DAFFODIL INTERNATIONAL UNIVERSITY

Faculty of Engineering

Department of Textile Engineering

Thesis paper on

STUDY ON THE EFFECT OF BIO-POLISHING ON KNIT FABRIC PROPERTIES

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

Advance in Wet Processing Technology
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DECLARATION

We hereby declare that, this thesis paper has been done 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 thesis paper nor any part of this paper has been submitted elsewhere for award of any degree or diploma.

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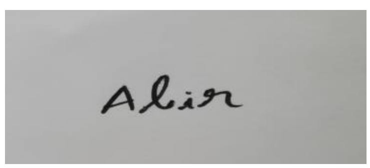

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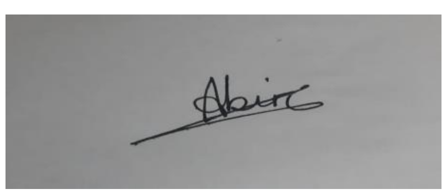
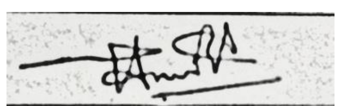


LETTER OF APPROVAL

This project report prepared by **Enamul Hasan Abir** (ID: 181-23-5270) and **Md. Abir Khan** (ID: 181-23-5276), is approved in Partial Fulfillment of the Requirement for the Degree of BACHELOR OF SCIENCE IN TEXTILE ENGINEERING. The said students have completed their project work under my supervision. During the research period I found them sincere, hardworking and enthusiastic.



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ABSTRACT

The main purpose of this paper is to investigate the quality improvement based on before and after bio-polishing process on different types of fabrics. The research was done on s/jersey, 1x1 rib, single lacost and terry fabric. Carefully monitoring has been done on fabrics GSM, stitch length, pilling test and yarn count. Comparison been done on each fabric made of 100% cotton yarn and CVC yarn. The outcome illustrates after bio-polishing process at certain temperature, concentration and time, fabrics quality gotten significantly improved. Not only it decreases fabrics pill formation tendency but also makes it more lustrous. The four aspects has been evaluated with table and graphs. The results obtained has been showed separately in different sections and subsections according to topic.

TABLE OF CONTENT

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CHAPTER-01

INTRODUCTION

1. Introduction:

1.1. Background

Textile industry is among the most important industries around the world. This industry provides one of the five basic needs of human. Textile industry also plays a significant role in building the economic block of a country. Nowadays, its importance is growing more and more all over the world. Along with it its demand is increasing further. Textile industry has a lot of classes. The industry provides different sorts of category products. Starting from clothing and protective gear to blanket and sheet for worming. They also produce products other than human comforting and aesthetic purposes such as equipment filter, protective covering for planting, covering, harvesting and covering crops, geo-tube for soil embankment, single sheet covering for construction purposes and so on. They are also playing active roles in medical field providing artificial veins, heart valves and other medical implants to improve lifespan of many people. The industry also playing leading role in economic solution of the country. Textile industry is giving billion dollar solution of a country along the unemployment solution with offering millions of job openings leading major role in GDP of the country. One of the most important parts of textile industry is dyeing industry. There are a lot of processes involved in dyeing industry. Bio-polishing is one of them. Hairy fiber degrades fabrics quality. It increases fabrics pill formation tendency and makes it less lucrative and lustrous. As a result it degrades fabrics quality and demand. Bio-polishing is one of the most commonly practiced wet processing stages applied on knit fabric which creates a permanent effect on fabric's surface. It is similar to singing process. Unlike singing process, bio-polishing is a chemical process only applied on cotton fabric. The process can be done before or after dyeing process. It is generally done after bleaching process. For bio-polishing, cellulase enzyme is used as chemical. It is done by hydrolysis action of enzyme. The process is eco-friendly and bio-degradable. It makes fabric more lustrous and enhances handle properties. It is performed at specific temperature, time and concentration. The process removes hairy fibers from fabric surface. As a result, reduces fabrics weight. As well as it also slightly effects fabrics strength by reducing it to a certain level. After bio-polishing, fabrics surface become smoothens so rubbing properties also improved. Besides, it also improves fabrics quality. As a result, it increases fabrics aesthetic value and increase its demand.

