normal temp. 6 min
02	Tagga Wash 01 (impregnation chamber)	Scouring + Bleaching	1. Caustic soda (5.0g/l) 2. Sequestering agent (3g/l) 3. Wetting agent (5g/l) 4. H_2O_2 (7.0g/l) 5. H_2O_2 Stabilizer (JingenSTRS 200 1.0g/l)	08 sec
03	Steamer	Dry the fabric.	Water Steam	99°C 15 min
04	Tagga wash 02	1. pH control by neutralizing the fabric. 2. Killing the rest of H2O2.	Acetic acid (3g/l)	99°C 06 min
05	Wash Drum	Normal Wash		05 min

Table 3.2.2.2: Scouring & Bleaching process parameters.

3.2.2.3. CPB Machine parameters:

Total liquor in pad	15 liter per meter of width		
Immersion time	1.5 sec		
Bath temperature	(14/15)°C		
Machine speed	40 m/min		
Pick-up %	80%		
Padder pressure	Left	Middle	Right
	1.2	1.8	1.2
Total require time	02 hour (12.50 kg/min)		

Table 3.2.2.3: CPB Machine parameters

Recipe calculation based on:

- Fabric : Dye = 1 : 1 (took 40/50 liter extra)
- Dye liquor : Chemical liquor = 4 : 1

3.2.2.4. Dyed fabric resting and rotation

The dyed fabric roll rolled with thick polythene airtight and leave to rest for a certain time with a constant rotation rate.

- CPB out time: 11.20 pm
- Rest time: 16 hours
- Wash time: 03.20 pm
- RPM: 60

3.2.2.5. Washing

These are 04 chambers in the washing machine. Here the ratio of fabric & water is always 1:12.

Chamber no.	Chamber name	Process / Work	Chemicals	Fabric stays time & temp.
01	Normal wash Double drum	Normal / Cold wash	Acetic acid (1gm/lt)	(1-1.30) min
02	Parco wash 01	Hot wash Dark color: 90+°C	Detergent / Soap (1-2 gm/lt)	(4-8) min 90°C
03	Parco wash 02	Hot wash Dark color: 90+°C	No chemical	(4-8) min 90°C
04	Cold wash Single drum	pH control (5.0)	Acetic acid (1-2 gm/lt)	Room temperature

Table 3.2.2.5: Washing machine chemical quantity and parameters.

3.2.2.6. Stenter machine

Applied chemical	Cefasoft MSR (silicon softener) 40g/l
	Albafix FRD (fixer) 15 g/l
Chemical apply temperature	Room temperature
Machine speed (m/min)	30
Over Feed %	80%
Set width	68
Temperature	140°C
1st/2nd padder pressure	5 / 2.5
After GSM	145/147

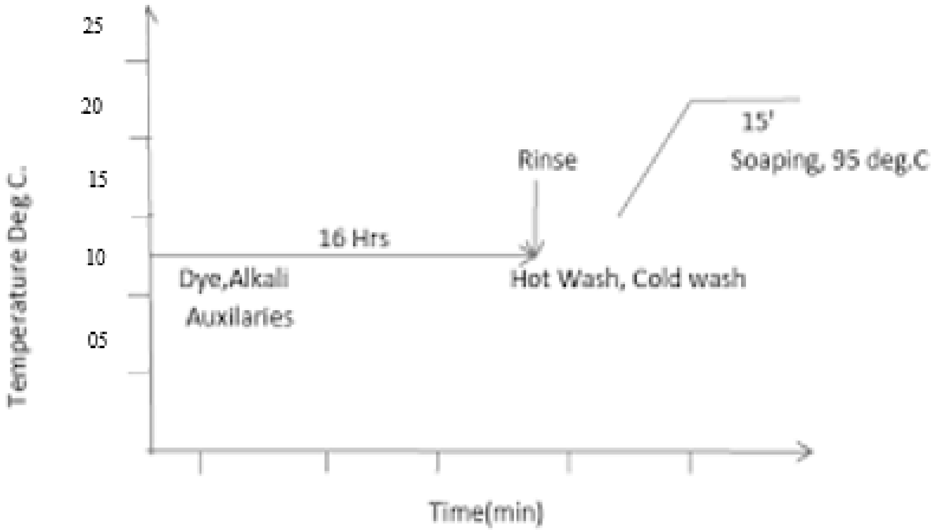
Table 3.2.2.6: Stenter machine parameters.

3.2.2.7. Compacting

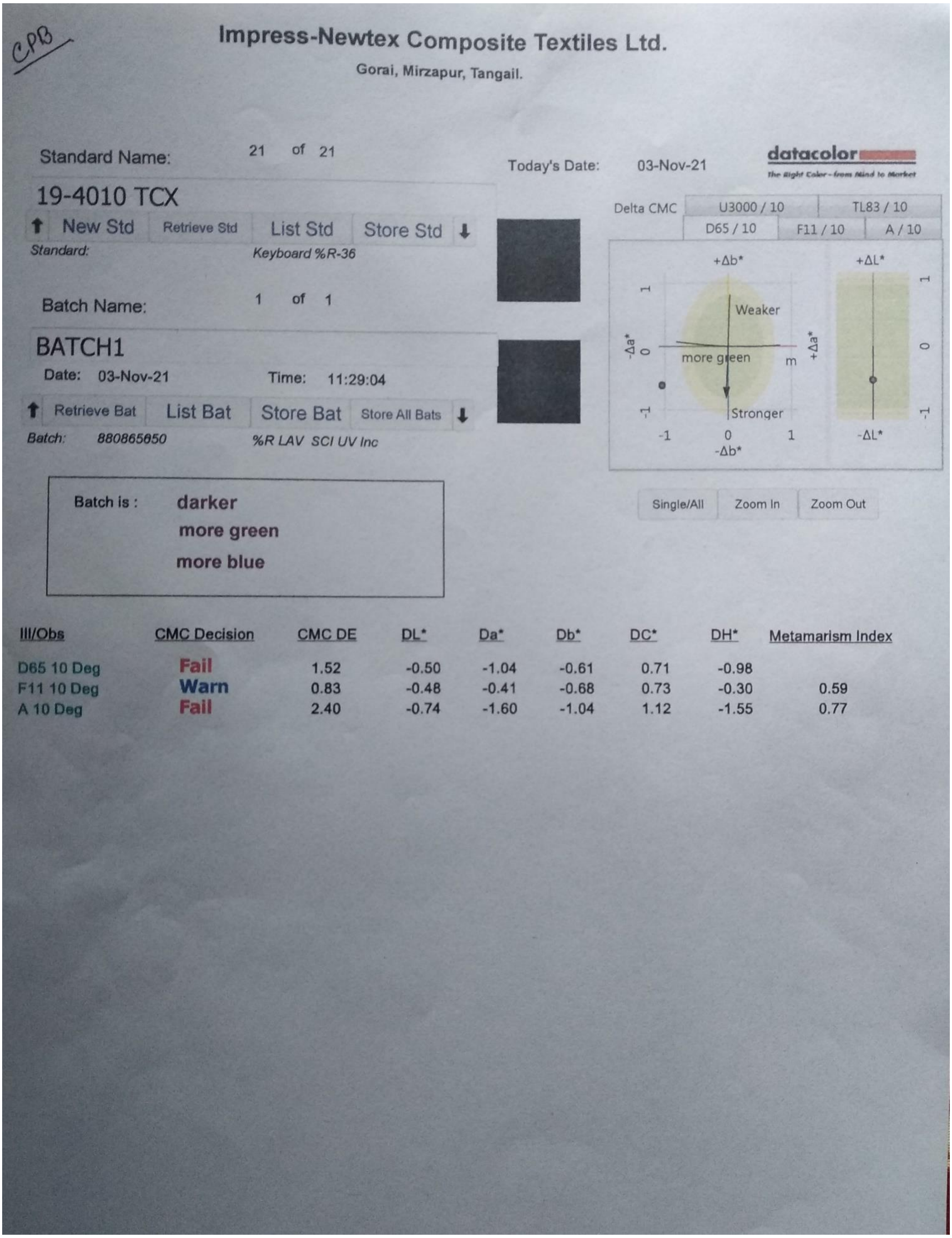
Machine speed (m/min)	24
Over Feed %	50%
Set width	65
Temperature	130°C
Pressure/steam	Normal
After GSM	158/160 (relaxed)
After width	69/70 (relaxed)

Table 3.2.2.7: Compactor machine parameters.

3.2.2.8. Process curve of CPB dyeing



3.2.2.9. Wet Lab report



CPB

Impress-Newtex Composite Textiles Ltd.

Gorai, Mirzapur, Tangail.

Standard Name: 21 of 21

Today's Date: 03-Nov-21

datacolor

19-4010 TCX

New Std | Retrieve Std | List Std | Store Std

Standard: *Keyboard %R-36*

Batch Name: 1 of 1

BATCH1

Date: 03-Nov-21 Time: 11:29:04

Retrieve Bat | List Bat | Store Bat | Store All Bats

Batch: *880865650* *%R LAV SCI UV Inc*

Delta CMC | U3000 / 10 | TL83 / 10 | D65 / 10 | F11 / 10 | A / 10

Single/All | Zoom In | Zoom Out

Batch is : darker
more green
more blue

Ill/Obs	CMC Decision	CMC DE	DL*	Da*	Db*	DC*	DH*	Metamarism Index
D65 10 Deg	Fail	1.52	-0.50	-1.04	-0.61	0.71	-0.98	
F11 10 Deg	Warn	0.83	-0.48	-0.41	-0.68	0.73	-0.30	0.59
A 10 Deg	Fail	2.40	-0.74	-1.60	-1.04	1.12	-1.55	0.77

Figure 3.2.2.9: Wet lab report of CPB dye sample.

3.2.2.10. CPB method dyed sample

Figure 3.2.2.10: CPB method dyed sample.

3.3. Methods of experimental tests on the dyed samples

3.3.1 Dimensional stability to washing

To determine the dimensional change of fabrics/ garments when subordinated to an applicable combination of specified washing and drying procedures.

Test Method

ISO 3759/ **ISO 6330**/ ISO 5077/ AATCC 150/ AATCC 135

This test system is intended for the determination of dimensional changes in woven & knit fabrics/ garments when subordinated to repeated automatic laundering procedures generally used at home.

The dimensional changes of textile instances subordinated to washing are measured using pair of benchmarks applied to the fabric before washing.

Chemicals:

Total 20 mg

- TAED: 3%
- Sodium perborate tetrahydrate: 20%
- ECE nonphosphate (detergent): 77%

3.3.2. Colorfastness to washing

Color fattiness to washing means, A instance of the cloth, in contact with one or two specified conterminous fabrics, is mechanically agitated under described conditions of time and temperature in a cleaner result, also irrigated and dried. The change in color of the instance and the staining of the conterminous fabric are assessed with the slate scales.

Test method:

ISO 105-C06

Process:

- ECE detergent: 04 gm/l
- Sodium perborate: 01 gm/l
- Water in the pot: 150 ml
- Sample fabric: (10*4) cm with same size cotton and wool fabric for color stain measure
- Time: 30 min
- Double time cold wash with 100ml distilled water each time
- Oven dry below 60 degree

3.3.3. Colorfastness to Water

Colorfastness to Water testing is specifically used to measure the migration of color to another fabric when wet and in close contact. The washing test also generally uses an introductory PH result due to the addition of detergent, while this test is conducted in neutral PH situations.

Test method:

ISO 105-E01

Process:

- M:L : 1:50
- Time: 30 min
- Tapping: every 15 min
- For 10 sample resin plate is 11
- Pressure: 12.5 N
- Rest time: 4 hours, room temperature
- Oven dry: below 60 degree

3.3.4. Colorfastness to Perspiration

To determine the resistance of the color of fabrics to the action of artificial mortal sweat when comes into contact with the body reference where perspiration is heavy (like neck, underarm, etc.) may suffer from original severe abrasion. The resistance to the color of cloth against the abrasion effect of acidic or alkaline perspiration is the colorfastness to perspiration.

Test method:

ISO 105-E04

Process:

- M:L : 1:50
- Time: 30 min
- Tapping: every 15 min
- For 10 sample resin plate is 11
- Pressure: 12.5 N
- Rest time: 4 hours, room temperature
- Oven dry: below 60 degree

Chemicals:

For acid, **pH: 5.5**

1. Histidinemono hydrochloride: 0.5g/l
2. NaCl: 5.0 g/l
3. Sodium hydrogen phosphate hydrate: 2.2 gm/l

For alkali, **pH: 8.0**

1. Histidinemono hydrochloride: 0.5g/l
2. NaCl: 5.0 g/l
3. Di-sodium hydrogen phosphate dihydrate: 2.2 g/l

3.3.5. Color fastness to Rubbing

Colorfastness to rubbing refers to the capability to sustain the original color of dyed fabrics when rubbing. Dry rubbing color fastness refers to the situation of fading and staining of dyed fabric when rubbed with a standard white cloth. Wet rubbing color fastness refers to the situation of fading and staining of dyed fabric when rubbed with a standard white cloth whose water content is 95 to 105. The evaluation of Rubbing color fastness depends on the degree of staining of white cloth. After testing, the white cloth is compared to staining sample cards to measure staining fastness.

Test method:

ISO 105-X12

Process:

- Force: 09 N
- To and fro: 10 times
- Test fabric: 100% cotton woven finished (50*50) cm, finished without OBA
- Process:
    - Lengthwise 2 times
    - Widthwise 2 times
- Anger radius: 16 mm
- Sample size: (140*5) cm minimum
- Soak % of water for wet: 95-100

3.3.6. ICI Pilling resistance

ICI Pilling Tester is used to assess fabric surface pilling and fuzzing by tumbling randomly.

Test method:

ISO 12945-1

Process information:

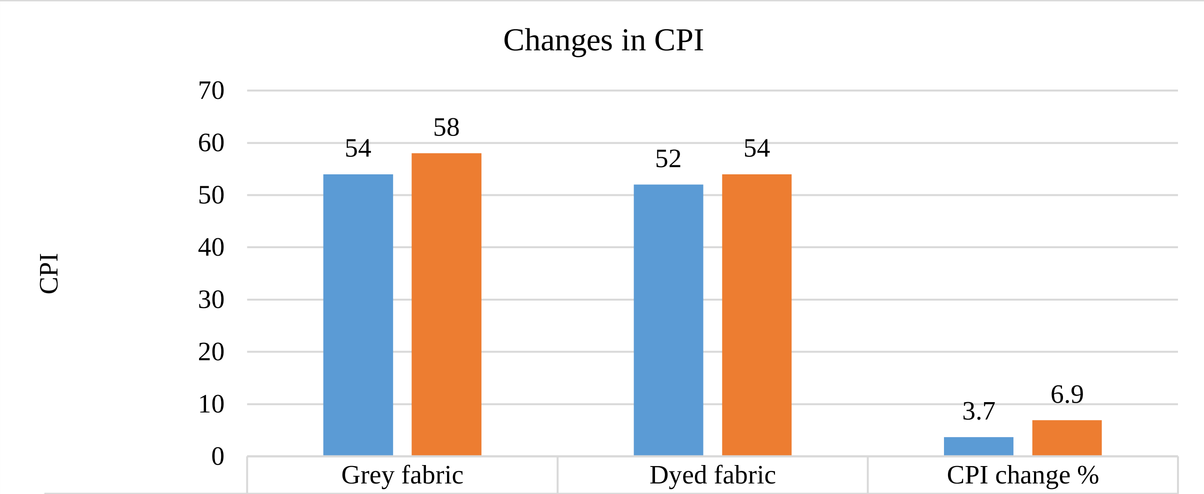
- Template: (12.5*12.5) cm
- Sewing allowance: 1.5 cm
- Rotation: 10,800

Chapter-4

DISCUSSION OF RESULTS

4.1 Changes in CPI of fabric in Exhaust and CPB dyeing processes:

At first, the CPI for the grey fabric of the illustration of the single jersey was being recorded. At that point, we recorded the CPI of each of the two exemplifications used in both processes. Also, we recorded the CPI of the dyed exemplifications. After that, we've established the distinction in the measure of CPI by a diagram applying the co-existing integer.



	Grey fabric	Dyed fabric	CPI change %
Exhaust sample	54	52	3.7
CPB sample	58	54	6.9

Figure 4.1: Line diagram represents changes in CPI of fabrics after dyeing.

The line diagram shows the variation in CPI of fabric before and after dyeing. In the line diagram, a diverse time is pointed horizontally or along the X-axis and the number of fluctuations in the CPI of fabric valuation is pointed vertically or along the Y-axis.

For the alteration, the time of different conditions changes in CPI of fabrics decreases. Because, when the whole dyeing process has been completed. In the operation dust, dirt, oil is removed from the fabrics, and the color is added.

From the line diagram, we can experience that for the single jersey, after dyeing processes change in CPI is actually little. After dyeing the GSM for both fabrics decreased a little, which means the fabric had expanded a little. So, CPI was decreased.

Here the exhaust dyed fabric shows less CPI change percentage than the CPB dyed fabric.

4.2 Changes in WPI of fabric before and after the dyeing processes:

At first, we recorded the WPI for the grey fabric of the illustration of the single jersey. At that point, we recorded the WPI of each of the two exemplifications used in both processes. Also, we recorded the WPI of the Dyed exemplifications. After that, we've established the distinction in the measure of WPI by a diagram applying the coexisting integer.

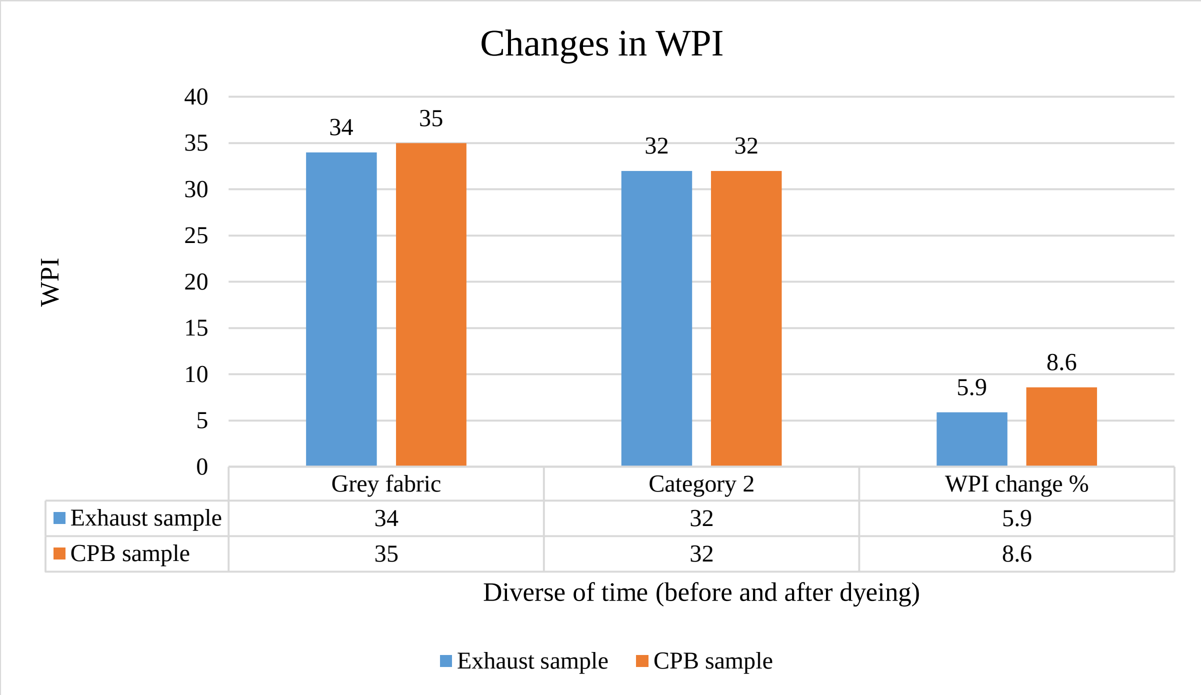


Figure 4.2: Line diagram represents changes in WPI of fabrics after dyeing.

The line diagram shows the variation in WPI of fabric before and after dyeing. In the line diagram, a diverse time is pointed horizontally or along the X-axis and the number of fluctuations in the WPI of fabric valuation is pointed vertically or along the Y-axis.

For the alteration, the time of different conditions changes in WPI of fabrics decreases. Because, when the whole dyeing process has been completed. In the operation dust, dirt, oil is removed from the fabrics, and the color is added.

From the line diagram, we can experience that for the single jersey, after dyeing processes change in WPI is actually little. After dyeing the GSM for both fabrics decreased a little, which means the fabric had expanded a little. So, WPI was decreased.

Here the CPB dyed fabric shows more WPI change percentage than the exhaust dyed fabric.

4.3 Change in GSM of fabric in different processes:

At first, we recorded the GSM for the grey fabric of the illustration of the single jersey. At that point, we recorded the GSM of each of the two exemplifications used in both processes. Also, we recorded the GSM of the exemplifications after different stages during the whole process of dying. After that, we've established the distinction in the measure of GSM by a diagram applying the co-existing integer.

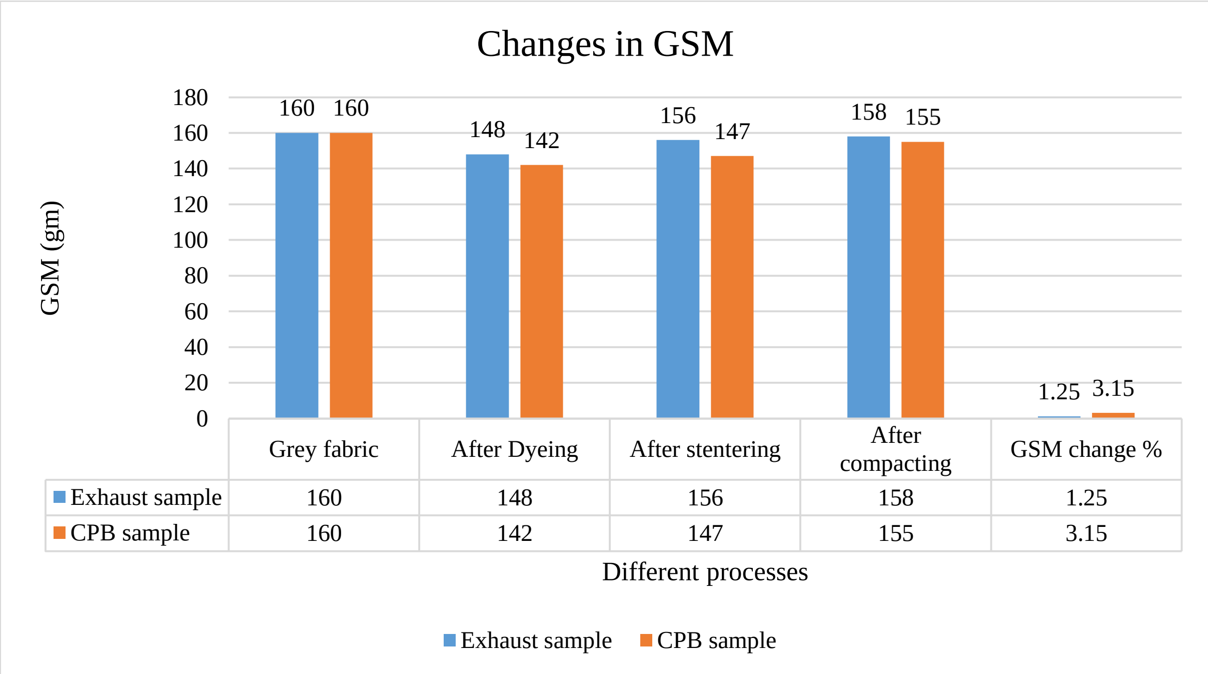


Figure 4.3: Line diagram represents changes in GSM of fabrics in different processes.

The line diagram shows the variation in GSM of fabrics before and after dyeing. In the line diagram, a diverse time is pointed horizontally or along the X-axis and the number of fluctuations in the GSM of fabrics valuation is pointed vertically or along the Y-axis.

For the alteration, the time of different conditions changes in GSM of fabrics decreases. Because, when the whole dyeing process has been completed. In the operation dust, dirt, oil is removed from the fabrics, and the color is added.

From the line diagram, we can experience that for the single jersey, after dyeing processes change in GSM is actually little. The final GSM decreases a little for both cases after the finishing processes. That means the fabrics expanded a little.

But the percentage of change (decrease) in GSM is under the acceptable level.

4.4 Change in SL (mm) of fabric before and after the dyeing processes:

At first, we recorded the SL for the grey fabric of the illustration of the single jersey. At that point, we recorded the SL of each of the two exemplifications used in both processes. Also, we recorded the SL of the Dyed exemplifications. After that, we've established the distinction in the measure of SL by a diagram applying the coexisting integer.

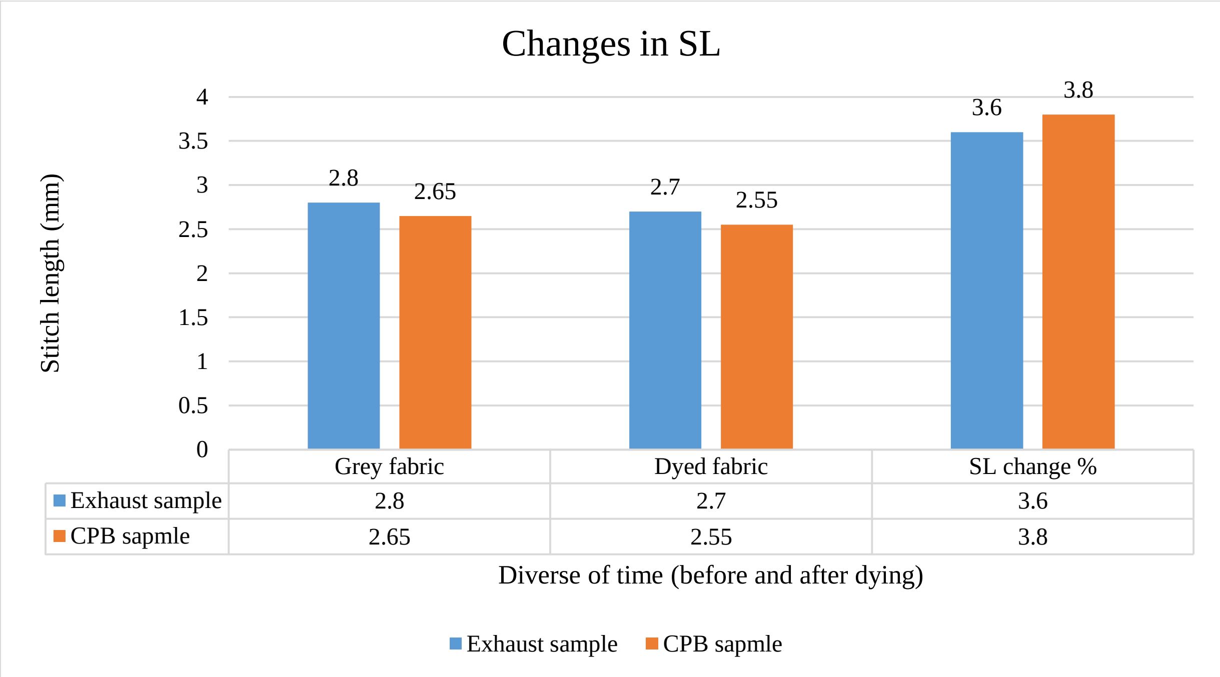


Figure 4.4: Line diagram represents changes in SL of fabric after dyeing.

The line diagram shows the variation in SL of fabrics before and after dyeing. In the line diagram, a diverse time is pointed horizontally or along the X-axis and the number of fluctuations in the SL of fabrics valuation is pointed vertically or along the Y-axis.

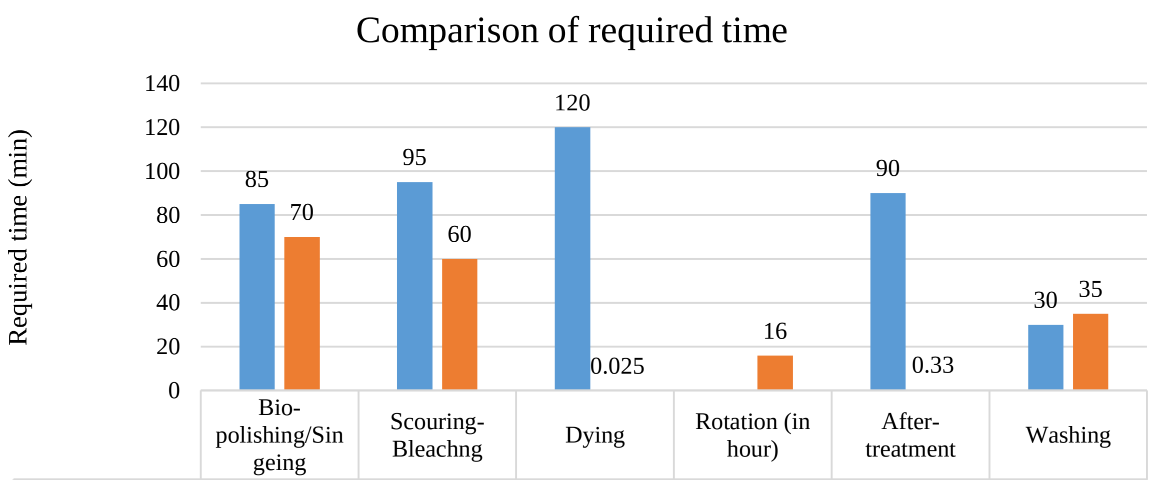
For the alteration, the time of different conditions changes in SL of fabrics decrease. Because, when the whole dyeing process has been completed. In the operation dust, dirt, oil is removed from the fabrics and color is added. So, with heat the fabric shrink a little.

From the line diagram, we can experience that for the single jersey, after dyeing processes change in SL is little. After heat-setting the fabrics expanded in a very little quantity. It occurs to be in change in SL of the fabrics.

The CPB dyed fabric shows a little more percentage in change of SL than the exhaust dyed fabric.

4.5 Required time (min) for different processes in dying methods:

At first, we recorded the required time for different processes in exhaust method dying. At that point, we only focus on the main or major processes, not within them the sub-processes. Then, we recorded the required time for different processes in the CPB method dying. One or two major processes may not be the same but they are also been recorded for the thesis. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer.



	Bio-polishing/Singeing	Scouring-Bleachng	Dying	Rotation (in hour)	After-treatment	Washing
Exhaust method	85	95	120		90	30
CPB method	70	60	0.025	16	0.33	35

Figure 4.5: Line diagram represents the required time for different processes in dyeing.

The line diagram shows the variation in the required time for different processes in both dying methods. In the line diagram, different processes are pointed horizontally or along with the X-axis and the required time required for those processes valuation is pointed vertically or along the Y-axis.

Here both processes passes through almost same stages. But CPB dyeing is very fast but the dyed fabric has to be in rest (rotating) for a long period of time. It also need of wash after resting where in Exhaust it is done within the machine as a stage of dyeing.

The overall time for a normal exhaust dyeing is almost 08 hours where CPB dyeing requires almost a whole day.

4.6 Changes in the temperature for different processes in dying methods:

At first, we recorded the required temperature for different processes in exhaust method dying. At that point, we only focus on the main or major processes, not within them the sub-processes. Then, we recorded the required temperature for different processes in the CPB method dying. One or two major processes may not be the same but they are also been recorded for the thesis. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer.

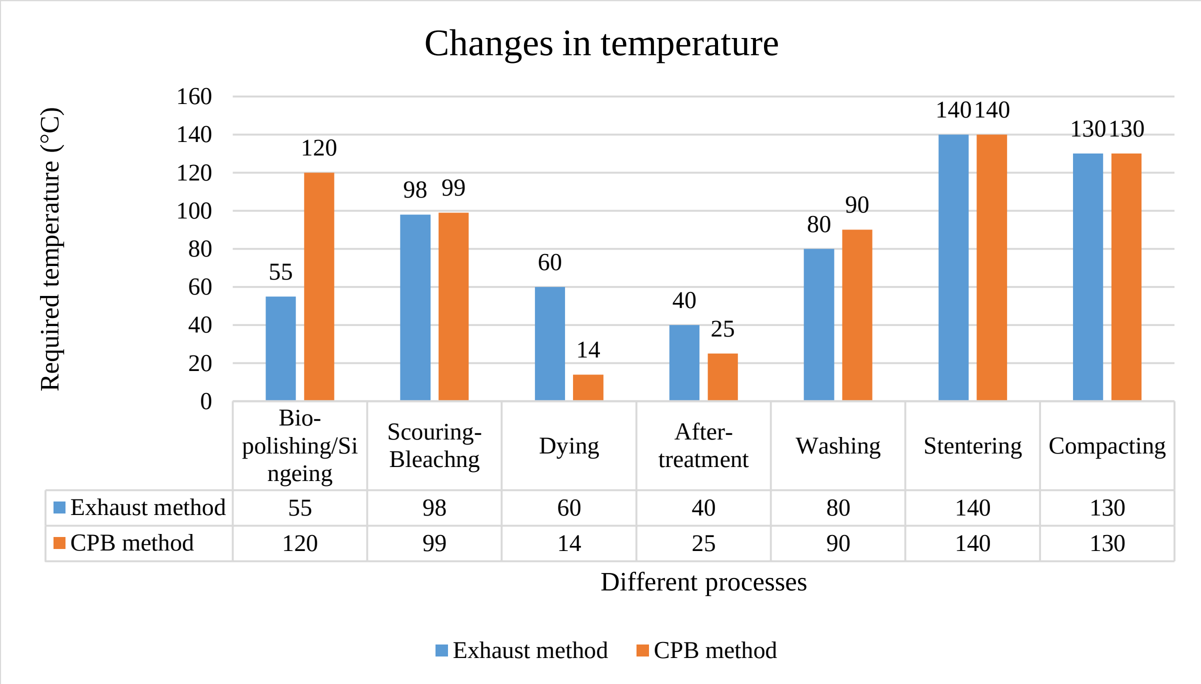


Figure 4.6: Line diagram represents changes in the temperature for different processes.

The line diagram shows the change in CPI of fabric over time. In the line diagram, a different time is indicated horizontally or along the X-axis and the number of changes in the CPI of fabric value is indicated vertically or along the Y-axis. For the change, the time of different conditions changes in CPI of fabrics decreases. Because, when the scouring process has been completed. In the process dust, dirt, oil is removed from the fabrics.

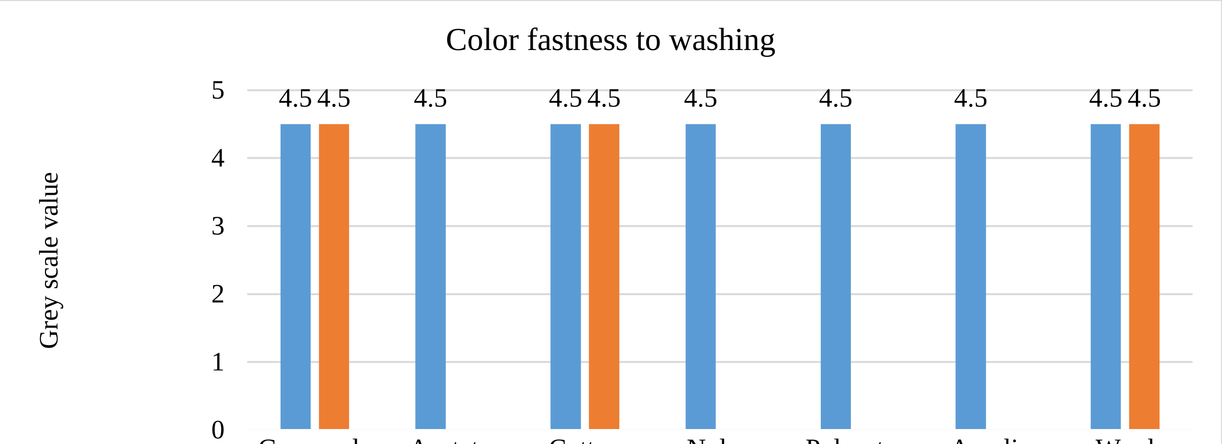
From the line diagram, we can see both processes have to go through the same stages. Bio-polishing is done in exhaust whereas CPB requires singeing. The most variable in temperature is seen in the dyeing process. As CPB is a cold pad process it requires a very low temperature.

On the other stages, the fluctuation of temperature is not that much. Only singeing is burning with the help of gas, so it is natural for that for being at a high temperature.

The dyed samples had also gone through some physical lab tests as mentioned earlier. These reports will present the quality of the dyed fabric aspect of the dyes applied to them. Let's follow the test results to construct a decision about which process stands well.

4.7 Discussion on the result of colorfastness to washing (ISO 105-C06)

At first, we test the exhaust dyed sample along with the multi-fiber. Here, staining on multi-fiber is also paly an important role. On the other hand, we also test the CPB dyed sample along with multi-fiber. But, here only staining on cotton and wool is counted. The whole test result is represented by Grey Scale where the value is 1 to 5. 1indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer.



	Grey scale	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
Exhaust sample	4.5	4.5	4.5	4.5	4.5	4.5	4.5
CPB sample	4.5		4.5				4.5

Figure 4.7: Line diagram represents the result of colorfastness to washing.

The line diagram shows the result of colorfastness to the washing of the dyed fabrics. In the line diagram, the result of colorfastness to washing of the dyed fabrics in greyscale and staining on multi-fiber is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-axis.

We can see that both fabrics show good dying quality by scoring 4.5 in both greyscale and staining results on multi-fiber.

So, we can wash these fabrics with any type of fabric without any risk of color bleed.

That means we can achieve good dying from both processes under their favorable conditions.

4.8 Discussion on the result of colorfastness to rubbing (ISO 105-X12)

At first, we prepare the cut part from the fabric for the test and also fulfill the conditions for wet rubbing test Then, we tested the exhaust sample in both dry conditions and recorded the result. Then, we tested the CPB dyed sample also in both conditions and recorded the result. The whole test result is represented by Grey Scale where the value is 1 to 5. Where 1 indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the co-existing integer.

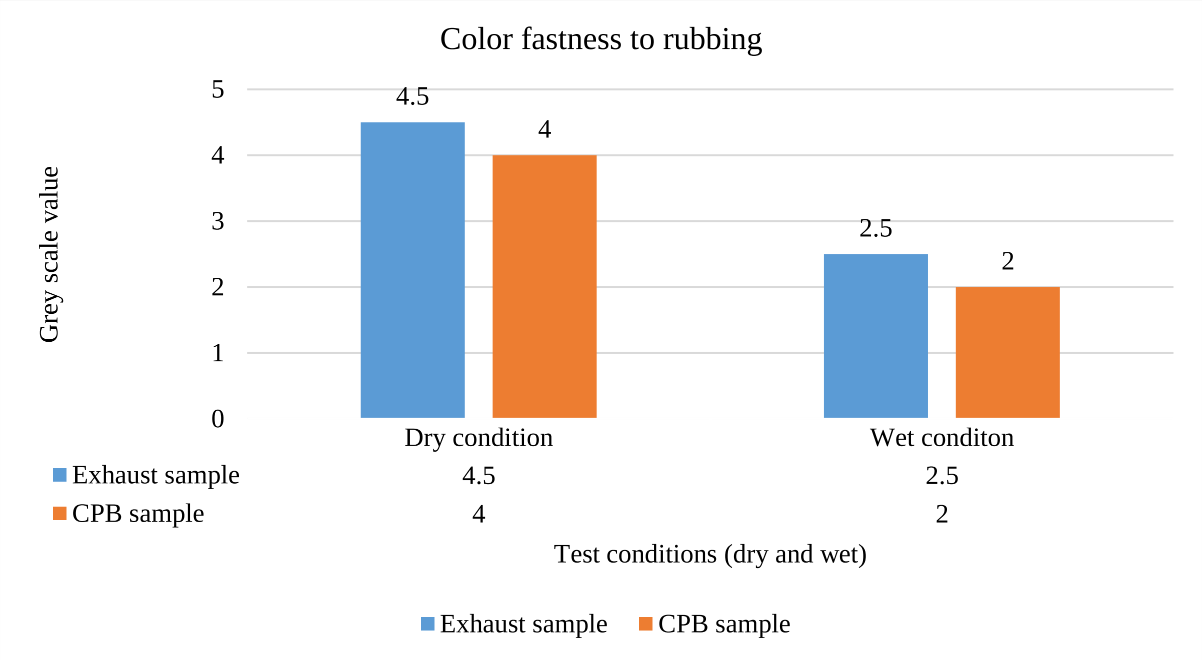


Figure 4.8: Line diagram represents the result of colorfastness to rubbing.

The line diagram shows the result of colorfastness to the washing of the dyed fabrics. In the line diagram, the result of colorfastness to washing of the dyed fabrics is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-axis.

In exhaust dying from pre-treatment to after-treatment all processes are done in one time whereas in CPB dying after-treatment is done during stenting. So, sometime this after-treatment left a very little quantity of unfix dye on the surface and dry the fabric. These happened to be stain on the test fabric.

That's why exhaust performed better than CPB in both condition scoring 4.5 and 4 greater than 2.5 and 2 respectively on grey scale.

That means exhaust stands well than CPB in rubbing test.

4.9 Discussion on the result of colorfastness to water (ISO 105-E01)

At first, we test the exhaust dyed sample along with the multi-fiber. Here, staining on multi-fiber is also paly an important role. On the other hand, we also test the CPB dyed sample along with multi-fiber. But, only staining on cotton and wool is counted. The whole test result is represented by Grey Scale where the value is 1 to 5. Where 1 indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer.

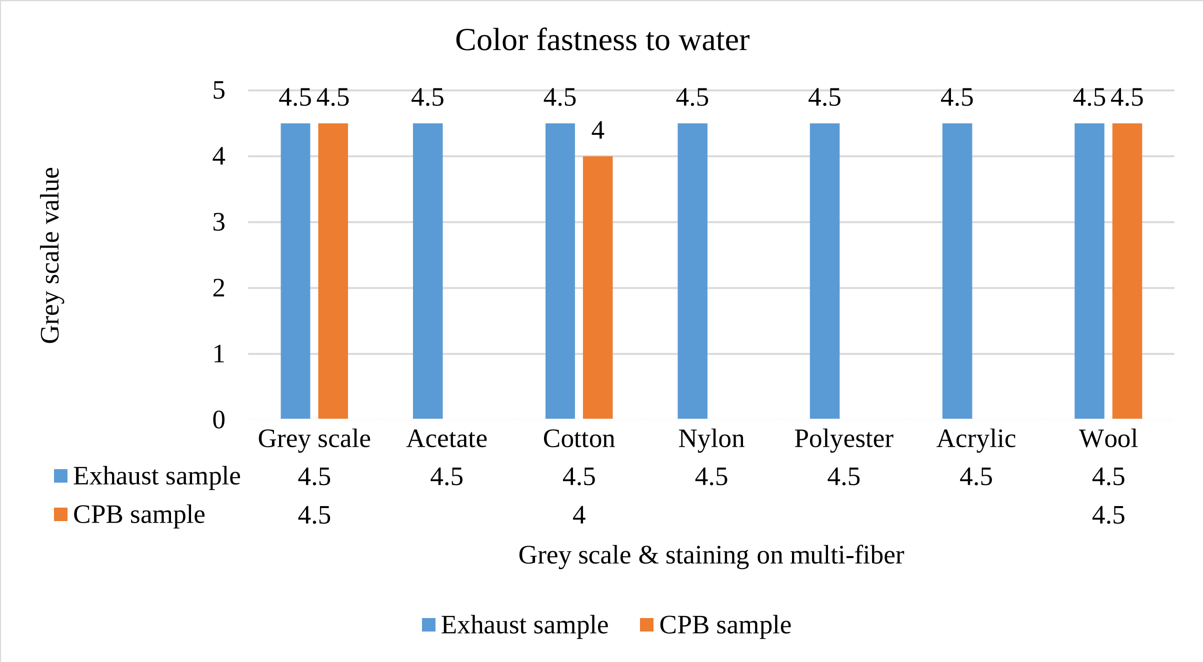


Figure 4.9: Line diagram represents the result of colorfastness to water.

The line diagram shows the result of colorfastness to the water of the dyed fabrics. In the line diagram, the result of colorfastness to the water of the dyed fabrics is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-axis.

We can see that both fabrics show good dying quality where the exhaust dying value on both greyscale and multi-fiber staining is 4.5. But, for CPB though the greyscale value is 4.5 it shows a little stain on the cotton.

That means if more of these types of cotton clothes soak in the water together there is a chance of color bleed on a very low scale. So, when soaking in water with other cotton fabric we have to be careful and use detergent to clear the bleed color.

4.10 Discussion on the result of colorfastness to perspiration – acid & alkaline (ISO 105-E04)

At first, we test the exhaust dyed sample along with the multi-fiber. Here, staining on multi-fiber is also paly an important role. On the other hand, we also test the CPB dyed sample along with multi-fiber. But, only staining on cotton and wool is counted. The whole test result is represented by Grey Scale where the value is 1 to 5. Where 1 indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer.

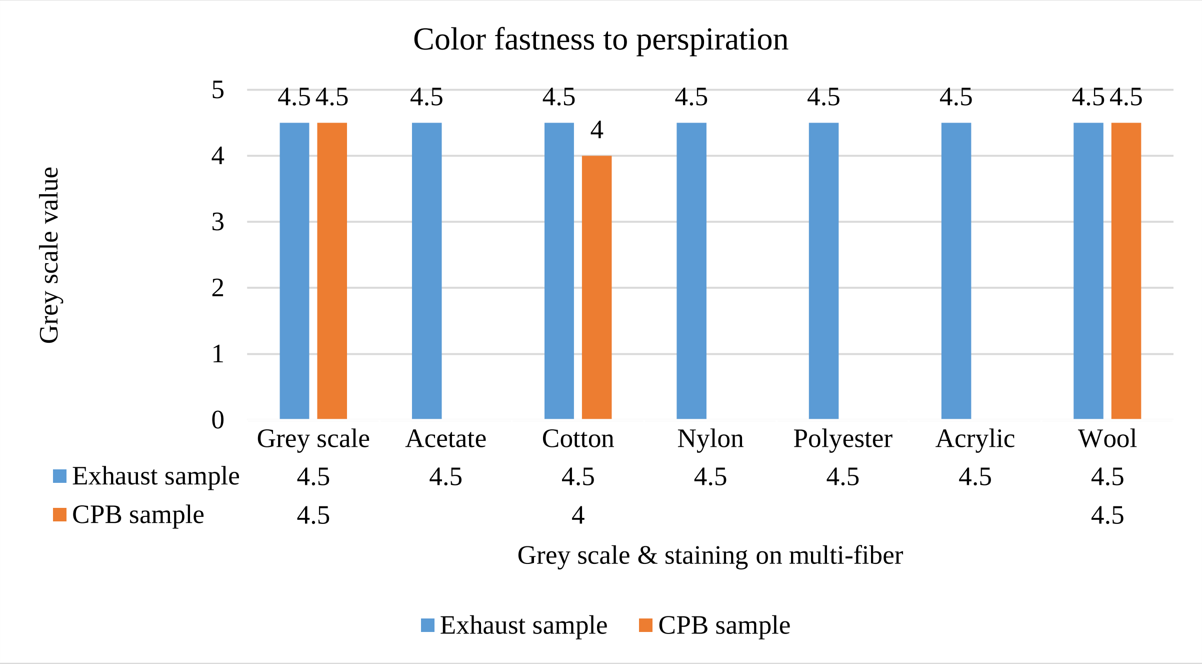


Figure 4.10: Line diagram represents the colorfastness to perspiration – acid & alkaline.

The line diagram shows the result of colorfastness to the perspiration of the dyed fabrics. In the line diagram, the result of colorfastness to the perspiration of the dyed fabrics is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-axis.

We can see that both fabrics show good dying quality and prevention against perspiration of both types. The exhaust dying value on both greyscale and multi-fiber staining is 4.5. But, for CPB through the greyscale value is 4.5 it shows a little stain on the cotton scoring 4 on greyscale.

That means if CPB dyed cotton clothes come in contact with perspiration (both acid or alkaline) it may bleed or lose color on a very low scale with time and finally results to shade fading or dead color effect. So, these fabrics need quick washing right after soaking with perspiration.

4.11 Discussion on the result of ICI pilling resistance (ISO 12945-1)

At first, we had to prepare the test specimens as per the ISO standards for both dyed samples. Then, we tested the exhaust dyed sample by ICI pilling test machine with a revolution number of 10,800 and examined it with greyscale. After that, we did the same procedure to the CPB dyed sample and noted the result. The whole test result is represented by Grey Scale where the value is 1 to 5. Where 1 indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer.

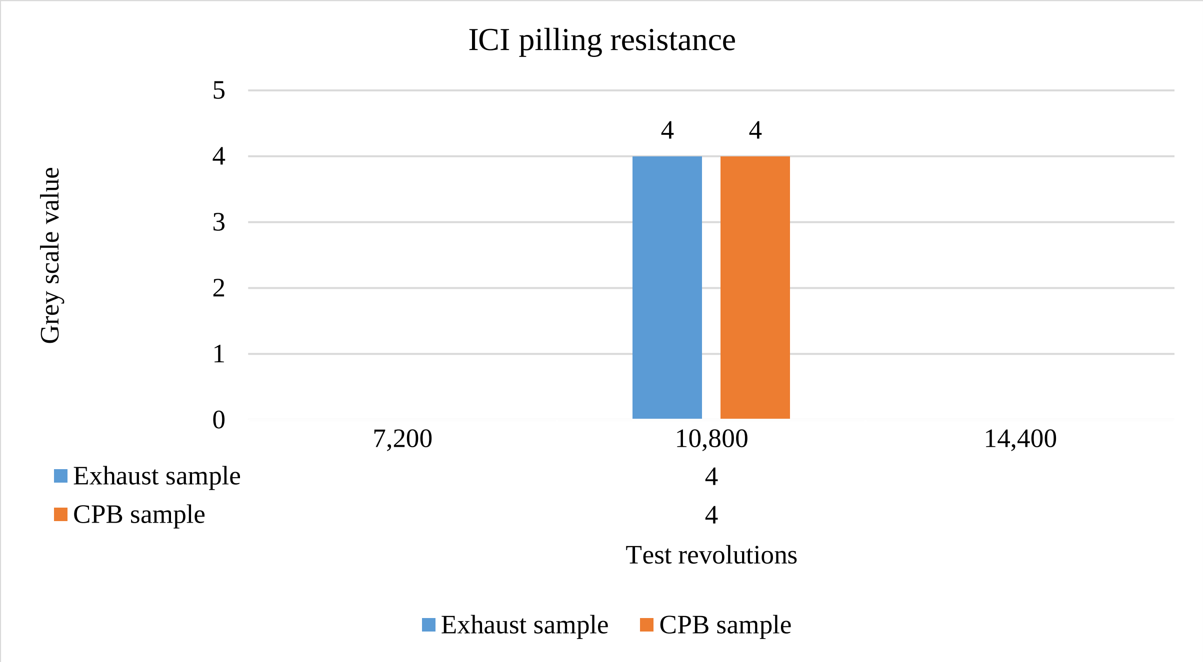


Figure 4.11: Line diagram represents the result of the ICI pilling resistance test.

The line diagram shows the result of ICI pilling resistance of the dyed fabrics. In the line diagram, the result of ICI pilling resistance of the dyed fabrics is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-axis.

We can see that both fabrics show good dying quality whereas the exhaust dyed sample and the CPB dyed sample both score 4 in the greyscale test.

That means if we are concerned about storing these fabrics with other fabrics or with the same, there will be almost no chance of color mixing among them. So, storing, packaging, or delivery (normal rubbing among the fabrics) will not affect the quality of color of the fabrics.

Chapter-5

CONCLUSION

Dyeing is undoubtedly an irreplaceable and essential part of the textile industry. Throughout this study, we tried to overview the most tow methods of dyeing. We tried to review all the stages of these processes in detail. During our study, we came up with some vital points that can be helpful to differentiate the processes and have a clear idea about them in a nutshell. Let's look over those points:

- ❖ Change in CPI after dyeing is decreasing. The decrease in CPI is seen more in the CPB dyed fabric than exhaust.
- ❖ Change in WPI after dyeing is also decreasing. The decrease in WPI is also seen more in the CPB dyed fabric than exhaust.
- ❖ Though it is under an acceptable level. But the higher percentage in GSM change is shown in the CPB dyeing method (3.15%).
- ❖ Changes in SL are not a major issue and it didn't seem as vast. But in here also the CPB dyed fabric shows more change percentage than the exhaust dyeing fabric.
- ❖ At a glance it may seem like CPB dyeing requires very little time. But with rotation, the overall time reaches almost a full day as compared to only 8-10 hours of exhaust dyeing.
- ❖ Temperature has mainly fluctuated in two processes. In CPB it requires singeing which is basically gad burning at high temperature. Also as it is a cold pad dyeing, the dyeing temperature is way less than in exhaust.

For any colorfastness test, the exhaust dyed fabric is tested with multi-fiber but the CPB dyed sample is tested with only cotton and wool fabric.

- ❖ Exhaust is tested with multi-fiber but CPB is tested only with cotton and wool. But they showed the same colorfastness in the greyscale test for washing (4.5).
- ❖ For rubbing in both dry and wet conditions the exhaust dyeing fabric showed better colorfastness in the greyscale test.
- ❖ In terms of water the CPB sample is a little less than the exhaust sample for cotton fabric (4). But in others, they both showed the same colorfastness in the greyscale test (4.5).
- ❖ Test of perspiration (acid & alkali) showed that the CPB sample is a little less than the exhaust sample scoring a 4 point for cotton. But in others, they both showed the same colorfastness in the greyscale test (4.5)
- ❖ In the ICI pilling resistance test both fabrics showed good performance with a score of 4 in greyscale.

Although both these methods are best in their own categories. But the CPB method requires much less water than the exhaust dyeing method. On the other hand, CPB requires almost 3 times more time than exhaust, need a lot of space for rotation of fabric, and above of all vast amount of dyes and chemical for dyeing. The desirable shade achievement is also a challenge in CPB.

During the study, we learn about both Exhaust and CPB dyeing processes briefly. Hopefully, this practical knowledge will be helpful in our future life.

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APPENDIX

Table A1: Changes in CPI of fabric in Exhaust and CPB dyeing processes

Sample type	Changes in CPI		CPI change %
	Grey fabric	Dyed fabric	
Exhaust dyed sample	54	52	3.7
CPB dyed sample	58	54	6.9

Table A2: Changes in WPI of fabric before and after the dyeing processes

Sample type	Changes in CPI		CPI change %
	Grey fabric	Dyed fabric	
Exhaust dyed sample	34	32	5.9
CPB dyed sample	35	32	8.6

Table A3: Changes in GSM of fabrics in different processes

Sample type	Changes in GSM (gm)				GSM change %
	Grey fabric	After dyeing	After stentering	After compacting	
Exhaust dyed sample	160	148	156	158	1.25
CPB dyed sample	160	142	147	155	3.15

Table A4: Changes in SL (mm) of fabric before and after the dyeing processes

Sample type	Changes in SL (mm)		SL change %
	Grey fabric	Dyed fabric	
Exhaust dyed sample	2.80	2.70	3.6
CPB dyed sample	2.65	2.55	3.8

Table A5: Required time (min) for different processes in dying methods

Dyeing method	Required time (min)					
	Bio-polishing / Singeing	Scouring-Bleaching	Dyeing	Rotation (in hour)	After-treatment	Washing
Exhaust	85	95	120	No rotation	90	30
CPB	70	60	0.025	16	0.33	35

Table A6: Changes in the temperature (°C) for different processes in dying methods

Dyeing method	Changes in the temperature (°C)						
	Bio-polishing / Singeing	Scouring-Bleaching	Dyeing	After-treatment	Washing	Stentering	Compacting
Exhaust	55	98	60	40	80	140	130
CPB	120	99	14	25	90	140	130

Table A7: Discussion on the result of colorfastness to washing (ISO 105-C06)

Dyeing method	Colorfastness to washing						
	Greyscale	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
Exhaust	4.5	4.5	4.5	4.5	4.5	4.5	4.5
CPB			4.5				4.5

Table A8: Discussion on the result of colorfastness to rubbing (ISO 105-X12)

Dyeing method	Colorfastness to rubbing	
	Dry condition	Wet condition
Exhaust	4.5	2.5
CPB	4	2

Table A9: Discussion on the result of colorfastness to water (ISO 105-E01)

Dyeing method	Colorfastness to water						
	Greyscale	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
Exhaust	4.5	4.5	4.5	4.5	4.5	4.5	4.5
CPB			4				4.5

Table A10: Discussion on the result of colorfastness to perspiration – acid & alkaline (ISO 105-E04)

Dyeing method	Colorfastness to washing						
	Greyscale	Acetate	Cotton	Nylon	Polyester	Acrylic	Wool
Exhaust	4.5	4.5	4.5	4.5	4.5	4.5	4.5
CPB			4				4.5

Table A11: Discussion on the result of ICI pilling resistance (ISO 12945-1)

Sample type	Rotation wise result of ICI pilling resistance in greyscale		
	7,200	10,800	14,400
Exhaust dyed sample		4	
CPB dyed sample		4	

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Faculty of Engineering Department of Textile Engineering Project (Thesis) on COMPARATIVE STUDY BETWEEN EXHAUST METHOD AND COLD-PAD BATCH (CPB) METHOD FOR DYEING 100% COTTON FABRIC Course Title: Project (Thesis) Course Code : TE-4214 Submitted By K. M. Rounoque, ID : 181- 23 -5256 Amit Kumar Sarkar, ID: 181-23-5267 Reduanul Karim, ID: 181-23-5282 Supervised By Tanvir Ahmed Chowdhury Assistant Professor Department of Textile Engineering Faculty of Engineering Daffodil International University This thesis is submitted in partial fulfillment of the requirements for the Degree of Bachelor of Science in Textile Engi neering. Advance in Wet Processing Technology Fall , 2021. DECLARATION We sincerely 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 the award of any degree . Name ID Signature **K. M.** Rounoque 181-23-5256 Amit Kumar Sarkar 181-23-5267 Reduanul Karim 181-23-5282 i LETTER OF APPROVAL The project is prepared by **K. M.** Rounoque; ID: 181-23-5256, Amit Kumar Sarkar; ID: 181-23-5267 & Reduanul Karim; ID: 181-23-5282. This project is submitted in partial fulfillment of the requirements for the degree of BACHELOR OF SCIENCE IN TEXTILE ENGI NEERING. The whole project is prepared under my supervision and guidelines. During the time of completing their project, the students were found sincere, punctual, and hard- working. I wish them every success in life -------------------------------- ----------------- TANVIR AHMED CHOWDHURY ASSISTANT PROFESSOR DEPARTMENT OF TEXTILE ENGINEERING FACULTY OF ENGINEERING DAFFODIL INTERNATIONAL UNIVERSITY ii ACKNOWLEDGEMENT At first, our absolution goes to Almighty Allah for giving us the strength and ability to complete our thesis. Now we would like to take the opportunity to thank a lot of people who have aided and motivated us in the completion of the Project Report. Md. Tanvir Ahmed Chowdhury, Assistant Professor of Daffodil International University our supervisor, to whom we are highly obliged for his enormous support and guidance throughout the time. Being working with him we have not only achieved valuable knowledge but also been motivated by his innovatives which heli::ied us to enhance our experience in g higher range. His idea and way of working were trulv. phenomenal. We are also expressing our gratitude to Asit Ghosh, Assistant Professor & Associate Head, Department of Textile Engineering, for his support and guidance throughout our long journey in Daffodil International University and industrial training . It's a great pleasure to express our satisfaction to The Impress- Newtex Composite Textiles Ltd. and authority for their sincere and cordial co-operation and we are very much obliged to MD. Nurul Islam Director Operations for his association in completion successfully. Another man who was the best guidance and support for us was our supervisor Md. Azad Hosen, Assistant Manager, R&D. We are very much in the debt for his love and support towards us. Thanks would not be enough to show our gratitude and love to him. Lastly, we must accept our Parents with due respect for their constant support, patients, and belief in our caliber which drives us in the successful completion of this report . iii DEDICATION This project § devoted to our beloved parents , honorable teachers, and fellow mates who always stand by us. iv ABSTRACT Dyeing is the operation of colorings or colors on cloth accouterments similar as filaments, yarns, and fabrics with the thing of achieving color with asked colorfastness. Dyeing is typically done in a g:iecial result containing colorings and particular chemical material . Color motes are fixed to the fiber by immersion, prolixity, or relating with temperature and time being crucial controlling fact ors . The bond between color patch and fiber may be strong or weak, depending on the color used. This paper shows the usual two methods of dying which are exhaust dyeing and CPB dying with their process difference. It also presents the results of different tests of the dyed fabric from these two dying methods. In this thesis, we use one type of single jersey fabric of the same construction for both dying processes. The dyed fabrics have been gone through different types of tests in the physical lab like; dimensional stability test, color fastness to- washing, rubbing, light, water, perspiration, ICI pilling resistance test. This thesis analyses the end lab results and presents if there is any difference in the dyed fabric to evaluate the overall better process for this type of single jersey. v Table of Contents Content Page No.

Discussion on the result of ICI pilling resistance (ISO 12945-1) Page No. 22 28 32 36 36 39 40 40 41 41 42 42 64 64 64 64 65 65 65 65 66 66 66 x Chapter-1 INTRODUCTION Ll . Dyeing One of the most essential processes in the cloth sector is dyeing. Dyeing is a process of adding color into cloth accouterments either in fiber, yarns, or fabric stage . The natural color of fibers (natural yarns and fabric) is out- white or slate. So dyeing is an important process for perfecting the aesthetic and look of the cloth accouterments. Dyeing is a value-added process and an essential part of cloth design. A dyeing liquor is made in a dyeing bath (pane) with dyeing chemicals and accessories . The fabric or other form of cloth accouterments are dipped into or passed through the dyeing bath. Dyeing can be performed in hot and cold liquor . Colorful types of chemicals, liquor rate, and temperature are involved in dyeing . Pigmenting manufactories and small dyeing houses follow dyeing form !O get demanded colors and shades of color in the cloth material or garments. As a single jersey fabric is made of cotton, we usually use reactive dye to dye the fabric. Reactive colorings combine directly with the fiber, performing in excellent colorfastness. The first ranges of reactive colorings for cellulose filaments were introduced in the mid-1950. Moment, a wide variety is available. It can be applied to fabric in two ways. Either by exhaust or CPB method. 1.1.1. Exhaust dyeing Exhaust dyeing is one of the most popular dyeing styles. Utmost of the colorings could be used for exhaust dyeing of cloth material. The exhaust dyeing process is used for chief fiber dyeing. Yarn and fabric could be dyed by an exhaust dyeing system. Color result or color bath is produced by dissolving the dye according to the needed liquor rate. Also, Textile material is immersed in the color result. Originally the face of the fiber is dyed when colorings communicate with the fiber, also the colorings are entered in the core of the fiber. Proper temperature and time are maintained for prolixity and penetration of colorings patch in the fiber's core. During the process, kinetic and thermodynamic responses interact. 1.1.2. CPB (Cold Pad-Batch) dyeing CPB dyeing is an advanced quality dyeing system for woven and knitted cellulosic filaments. The process reduces the use of swab, water, energy , dye, chemical and therefore significantly reduces the chemical attention of effluent . It 's dispensable to say that it facilitates bacterial treatment effectively . CPB dyeing attempts the utmost cost-effective and profitable approach of dyeing the cotton with reactive colorings. The elimination of swab addition also supports the minimal energy and water consumption; hence rendering it more eco-friendly and obsession with color is also much advanced. 1.2. Objectives of the study The objective of this study is to analyze both processes and differentiate them in many criteria such as pre-treatment, during dyeing, after treatment, time consumption, materials, product comparison, etc. The broad objective of the study: Comparative Study Between Exhaust Method and Cold-Pad Batch (CPB) Method for Dyeing 100% Cotton Fabric . To achieve the broad objective we had to go through some processes which we can consider as our specific objectives : • Analyses both exhaust and cold-pad batch (CPB) dyeing by production follow-up. • To know the process difference between exhaust and cold-pad batch (CPB) dyeing. • To know about the chemicals and machinery used for the processes. • Compare the results of different tests on dyed fabrics of two processes. Chapter-2 LITERATURE REVIEW 2.1 Dyeing process Dyeing and printing processes are value-added treatments for utmost cloth accouterments. A dyeing process is commerce between a color and a fiber, as well as the movement of color into the internal part of the fiber . Generally, a dyeing process involves adsorption (transfer of colorings from the waterless result onto the fiber face) and prolixity (colorings diffused into the fiber). In addition to direct immersion, dyeing may also involve the rush of colorings inside the fiber (handbasket colorings) or chemical response with the fiber (reactive colorings). For cotton part dyeing reactive dye is mostly used. Reactive color is the color that can reply with a fiber to form a covalent link, that's forming an endless attachment in the fiber and couldn't be removed by repeated treatment with scorching water under neutral conditions. Accordingly, the colorings come corridor of the fiber, leading to outstanding colorfastness to washing. Due to the advantages of full-color ranges, brilliance, high fastness, low cost, easy operation, etc., the reactive color came the predominant color for cotton dyeing and printing in cloth assiduity since it was constructed. Compared with direct color, reactive color is applied as easily as direct color but has veritably high situations of fastness, especially for wet fastness. 2.1.1. Objectives of dyeing The primary idea of dyeing is to apply livery color to the substrate (fiber, yarn, or fabric) with needed colorfastness. Tie-dye and printing are the styles where the color is applied in a localized manner . The main idea of dyeing are: ? ? To conduct color to cloth material slightly To achieve respectable continuity of the color to further treatment in product and normal use. ? ? ? To reproduce the needed shade from batch to batch To give and use an eco-friendly process Fixing the color in the shortest possible time. 2.1.2. Dye Selection There are multitudinous factors involved in the selection of colorings for coloring a fabric in a particular shade. Some of these are as follows: ? ? The type of fiber to be dyed. The form of the cloth material and the degree of status needed- position dyeing is less critical for loose fibers, which are latterly blended than it 's for fabric . ? The fastness parcels needed for any. posterior manufacturing processes and the particular end-use . ? ? The dyeing system to be used, the overall cost, and the ministry available The factual color needed OY. the client. For g v.eing cotton or cellulose fiber-made fabric, reactive dye is the most common dye that is used in the industries. So, for our thesis work, we also choose Reactive dye for dyeing methods. Textile dyeing can take place at different stages of the manufacturing of the cloth. There are colorful styles of cloth dyeing which are as follows : ? Fiber Stage Dyeing Method ? Yarn Stage Dyeing Method ? Fabric Stage Dyeing Method ? Garment Stage Dyeing Method Fabric Stage Dyeing Method In this system, color § applied to the fabric after its construction (woven or knitt ed). The fabric is submerged into the color bath to get the asked color. I!; 's the most common system of dyeing used. The colorful styles used for this type of dyeing include spurt dyeing . Jig dyeing, pad dyeing, and ray g v.eing. Most of the industries follow the fabric stage dyeing method. It can be done generally in ow methods in the industries. One of them is the exhaust method and the other one is the cold-pad batch dyeing method. 2.1.3. Factors affecting the choice of dyeing methods in textile The following is a list of factors that mandate the choice of conditions under which particular composites might best be dyed: ? Coloristic effect needed. Check is it a union, serve, tone-in-tone or what -additional? Ask the buyers what he wants and dye the fabric or any other cloth accouterments as per buyer conditions. ? Colorfastness is needed for the attendant dyeing. It 's worth mentioning that - before starting a dying process in the cloth you must have to ask your buyer that, what type of colorfastness property he/ she wants . Use grayscale to measure the colorfastness of the sample that you have dyed and let the buyers be informed about it . ? Felicity of the dyeing for posterior finishing processes. Finishing is the pivotal point to consider. Every dyeing process might have a different finishing process. Check what kind of finish you can serve . ? Comity of colorings from different operation orders with one another . Blended fiber or Mix cloth requires particular and fiber-specific colorings to be duly. I!; 's seen that ; if you use the usual dye to make an amalgamated fiber or amalgamated fabric g v.ed, also some corridor of that fabric has been dyed and some other corridors haven't been dyed . ? Vacuity of particular types of batch, semi-continuous and nonstop dyeing equipment . However, accouterments, colorings, and batches; how would you dye? So, If you don't have the needed instruments. ? Cost of the colorings and chemicals involved . It does completely depend on the buyers and on the services you give. If your buyers want amalgamated dyeing with good colorfastness and good condition; also you might have to rush to buy good chemicals and good colorings. And most important ly ; good services mean producing good products by using good accouterments. So it varies the cost . ? Economics of the overall process. The last thing one must have to consider; is Plutocrat. How about your budget? How important plutocrat do you want to spend to color these fabrics or filaments? 2.1.4. Different Types of Dyeing Methods or Processes: Figure 2.1.4: Different Types of Dyeing Methods . 2.1. 5. Process flow chart of conventional cotton knit dyeing The dyeing process is carried out with the help of colorings and chemicals Different types are used for dyeing knit fabric Cotton dyeing is the most important dyeing operation among all of the dyeing processes. From spinning to garments finished goods, a line of process is maintained . Cotton fiber and its generated finished goods are more comfortable than other filaments products. Cotton knit fabric dyeing is carried out as the following : Fabric entering Fabric examination Batching Demineralization Combing Bleaching Per-Oxide kills Wash Neutralization Dyeing Neutralization after dyeing Softening Fixing Dewatering/ Constricting DrY..ing Steering / Condensing Final Examination It is the full wet processing way of knit dyeing . The pre-treatment, dyeing, after treatment, and finishing process is expressed together. The most common two methods used in industries are Exhaust and Cold-Pad Batch methods. Now let's know about these methods. 2.2. Exhaust dyeing method 2.2.1. Introduction Exhaust dyeing is one of the most popular dyeing styles. Utmost of the dyes could be used for exhaust dyeing of cloth material. The exhaust dyeing process is used for chief fiber dyeing. Yarn and fabric could be dyed by an exhaust dyeing system. Dye result or dye bath is produced by dissolving the dye according to the needed liquor rate. , Also Textile material is immersed in the color result. Originally the face of the fiber is dyed when dyes communicate with the fiber, also the colorings are entered in the core of the fiber. Proper temperature and time are maintained for prolixity and penetration of the colorings patch in the core of the fiber. During the process, kinetic and thermodynamic responses interact. Figure 2.2.1: Exhaust dyeing. 2.2.2. Flow chart of Exhaust Dyeing Pretreatment Batch loaded Demineralization (50°C, 20 min; pH=4.5) Scouring & bleaching (100°Cx40 min.) Drain Rinse Drain Neutralization with acid (50°C x20 min) Hot Wash with peroxide killer (60°C, 20 min.) Drain Dyeing Leveling agent & Salt (60° x 20 min; PH=6) Color dosing (60°Cx20 min.) Run time= 10 min. (60°() Color migration (80°C x 20 min.) Cooling (60°() Level Check Soda dosing (60°Cx30 min) Dyeing run (Dark shade: 60 °Cx 60 min; Medium shade: 60° Cx 40 min; Light shade: 60° Cx 30 min) Dyeing sample check (If Ok) Drain After-treatment Rinse (with cold Water) Neutralization after dyeing (50°Cx20 min.) Drain Soaping (Hot wash) Drain Rinse Add finishing chemical (60°Cx20 min) Drain Unload 2.2.3. A basic process curve of Exhaust dyeing Figure 2.2.3: A basic process curve of Exhaust dyeing. 2.2.4. Advantages of exhaust dyeing ? Simple construction & thus provident to buy and operate . ? Suitable for all types of fabric especially light weights . ? It imposes much lower pressure than Jigger so it's suitable for delicate fabrics . ? Combing effectiveness is high due to lesser mechanical action caused by the constant reformation of lengthways crowds. ? Tubular knitted fabrics are trolled &g v.ed expansive because of the low pressure. ? Creases are developed due to lesser mechanical action & low pressure. ? The dyed fabric is thicker with a fuller handle, more fabric cover & better crinkle recovery. 2.2.5. Disadvantages of exhaust dyeing ? The temperature varies in the different corridors. The heating unit is present only in one cube so when the fabric leaves that cube it cools & also enters So, temperature- sensitive colorings it's a major debit. ? Inordinate movement may lead to undesirable felting in Hair fabrics. ? The fabric is desultorily piled & uneven dyeing may do unless suitable colorings & leveling agents are used. ? Due to the high liquor rate, color prostration Roor & a considerable quantum of color remains in the bath which hampers the frugality. ? Confirmation of running crimps during dyeing may not be removable indeed after st entering . ? Extension & distortion mav. do due to longitudinal pressure. ? Longer rope may beget trap at the bottom. 2.3. Cold pad batch dyeing (CPB 2.3.1. Introduction Cold pad batch dyeing (CPB) is an indispensable system of reactive dyeing that uses smaller coffers. With CPB there 's no need to apply heat during the process, and no swab or humectants are demanded, it's good practice to carry out color obsession in a heat-regulated room. The costs and the quality of a product define its success. The dyeing and posterior washing of knitwear in open range form is a complex process and is particularly applicable to these two parameters . Dyeing using the deep freeze pad batch (CPB) system is an established and dependable process for cotton fabric for carrying veritably good dyeing results with minimal use of coffers. The Schematic donation of Cold pad batch (CPB) dyeing of cotton knitted fabric is shown below : .Ei gure 2.3.1.1: Schematic donation of Cold pad batch dyeing (CPB). Figure 2.3.1.2: Cold Pad Batch Dyeing. 2.3.2. Flow chart of Cold Pad Batch Dyeing: Batch Preparation Slitting Singeing Scouring-Bleaching Stenter Dry Dye padding (CPB) Rotating(8-24) hour Washing Compacting Inspection Delivery The steps are: 1. The fabric is first padded in a padding murder with reactive color in presence of an alkali . 2. The paddedfabric is rolled in a batch and the batches are wrapped by polyethylene wastes and stored in wet condition for 16-24 hours at 20-30 °c in a room. 3. During the storehouseperiod, the rolls may be kept sluggishly rotated to help seepage of the color liquor. 4. After storing time is finished fabric is washed in open - range washing machine to removethe unfixed color from the fabric face. Figure 2.3.2: Process curve of cold pad batch dyeing. 2.3.3. CPB dyeing chemical ratio: ? Fabric: Dye = 1: 1 (Generally we take 40/50 liter extra). If the total dye liquor is 05. ? Then dyes will be 04 portions and chemical will be 01.? Total Dye (05) = Dye (04) + Chemical (01). 2.2.4. Cold pad batch (CPB) dyeing process: The ensuing Rrocess is followed - • Colorings and auxiliaries grounded on the base form are ladened using a balance or with an electronic pipett e. • Weighted colorings are mixed with 500 ml of water and stirred for 2 min. • According to the quality of the fabric padder Mathis is acclimated (generally 60 pick up). Then the sample , the fabric is set in the machine, and dyed liquor is poured in for padding . • The coming steR..§ to fix the color . The padded sample is put in a polythene bag for 5 min . Then a sample piece of that fabric is cut from the sample for rapid -fire obsession test bY. fryer oven. The sample is hung on a glass rod over the vassal containing about 50 ml of water and covering the sample and the vassal with a lid . At the power of 2 settings. The sample is fumed for 6 min . • For the color obsession, there are two styles. In one system the padded fabric is wrapped for 8 - 24 hours with a polythene bag. In the other system which is the raRi d -fire Rro cess, fryer woven is used. Then the dyeing piece should be kept in the fryer woven (power of 2) in plastic vassals with 50 ml of water for 6 min. • Next the sample is washed grounded on the washing condition . • Then the sample is dried using an iron . • It 's then set in the lightbox and audited for color matching . • If the color match with the client samRle then the trial ends and the sample is developed; if not also the form is acclimated and the trial continues following the same process until a sample match happens. 2.2.5. The impregnation processes During impregnation the following parameters are important: ? Temperature and rate of rotation of the color liquor ? Squeeze line in the padder? Absorbency of the fabric ? Fabric pressure Still, there's nothing different in the way of a reproducible, controllable, If these introductory conditions are controlled rightly. 2.2.6. Machine Factors An ultramodern CPB dyeing machine for knitwear should meet the following criteria : ? Centre unwinder (if fabric from batch) ? Member control comber for polarizing and feeding of knitwear ? Selvage uncurled in front of through and squeezing nip ? As numerous drives as possible ? Good availability and view 2.3.7. Advantages of Cold Pad Batch Dyeing? Reduced water consumption (more so if counter-flow washing ranges are used). ? Less affluent with veritably low Swab content-suitable for recovering with a single- stage RO with further than 85 permeability. ? Reduced energy consumption, as it 's done at room temperature. ? Advanced chance of color obsession. ? Excellent wet fastness parcels. ? No swab used - performing in easy color wash off and no swab being present in the effluent . ? Pre-dye checks can be carried out icing further fabric is dyed rightly. ? Productivity - one CPD machine can dye further fabric than a spurt machine. ? More suited to stretch fabrics and knits because it 's easier to manage pressure control in a small machine. ? Fabrics are smoother so no need to bio polish ? Fabrics are stronger than bio-polished fellows. 2.3.8. Limitations of CPB ? Compared to other reactive dyeing styles, similar to spurt dyeing, the disadvantages of CPB include: ? The dyed fabric product rate is low - requires at least 12hours of batching time for color obsession. ? Delicate to make emendations to out- shade batches so the pressure to get effects right first time. ? The Rrocess is not feasible unless high-quality ministry is used. ? Requires off-line bleaching and wash off which makes planning more complex . ? Requires an intermediate drying process after dulling.? Requires fabrics to have fully invariant humidity and temperature throughout to achieve optimum results. ? Immaculately requires a bite for colorings and thermo- regulated room for color obsession. 2.4. Selection of fabric For our thesis work, we choose single jersey knit fabric for conventional (exhaust) and CPB dyeing. We decided to go with the most common and available fabric of any industry. The construction and specification of the fabric are given below: Single jersey : Jersey fabric is g veritably common type of knit cloth that is made from cotton or cotton and synthetic mix. The common use of single jerseys is t-shirts and downtime coverlets. Single jersey is feeling warm, flexible, rubbery, and veritably separating, making it a popular choice for the layer worn closest to the body. Jersey fabric is also veritably soft and comfortable . Single jersey characteristics : ? The fabric face and reverse are unique. ? The twist or move of texture happens at the edges. ? Texture caricatures are demonstrated in all felicitations unmistakably in the texture. ? Texture unwinding happens from either side is conceivable. ? Consistence of texture is around double the breadth of yarn employed. ? There's just a single arrangement of darned circles per course in the texture. Single jersey features are: ? Feeling comfortable. ? Magnificent development, shape conservation, inconceivable serape capacity. ? Stupendous wrinkle rehabilitation. ? Shape conservation in knitwear is remarkable. ? Employed for both normally manufactured cowhide. ? Shoe uppers, Lycra gives 4-5 extend in shoes to give topmost solace to the wearer . ? Quality affecting high return in sewing Recuperation in the papers of apparel 100 Better protection from synthetic creations Figure 2.4: The structure of a single jersey. 2.5. Fabric parameters: Knitting: It's a procedure of texture made by changing over yarn into circle structure and after that, these circles interlock/ intermesh/ interloped together which structure a structure is called weaving or sewed structure. 2.5.1. Weft knit stitches It's the most well-known feathers utilized by the maker in producing material weaved particulars, for illustration, Shirts, and Socks. As far as shading designing, weft weave might be sewn with colorful yarns to produce a fascinating illustration plan. There aren't numerous feathers systems to deliver weft sew structure, Single pullover, Purl, and Rib are a portion of the procedure that has been utilized to produce weft sewed structure. 2.5.2. Course knit stitches Twist sewed is created from a lot of twist yarn. It's resembling weaved to one another down the length of the texture. Since weaved texture may have numerous grains, twist sewed is naturally done by machine. Figure 2.5. (1+2): Courses and wales. 2.5.3. Course per inch (CPI) During the same knitting cycle and are measured in units of courses per inch. The courses determine the length of the fabric. 2.5.4. Wales per inch (WPI) A monster is a perpendicular column of circles in the fabric which is produced by the same needle stitching at consecutive knitting cycles . The number of wales indicates the range of the fabric and they 're measured in the unit of wales per inch. Figure 2.5. (3+4): Courses per inch and wales per inch. 2.5.5. Sewing or Stitch Length A caricature is a perpendicular member of circles in the texture which is delivered by analogous needle sewing at progressive sewing cycles. The amounts of crests demonstrate the range of the texture and they're estimated in a unit of caricatures per inch. Figure 2.5.5: Stitch length. 2.5.6. GSM GSM implies grams per forecourt cadence of any suture woven or non-woven fabric. It 's critical to know the heaviness of any fabric before assembling and in the wake of getting the completed texture. It's introductory to quantify the heaviness of the texture to make sure about the completed cargo of the texture. This test can be done in colorful ways yet it's anything but delicate to know the heaviness of the texture by cutting the texture with a GSM shaper. 2.5.7. Yarn count Yarn count is numerical regard that conveyed its fineness or tastelessness. It likewise communicates if the yarn is thick or slim. Yam includes can be estimated in multitudinous frame still more frequently than not use two frames. They're circular frames and direct frames. Estimating yarn check of any texture is significant as GSM texture plan, texture type relies upon yarn census. Chapter-3 EXPERIMENTAL DETAILS 3.1 Materials at a glance This section will be mainly explained by focusing on two main factors. The first one is the material used and the other one is the process details of the method. Experimental grey fabric specification: Fabric type Fabric composition Exh. Grey fabric Stitch length (mm) CPB Grey fabric GSM (gm) Exh. Grey fabric Diameter CPB Exh Yarn count (Ne) CPB Single jersey 100% Cotton 2.80 2.65 160 70 76 28's 28's Table 3: Experimental grey fabric specification. Experimental methods of dyeing: ? Exhaust dyeing ? Laccifer lacca Kerr. and *Garcinia dulcis (Roxb.)* Kurz Bark", Advanced Materials Research, 201 3. " > Cold-Pad Batch (CPB) dyeing Experimental tests the finished Laccifer lacca Kerr. and *Garcinia dulcis (Roxb.)* Kurz Bark", Advanced Materials Research, 2013." > fabric has been gone through: ? Dimensional stability to washing ? Colorfastness to washing ? Colorfastness to Rubbing ? Colorfastness to Light ? Colorfastness to Water ? Colorfastness to Perspiration (Acid) ? Colorfastness to Perspiration (Alkali) ? ICI Pilling resistance Test results by: Physical Lab Impress-Newtex Composite Textiles Ltd. (3rd party lab quality with certification by BAB). We will present this whole thesis work through this chapter which will be divided into two main parts. One is the materials and the other one is a method. Every action or process detail with its component will be discussed through these two sub-chapters. Here, all the materials and machines will be mentioned according to their working stages and functions for both the exhaust and cold-pad batch (CPB) dyeing process. It will focus on: 1. Machine used in the process. 2. Dyes and chemicals used. 3. Functions of the dyes and chemicals in different stages. List of Raw materials (dyes & chemicals) used for dyeing: Figure 3.1: Raw materials used for dyeing. Figure 3.1: Raw materials used for dyeing. Figure 3.1: Raw materials used for dyeing. 3.1.2 Materials for Exhaust dyeing Method 3.1.2.1. Experimental grey fabric sample Figure 3.1.2.1: Experimental grey fabric sample. 3.1.2.2. Chemicals used in Exhaust dyeing Chemicals used in different stages of exhaust dyeing: (Recipe) Figure 3.1. 2.2 : Recipe of Exhaust dyeing with chemical & dye quantity. 3.1.2.3. Functions of chemicals in different stages of exhaust dyeing Stage Chemical Functions Detergent Emulsify oils, fat and waxes , expel oil borne - stains, suspend materials after they have been expelled Sequestering agent Evacuates hardness of water, Neutralize calcium and magnesium particles and some substantial metal particles in water Scouring & Anti-crease agent Reduces the disunion between fibers and fibers-dyeing tank that prevents crimps or scrapes, due to its soothing and softening goods Bleaching Caustic soda Kill acidic issue, waxes, oil, dust evacuate, Also go about as a swelling operator Stabilizer To control the decomposition of H_2O_2 H_2O_2 Utilized as blanching operators. Expels shaded contaminations, Whiten the texture Jin.Neutra acid Used for an acid wash. H_2O_2 killer used for removing the residual hydrogen peroxide from fabric blends Bio- Acid enzyme For the modification of the surface of cellulosic fabrics to reduce the hairiness and increase the resistance to pilling polishing Anti-crease agent Reduces the disunion between fibers and fibers-dyeing tank that prevents crimps or scrapes, due to its soothing and softening goods Leveling agent Work on the color patch and help in fixing the color patches slightly which enables to gain invariant shade Anti-crease agent Reduces the disunion between fibers and fibers-dyeing tank that prevents crimps or scrapes, due to its soothing and softening goods Dyeing Everzol Yellow 2GR Everzol Red 6BN Everzol Navy- ED During dyeing, the reactive group of this color Reactive forms a covalent bond with fiber polymer and dyes becomes an integral corridor of the fiber. Glauber salt Work as an electrolyte, perfecting the affinity of the dye towards the fiber accelerating the commerce of the dye, and reducing its solubility Soda ash light Changes the pH of the fiber-reactive color and cellulose fiber so that the color reacts with the fiber, making an endless connection that holds the color to the fiber Jin.Neutra acid Used for an acid wash. After Jingen SP AWP (soaping) Used for a normal wash of dyed fabric. treatment Pearl Soft Cat (cationic softener) Handling can be bettered by after-treatment with a cationic softener. Table 3.1.2.3: Functions of chemicals in different stages of exhaust dyeing. 3.1.2.4. Specification of the machine used in exhaust dyeing ? Machine No : 21 ? Origin : China ? Brand : Tonjong ? Body : Stainless steel ? Heating rate : 4°C/ min ? Cooling rate : 4°C/min ? Maximum working : 135°C temperature ? Maximum working : 3.2 Bar pressure ? Control : Manual + Automatic 3.1.3. Materials for cold-pad batch (CPB) dyeing method 3.1.3.1. Experimental grey fabric sample Figure 3.1.3.1: Experimental grey fabric sample. 3.1.3.2. Chemicals used in CPB dyeing process (only during dyeing) Chemicals used for dyeing: (Recipe) Figure 3.1.3.2: Recipe CPB dyeing with chemical & dye quantity. 3.1.3.3. Chemicals used in different stages of CPB dyeing & their function: Stage Chemical Functions Sequestering agent (Jingen SQ PBS) Neutralize the metal ion on the fabric surface Wetting agent (Prader JTLF AC) Helps to wet the fabric properly Scouring & bleaching Caustic soda Sequestering agent H2O2 H2O2 Stabilizer (JingenSTRS 200) Wetting agent Scouring and bleaching. Acetic acid 1. pH control by neutralizing the fabric. 2. Killing the rest of H2O2. Colorcontin SAN Work as a wetting agent for better dyeing performance Sarabid LDR A dispersing agent with sequestering and leveling properties for perfecting the solubility of reactive dyestuffs Dyeing Everzol Yellow LX Everzol Red ED-3B Everzol Black B 133% During dyeing, the reactive group of Reactive this color forms a covalent bond with dyes fiber polymer and becomes an integral corridor of the fiber. Caustic soda liquid Caustic soda is added to the solution to maintain the pH levels during the dyeing processes. Soda ash light Changes the pH of the fiber-reactive color and cellulose fiber so that the color reacts with the fiber, making an endless connection that holds the color to the fiber . Washing Acetic acid pH control (5.0) Detergent/ Soap Hot wash Stenting Cefasoft MSR (silicon softener) Improve the hand feel of the fabric Albafix FRD (fixer) Improve the fixation of dye with the fabric Table 3.1.3.3: Functions of chemicals during CPB dyeing. 3.1.3.4. Specification of the machine used in CPB dyeing ? Country of Origin : Made in India ? Shape : Bhatt Bros ? Automation Grade : Automatic ? Voltage : 440 V ? Padder Model : FHDH -180 ? Dia. Of Cylinder : 180mm ? Length : 900 mm ? Height : 1450mm ? Maximum Liner Pressure : 50 Kg/CML? Roller width : (1800 - 3600) mm ? Machine speed : (15 - 70) m/min ? Driving control mode : PLC, Frequency conversion AC drive ? Fabrics weight scope : (100 - 450) g/m2? Dosing pump : 1: 4 ? Fabric delivery type : Center batching 3.2. Methods of Exhaust and Cold-Pad Batch (CPB) dyeing processes This sub-chapter will describe the whole process of two dyeing processes. From the pre-treatment to finishing, every stage will be elaborated step by step in detail. 3.2.1. Process details of exhaust dyeing method Figure 3.2.1: Batch details of Exhaust dyeing 3.2.1.1: Dyeing As the total dyeing process is done in the machine. But from time to time observation and chemical insert timetable gives a clear idea about the stages of dying exhaust machine. The stages are : 1. Scouring & bleaching 2. Bio-polishing 3. Dyeing 4. After treatment Step 01: Scouring & Bleaching Fabric load with required water Temperature rising to 98°C Liquid Chemical injection Caustic soda dosing (OS min) Run for 50 min Steam up at 80°C Cold wash for 10 min PC hot wash at 80° C for 10 min with H2O2 killer Cold wash for 10 min ©Daffodil International University Step 02: Bio-polishing Take required water Temperature rise to 55°C Enzymes inject Run for 1 hour Hot wash at 80 / 70 ° C for 10 min Cold wash for 05 min Water drain Step 03: Dyeing Required water Leveling and anti-crease agent inject Salt dosing for 5 min Dye dosing for 30/35 min Run for 10/15 min at 60°C Then soda dosing for 40 min at 60° h Run for 10 min Shade check (color steam/running shed) The shade was ok. Color wash at S0°C Water drain Step 04: After-treatment Required water Temperature rise to 50°C Acid wash for 10 min Cold wash for 05 min Water drain and taking Hot wash (acid neutralization) at 80°C for20 min Cold wash for 20 min Water drain and again take Temperature rise to 40°C Softener dosing for 5/7 min Run for 10/15 min Fabric unload Finishing section (open width finish) 3.2.1.2. Slitting & de-watering machine Machine speed (m/min) 60 Over Feed% 2% Pre padder pressure 1.0 kg Post padder pressure 1.0 kg Table 3.2.1.2: Dewatering machine parameters. 3.2.1.3. Stenter machine Machine speed (m/min) 25 Over Feed % 25% Set width 180 Temperature 140°C 1st/2nd padder pressure 2.0 kg After GSM 150/155 Table 3.2.1.3: Stenter machine parameters 3.2.1.4. Compactor machine Machine speed (m/min) 24 Over Feed% 40% Set width 175 Temperature 130°C Pressure/steam Normal After GSM 155/158 After width 171 Table 3.2.1.4: Compactor machine parameters. 3.2.1.5. Process curve of Exhaust dyeing 3.2.1.6. Wet lab result Figure 3.2.1.6: Wet lab report. 3.2.1.7. Exhaust method dyed sample Figure 3.2.1.7: Exhaust method dyed sample. 3.2.2. Cold-Pad Batch (CPB) dyeing method 3.2.2.1. Singeing Fabric GSM 160 Quantity (kg) 1487 rated 16 Temperature 120°C Machine roller rpm 70 Process Both side Time 01 hour 10min (approximate) Table 3.2.2.1: Singeing machine parameters. 3.2.2.2. Scouring & bleaching The machine has 05 chambers.

Described below: Chamber no. Chamber name Process/ Work Chemicals Time & Temp. 01 Wetting Chamber 1. Neutralize the metal ion on the fabric surface. 2. Helps to wet the fabric properly. 1. Sequestering agent (Jingen SQ PBS 0.5g/l) 2. Wetting agent (Prader JTLF AC 0.5g/l) Normal temp. 6 min 02 Tagga Wash 01 (impregnation chamber) Scouring + Bleaching 1. Caustic soda (5.0g/1) 2. Sequestering agent (3g/l) 3. Wetting agent (5g/l) 4. H2O2 (7.0g/1) 5. H2O2 Stabilizer (JingenSTRS 200 1.0g/1) 08 sec 03 Steamer Dry the fabric. Water Steam 99°C 15 min 04 Tagga wash 02 1. pH control by neutralizing the fabric. 2. Killing the rest of H2O2. Acetic acid (3g/l) 99°C 06 min 05 Wash Drum Normal Wash 05 min Table 3.2.2.2: Scouring & Bleaching process parameters. 3.2.2.3. CPB Machine parameters: Total liquor in pad 15 liter per meter of width Immersion time 1.5 sec Bath temperature (14/15)°C Machine speed 40 m/min Pick-up% 80% Padder pressure Left Middle 1.2 1.8 Right 1.2 Total require time 02 hour (12.50 kg/min) Table 3.2.2.3: CPB Machine parameters Recipe calculation based on: ? Fabric : Dye= 1 : 1 (took 40/50 liter extra) ? Dye liquor : Chemical liquor = 4 : 1 3.2.2.4. Dyed fabric resting and rotation The dyed fabric roll rolled with thick polythene airtight and leave to rest for a certain time with a constant rotation rate. ? CPB out time: 11.20 pm ? Rest time: 16 hours? Wash time: 03.20 pm? RPM: 60 3.2.2.5. Washing These are 04 chambers in the washing machine. Here the ratio of fabric & water is always 1: 12. Chamber no. Chamber name Process/ Work Chemicals Fabric stays time & temp. 01 Normal wash Double drum Normal/ Cold wash Acetic acid (lgm/lt) (1-1.30) min 02 Parco wash 01 Hot wash Dark color: 90+°C Detergent/ Soap (1-2 gm/lt) (4-8) min 90°C 03 Parco wash 02 Hot wash Dark color: 90+°C No chemical (4-8) min 90°C 04 Cold wash Single drum pH control (5.0) Acetic acid (1-2 gm/lt) Room temperature Table 3.2.2.5 : Washing machine chemical quantity and parameters. 3.2.2.6. Stenter machine Applied chemical Cefasoft MSR (silicon softener) 40g/l Albafix FRO (fixer) 15 g/1 Chemical apply temperature Room temperature Machine speed (m/min) 30 Over Feed % 80% Set width 68 Temperature 140°C 1st/2nd padder pressure 5 / 2.5 After GSM 145/147 Table 3.2.2.6: Stenter machine parameters. 3.2.2.7. Compacting Machine speed (m/min) 24 Over Feed% 50% Set width 65 Temperature 130°C Pressure/steam Normal After GSM 158/160 (relaxed) After width 69/70 (relaxed) Table 3.2.2.7: Compactor machine parameters. 3.2.2.8. Process curve of CPB dyeing 3.2.2.9. Wet Lab report Figure 3.2.2.9 : Wet lab report of CPB dye sample. 3.2.2.10. CPB method dyed sample Figure 3.2.2.10: CPB method dyed sample. 3.3. Methods of experimental tests on the dyed samples 3.3.1 Dimensional stability to washing To determine the dimensional change of fabrics/ garments when subordinated to an applicable combination of specified washing and drying procedures . Test Method ISO 3759/ ISO 6330/ ISO 5077/ AATCC 150/ AATCC 135 This test system lli intended for the determination of dimensional changes in woven & knit fabrics/ garments when subordinated to repeated automatic laundering procedures generally used at home. The dimensional changes of textile instances subordinated to washing are measured using pair of benchmarks applied to the fabric before washing . Chemicals: Total 20 mg ? TAED: 3% ? Sodium perborate tetrahydrate: 20% ? ECE nonphosphate (detergent): 77% 3.3.2. Colorfastness to washing Color fattiness to washing means, A instance of the cloth, in contact with one or two specified conterminous fabrics, is mechanically agitated under described conditions of time and temperature in a cleaner result, also irrigated and dried The change in color of the instance and the staining of the conterminous fabric are assessed with the slate scales. Test method: ISO 105-C06 Process: ? ECE detergent: 04 gm/I? Sodium perborate: 01 gm/I? Water in the pot: 150 ml ? Sample fabric: (10*4) cm with same size cotton and wool fabric for color stain measure? Time: 30 min ? Double time cold wash with 100ml distilled water each time? Oven dry below 60 degree 3.3.3. Colorfastness to Water Colorfastness to Water testing is specifically used to measure the migration of color to another fabric when wet and in close contact . The washing test also generally uses an introductory PH result due to the addition of detergent, while this test is conducted in neutral PH situations. Test method: ISO 105-E0l Process: ? M:L: 1:50? Time: 30 min? Tapping: every 15 min? For 10 sample resin plate is 11 ? Pressure: 12.5 N ? Rest time: 4 hours, room temperature ? Oven dry: below 60 degree 3.3.4. Colorfastness to Perspiration To determine the resistance of the color of fabrics to the action of artificial mortal sweat when comes into contact with the body reference where perspiration is heavy (like neck, underarm, etc.) may suffer from original severe abrasion. The resistance to the color of cloth against the abrasion effect of acidic or alkaline perspiration is the colorfastness to perspiration. Test method: ISO 105-E04 Process:? M:L: 1:50 ?Time: 30 min ?Tapping: every 15 min? For 10 sample resin plate is 11? Pressure: 12.5 N? Rest time: 4 hours, room temperature? Oven dry : below 60 degree Chemicals: For acid, pH: 5.5 1. Histidinemono hydrochloride: 0.5g/l 2. NaCl: 5.0 g/1 3. Sodium hydrogen phosphate hydrate: 2.2 gm/l

For alkali, pH: 8.0 1. Histidinemono hydrochloride: 0.5g/l 2. NaCl: 5.0 g/l 3. Di-sodium hydrogen phosphate dihydrate: 2.2 g/l 3. 3.5. Color fastness to Rubbing Colorfastness to rubbing refers to the capability to sustain the original color of dyed fabrics when rubbing. Dry rubbing color fastness refers to the situation of fading and staining of dyed fabric when rubbed with a standard white cloth. Wet rubbing color fastness refers to the situation of fading and staining of dyed fabric when rubbed with a standard white cloth whose water content is 95 to 105. The evaluation of Rubbing color fastness depends on the degree of staining of white cloth. After testing, the white cloth is compared to staining sample cards to measure staining fastness. Test method: ISO 105-X12 Process: ? Force: 09 N ? To and fro: 10 times? Test fabric: 100% cotton woven finished (50*50) cm, finished without OBA? Process: • Lengthwise 2 times• Widthwise 2 times? Anger radius: 16 mm? Sample size: (140*5) cm minimum? Soak% of water for wet: 95-100 3.3.6. ICI Pilling resistance ICI Pilling Tester is used to assess fabric surface pilling and fuzzing by tumbling randomly. Test method: ISO 12945-1 Process information: ? Template: (12.5*12.5) cm? Sewing allowance: 1.5 cm? Rotation: 10,800 Chapter-4 DISCUSSION OF RESULTS 4. 1 Changes in CPI of fabric in Exhaust and CPB dyeing processes: At first, the CPI for the grey fabric of the illustration of the single jersey was being recorded. At that point, we recorded the CPI of each of the two exemplifications used in both processes. Also, we recorded the CPI of the dyed exemplifications. After that, we've established the distinction in the measure of CPI by a diagram applying the co-existing integer. Changes in CPI 70 60 58 54 52 54 CPI 50 40 30 20 10 0 Exhaust sample CPB sample Grey fabric 54 58 Dyed fabric 52 54 CPI change% 3.7 6.9 3.7 6.9 Diverse of time (before and after dyeing) Exhaust sample CPB sample Figure 4.1: Line diagram represents changes in CPI of fabrics after dyeing. The line diagram shows the variation in CPI of fabric before and after dyeing. In the line diagram, a diverse time is pointed horizontally or along the X-axis and the number of fluctuations in the CPI of fabric valuation is pointed vertically or along the Y-axis. For the alteration, the time of different conditions changes in CPI of fabrics decreases. Because, when the whole dyeing process has been completed. In the operation dust, dirt, oil is removed from the fabrics, and the color is added. From the line diagram, we can experience that for the single jersey, after dyeing processes change in CPI is actually little. After dyeing the GSM for both fabrics decreased a little, which means the fabric had expanded a little. So, CPI was decreased. Here the exhaust dyed fabric shows less CPI change percentage than the CPB dyed fabric. 4.2 Changes in WPI of fabric before and after the dyeing processes: At first, we recorded the WPI for the grey fabric of the illustration of the single jersey . At that point, we recorded the WPI of each of the two exemplifications used in both processes. Also, we recorded the WPI of the Dyed exemplifications. After that, we've established the distinction in the measure of WPI by a diagram applying the coexisting integer. Changes in WPI 35 34 35 32 32 WPI 30 25 20 15 10 5 0 Exhaust sample CPB sample Grey fabric 34 35 Category 2 32 32 WPI change% 5.9 8.6 5.9 8.6 Diverse of time (before and after dyeing) 40 Exhaust sample CPB sample Figure 4.2: Line diagram represents changes in WPI of fabrics after dyeing. The line diagram shows the variation in WPI of fabric before and after dyeing. In the line diagram, a diverse time is pointed horizontally or along the X-axis and the number of fluctuations in the WPI of fabric valuation is pointed vertically or along the Y-axis. For the alteration, the time of different conditions changes in WPI of fabrics decreases. Because, when the whole dyeing process has been completed. In the operation dust, dirt, oil is removed from the fabrics, and the color is added. From the line diagram, we can experience that for the single jersey, after dyeing processes change in WPI is actually little. After dyeing the GSM for both fabrics decreased a little, which means the fabric had expanded a little. So, WPI was decreased. Here the CPB dyed fabric shows more WPI change percentage than the exhaust dyed fabric. 4.3 Change in GSM of fabric in different processes: At first, we recorded the GSM for the grey fabric of the illustration of the single jersey . At that point, we recorded the GSM of each of the two exemplifications used in both processes. Also, we recorded the GSM of the exemplifications after different stages during the whole process of dying. After that, we've established the distinction in the measure of GSM by a diagram applying the co-existing integer. Changes in GSM 180 160 160 156 158 155 160 148 142 147 GSM (gm) 140 120 100 80 60 40 20 0 Exhaust sample CPB sample Grey fabric 160 160 After Dyeing 148 142 After stentering 156 147 Different processes After compacting 158 155 1.25 3.15 GSM change% 1.25 3.15 Exhaust sample CPB sample Figure 4.3: Line diagram represents changes in GSM of fabrics .in different processes. The line diagram shows the variation in GSM of fabrics before and after dyeing. In the line diagram, a diverse time is pointed horizontally or along the X-axis and the number of fluctuations in the GSM of fabrics valuation is pointed vertically or along the Y-axis. For the alteration, the time of different conditions changes in GSM of fabrics decreases. Because, when the whole dyeing process has been completed. In the operation dust, dirt, oil is removed from the fabrics, and the color is added. From the line diagram, we can experience that for the single jersey, after dyeing processes change in GSM is actually little. The final GSM decreases a little for both cases after the finishing processes. That means the fabrics expanded a little. But the percentage of change (decrease) in GSM is under the acceptable level. 4.4 Change in SL (mm) of fabric before and after the dyeing processes: At first, we recorded the SL for the grey fabric of the illustration of the single jersey . At that point, we recorded the SL of each of the two exemplifications used in both processes. Also, we recorded the SL of the Dyed exemplifications. After that, we've established the distinction in the measure of SL by a diagram applying the coexisting integer. Changes in SL 3.8 Stitch length (mm) 3.5 3 2.5 2 1.5 1 0.5 0 Exhaust sample CPB sapmle 2.8 Grey fabric 2.8 2.65 2.65 2.7 Dyed fabric 2.7 2.55 2.55 SL change% 3.6 3.8 4 3.6 Exhaust sample CPB sapmle Figure 4.4: Line diagram represents changes in SL of fabric after dyeing. The line diagram shows the variation in SL of fabrics before and after dyeing. In the line diagram, a diverse time is pointed horizontally or along the X-axis and the number of fluctuations in the SL of fabrics valuation is pointed vertically or along the Y-axis. For the alteration, the time of different conditions changes in SL of fabrics decrease. Because, when the whole dyeing process has been completed. In the operation dust, dirt, oil is removed from the fabrics and color is added. So, with heat the fabric shrink a little. From the line diagram, we can experience that for the single jersey, after dyeing processes change in SL is little. After heat-setting the fabrics expanded in a very little quantity. It occurs to be in change in SL of the fabrics. The CPB dyed fabric shows a little more percentage in change of SL than the exhaust dyed fabric. 4.5 Required time (min) for different processes in dying methods: At first, we recorded the required time for different processes in exhaust method dying. At that point, we only focus on the main or major processes, not within them the sub-processes. Then, we recorded the required time for different processes in the CPB method dying. One or two major processes may not be the same but they are also been recorded for the thesis. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer. Comparison of required time Required time (min) 140 120 100 85 95 120 90 80 60 70 60 40 20 0 0.025 16 0.33 polisgheiinngg/Sin Bleachng Scouring- Dying Rotation (in After- Bio- hour) treatment Exhaust method 85 95 120 90 CPB method 70 60 0.025 16 0.33 Different processes Exhaust method CPB method 30 35 Washing 30 35 Figure 4.5: Line diagram represents the required time for different processes in dyeing. The line diagram shows the variation in the required time for different processes in both dying methods. In the line diagram, different processes are pointed horizontally or along with the X- axis and the required time required for those processes valuation is pointed vertically or along the Y-axis. Here both processes passes through almost same stages. But CPB dyeing is very fast but the dyed fabric has to be in rest (rotating) for a long period of time. It also need of wash after resting where in Exhaust it is done within the machine as a stage of dyeing. The overall time for a normal exhaust dyeing is almost 08 hours where CPB dyeing requires almost a whole day. 4.6 Changes in the temperature for different processes in dying methods: At first, we recorded the required temperature for different processes in exhaust method dying. At that point, we only focus on the main or major processes, not within them the sub-processes. Then, we recorded the required temperature for different processes in the CPB method dying. One or two major processes may not be the same but they are also been recorded for the thesis. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer. Changes in temperature Required temperature (^{0} C) 160 140 120 120 100 98 99 80 90 80 55 60 60 40 40 20 14 25 0 Bio- polishing/Si SBcloeuacrihnngg- Dying treAafttmere-nt Washing ngeing Exhaust method 55 98 60 40 80 CPB method 120 99 14 25 90 Different processes Exhaust method CPB method 140 140 130 130 Stentering Compacting 140 130 140 130 Figure 4.6: Line diagram represents changes in the temperature for different processes. The line diagram shows the change in CPI of fabric over time. In the line diagram, a different time is indicated horizontally or along the X-axis and the number of changes in the CPI of fabric value is indicated vertically or along the Y-axis. For the change, the time of different conditions changes in CPI of fabrics decreases. Because, when the scouring process has been completed. In the process dust, dirt, oil is removed from the fabrics. From the line diagram, we can see both processes have to go through the same stages. Bio- polishing is done in exhaust whereas CPB requires singeing. The most variable in temperature is seen in the dyeing process. As CPB is a cold pad process it requires a very low temperature. On the other stages, the fluctuation of temperature is not that much.

Only singeing is burning with the help of gas, so it is natural for that for being at a high temperature. The dyed samples had also gone through some physical lab tests as mentioned earlier. These reports will present the quality of the dyed fabric aspect of the dyes applied to them. Let's follow the test results to construct a decision about which process stands well. 4.7 Discussion on the result of colorfastness to washing (ISO 105-C06) At first, we test the exhaust dyed sample along with the multi-fiber. Here, staining on multi- fiber is also paly an important role. On the other hand, we also test the CPB dyed sample along with multi-fiber. But, here only staining on cotton and wool is counted. The whole test result is represented by Grey Scale where the value is 1 to 5. Iindicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer. Color fastness to washing 5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 4.5 Grey scale value 4 3 2 1 0 Grey scale Acetate Exhaust sample 4.5 4.5 CPB sample 4.5 Grey scale & staining on multi-fiber Cotton 4.5 4.5 Nylon Polyester Acrylic 4.5 4.5 4.5 Wool 4.5 4.5 Exhaust sample CPB sample Figure 4.7: Line diagram represents the result of colorfastness to washing. The line diagram shows the result of colorfastness to the washing of the dyed fabrics. In the line diagram, the result of colorfastness to washing of the dyed fabrics in greyscale and staining on multi-fiber is indicated horizontally or along the X-axis and the value of greyscale § indicated vertically or along the Y-axis . We can see that both fabrics show good dying quality by scoring 4.5 in both greyscale and staining results on multi-fiber. So, we can wash these fabrics with any type of fabric without any risk of color bleed. That means we can achieve good dying from both processes under their favorable conditions. 4.8 Discussion on the result of colorfastness to rubbing (ISO 105-X12) At first, we prepare the cut part from the fabric for the test and also fulfill the conditions for wet rubbing test Then, we tested the exhaust sample in both dry conditions and recorded the result. Then,we tested the CPB dyed sample also in both conditions and recorded the result. The whole test result is represented by Grey Scale where the value is 1 to 5. Where 1 indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the co-existing integer. Color fastness to rubbing 5 4.5 Grey scale value 4 3 2 1 4 2.5 2 0 Dry condition Wet conditon Exhaust sample CPB sample 4.5 4 Test conditions (dry and wet) 2.5 2 Exhaust sample CPB sample Figure 4.8: Line diagram represents the result of colorfastness to rubbing. The line diagram shows the result of colorfastness to the washing of the dyed fabrics . In the line diagram, the result of colorfastness to washing of the dyed fabrics is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-a xis . In exhaust dying from pre-treatment to after-treatment all processes are done in one time whereas in CPB dying after-treatment is done during stenting. So, sometime this after- treatment left a very little quantity of unfix dye on the surface and dry the fabric. These happened to be stain on the test fabric. That's why exhaust performed better than CPB in both condition scoring 4.5 and 4 greater than 2.5 and 2 respectively on grey scale. That means exhaust stands well than CPB in rubbing test. 4.9 Discussion on the result of colorfastness to water (ISO 105-E0l) At first, we test the exhaust dyed sample along with the multi-fiber. Here, staining on multi- fiber is also paly

an important role. On the other hand, we also test the CPB dyed sample along with multi-fiber. But, only staining on cotton and wool is counted. The whole test result is represented by Grey Scale where the value is 1 to 5. Where 1 indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer. Color fastness to water Grey scale value 4 3 2 1 5 4.5 4.5 4.5 4.5 4 4.5 4.5 4.5 4.5 4.5 Exhaust sample 4.5 4.5 CPB sample 4.5 0 Grey scale Acetate Grey scale & staining on multi-fiber Cotton 4.5 4 Nylon Polyester Acrylic 4.5 4.5 4.5 Wool 4.5 4.5 Exhaust sample CPB sample Figure 4.9: Line diagram represents the result of colorfastness to water. The line diagram shows the result of colorfastness to the water of the dyed fabrics . In the line diagram, the result of colorfastness to the water of the dyed fabrics is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-a xis . We can see that both fabrics show good dying quality where the exhaust dying value on both greyscale and multi-fiber staining is 4.5. But, for CPB though the greyscale value is 4.5 it shows a little stain on the cotton. That means if more of these types of cotton clothes soak in the water together there is a chance of color bleed on a very low scale. So, when soaking in water with other cotton fabric we have to be careful and use detergent to clear the bleed color. 4.10 Discussion on the result of colorfastness to perspiration - acid & alkaline (ISO 105-E04) At first, we test the exhaust dyed sample along with the multi-fiber. Here, staining on multi- fiber is also paly an important role. On the other hand, we also test the CPB dyed sample along with multi-fiber. But, only staining on cotton and wool is counted.

The whole test result is represented by Grey Scale where the value is 1 to 5. Where 1 indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer. Color fastness to perspiration Grey scale value 5 4.5 4.5 4 3 2 1 4.5 4.5 4 4.5 4.5 4.5 4.5 4.5 0 Grey scale Acetate Exhaust sample 4.5 4.5 CPB sample 4.5 Grey scale & staining on multi-fiber Cotton 4.5 4 Nylon Polyester Acrylic 4.5 4.5 4.5 Wool 4.5 4.5 Exhaust sample CPB sample Figure 4.10: Line diagram represents the colorfastness to perspiration - acid & alkaline . The line diagram shows the result of colorfastness to the perspiration of the dyed fabrics . In the line diagram, the result of colorfastness to the perspiration of the dyed fabrics is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-axi s. We can see that both fabrics show good dying quality and prevention against perspiration of both types. The exhaust dying value on both greyscale and multi-fiber staining is 4.5. But, for CPB through the greyscale value is 4.5 it shows a little stain on the cotton scoring 4 on greyscale. That means if CPB dyed cotton clothes come in contact with perspiration (both acid or alkaline) it may bleed or lose color on a very low scale with time and finally results to shade fading or dead color effect . So, these fabrics need quick washing right after soaking with perspiration . 4.11 Discussion on the result of ICI pilling resistance (ISO 12945-1) At first, we had to prepare the test specimens as per the ISO standards for both dyed samples. Then, we tested the exhaust dyed sample by ICI pilling test machine with a revolution number of 10,800 and examined it with greyscale. After that, we did the same procedure to the CPB dyed sample and noted the result. The whole test result is represented by Grey Scale where the value is 1 to 5. Where 1 indicates the worst and 5 is excellent. After that, we've established the distinction in the measure of required time by a diagram applying the coexisting integer. ICI pilling resistance 5 Grey scale value 4 4 4 3 2 107,200 14,400 10,800 Exhaust sample 4 CPB sample 4 Test revolutions Exhaust sample CPB sample Figure 4.11: Line diagram represents the result of the ICI pilling resistance test. The line diagram shows the result of ICI pilling resistance of the dyed fabrics. In the line diagram, the result of ICI pilling resistance of the dyed fabrics is indicated horizontally or along the X-axis and the value of greyscale is indicated vertically or along the Y-axi s. We can see that both fabrics show good dying quality whereas the exhaust dyed sample and the CPB dyed sample both score 4 in the greyscale test. That means if we are concerned about storing these fabrics with other fabrics or with the same, there will be almost no chance of color mixing among them. So, storing, packaging, or delivery (normal rubbing among the fabrics) will not affect the quality of color of the fabrics. Chapter-5 CONCLUSION Dyeing is undoubtedly an irreplaceable and essential part of the textile industry. Throughout this study, we tried to overview the most tow methods of dyeing. We tried to review all the stages of these processes in detail. During our study, we came up with some vital points that can be helpful to differentiate the processes and have a clear idea about them in a nutshell. Let's look over those points: ? Change in CPI after dyeing is decreasing. The decrease in CPI is seen more in the CPB dyed fabric than exhaust . ? Change in WPI after dyeing is also decreasing. The decrease in WPI is also seen more in the CPB dyed fabric than exhaust . ? Though it is under an acceptable level. But the higher percentage in GSM change is shown in the CPB dyeing method (3.15%). ? Changes in SL are not a major issue and it didn't seem as vast. But in here also the CPB dyed fabric shows more change percentage than the exhaust dyeing fabric. ? At a glance it may seem like CPB dyeing requires very little time. But with rotation, the overall time reaches almost a full day as compared to only 8-10 hours of exhaust dyeing. ? Temperature has mainly fluctuated in two processes. In CPB it requires singeing which is basically gad burning at high temperature. Also as it is a cold pad dyeing, the dyeing temperature is way less than in exhaust. For any colorfastness test, the exhaust dyed fabric is tested with multi-fiber but the CPB dyed sample is tested with only cotton and wool fabric. ? Exhaust is tested with multi-fiber but CPB is tested only with cotton and wool. But they showed the same colorfastness in the greyscale test for washing (4 .5) . ? For rubbing in both dry and wet conditions the exhaust dyeing fabric showed better colorfastness in the greyscale test. ? In terms of water the CPB sample is a little less than the exhaust sample for cotton fabric (4). But in others, they both showed the same colorfastness in the greyscale test (4.5) . ? Test of perspiration (acid & alkali) showed that the CPB sample is a little less than the exhaust sample scoring a 4 point for cotton. But in others, they both showed the same colorfastness in the greyscale test (4.5) ? In the ICI pilling resistance test both fabrics showed good performance with a score of 4 in greyscale. Although both these methods are best in their own categories . But the CPB method requires much less water than the exhaust dyeing method . On the other hand, CPB requ ires almost 3 times more time than exhaust, need a lot of space for rotation of fabric, and above of all vast amount of dyes and chemical for dyeing. The desirable shade achievement is also a challenge in CPB. During the study, we learn about both Exhaust and CPB dyeing processes briefly. Hopefully, this practical knowledge will be helpful in our future life. REFERENCE

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APPENDIX Table Al : Changes in CPI of fabric in Exhaust and CPB dyeing processes Sample type Grey fabric Changes in CPI Dyed fabric CPI change % Exhaust dyed sample 54 52 3.7 CPB dyed sample 58 54 6.9 Table A2: Changes in WP! of fabric before and after the dyeing processes Sample type Grey fabric Changes in CPI Dyed fabric CPI change% Exhaust dyed sample 34 32 5.9 CPB dyed sample 35 32 8.6 Table A3: Changes in GSM of fabrics in different processes Sample type Changes in GSM (gm) GSM change % Grey fabric After dyeing After stentering After compacting Exhaust dyed sample 160 148 156 158 1.25 CPB dyed sample 160 142 147 155 3.15 Table A4: Changes in SL (mm) of fabric before and after the dyeing processes Sample type Grey fabric Changes in SL (mm) Dyed fabric SL change % Exhaust dyed sample 2.80 2.70 3.6 CPB dyed sample 2.65 2.55 3.8 Table AS: Required time (min) for different processes in dying methods method Dyeing Required time (min) Bio- polishing / Singeing Scouring- Bleaching Dyeing Rotation (in hour) After- treatment Washing Exhaust 85 95 120 No rotation 90 30 CPB 70 60 0.025 16 0.33 35 Table A6: Changes in the temperature (°C) for different processes in dying methods method Dyeing Changes in the temperature (°C) Bio- polishing / Singeing Scouring- Bleaching Dyeing After- treatment Washing Stentering Compacting Exhaust 55 98 60 40 80 140 130 CPB 120 99 14 25 90 140 130 Table A7: Discussion on the result of colorfastness to washing (ISO 105-C06) method Dyeing Colorfastness to washing Greyscale Acetate Cotton Nylon Polyester Acrylic Wool Exhaust 4.5 4.5 4.5 4.5 4.5 4.5 4.5 CPB 1 .S 4.5 Table AS: Discussion on the result of colorfastness to rubbing (ISO 105-X12) method Dyeing Colorfastness to rubbing Dry condition Wet condition Exhaust 4.5 2.5 CPB 4 2 Table A9: Discussion on the result of colorfastness to water (I SO 105-E0l) method Dyeing Colorfastness to water Greyscale Acetate Cotton Nylon Polyester Acrylic Wool Exhaust 4.5 4.5 4.5 4.5 4.5 4.5 4.5 CPB 4 4.5 Table Al0: Discussion on the result of colorfastness to perspiration - acid & alkaline (ISO 105-E04) method Dyeing Colorfastness to washing Greyscale Acetate Cotton Nylon Polyester Acrylic Wool Exhaust 4.5 4.5 4.5 4.5 4.5 4.5 4.5 CPB 4 4.5 Table All: Discussion on the result of !CI pilling resistance (ISO 12945-1) Sample type Rotation wise result of !CI pilling resistance in greyscale 7,200 10,800 14,400 Exhaust dyed sample 4 CPB dyed sample 4

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