1.2 Project Objective:

The main objective of the project is to compare with the different types of physical properties of knit fabric on before and after bio-polishing process. Besides the physical properties the research was done,

- To check different types of fabrics surface change after bio-polishing.
- To check yarn count, GSM and stitch length.
- To compare result between 100% cotton and CVC fabrics.
- To compare results among different types fabrics.

CHAPTER-02

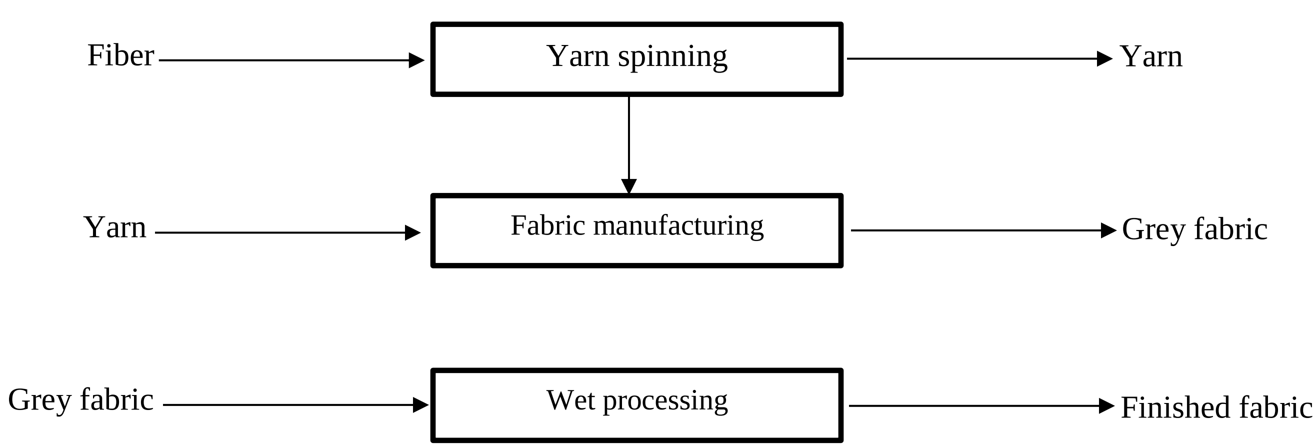
LITERATURE REVIEW

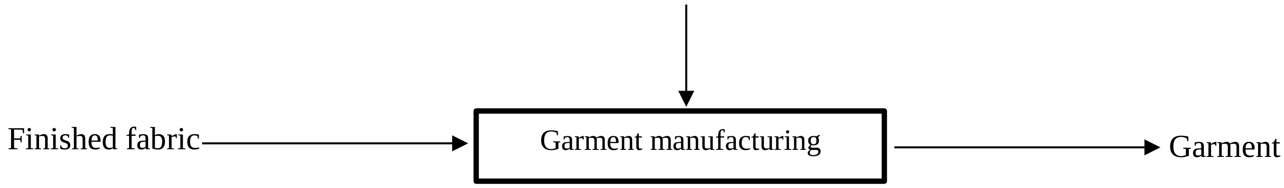
2. Literature Review:

2.1 History of enzyme:

The term enzyme comes from the Greek word "Enzymos "means from or in the cell. [Wikipedia] Up to early 18th century, mechanism of meat digestion by stomach sercretions and converting startch to sugar was still unknown. The first enzyme “diatase” was discovered by the French chemist Anselme Payen in 1833. Few decades later, another French chemist Luis Pasteur while studying fermentation of sugar by yeast concluded that fermentation of yeast is caused by a vital force. He named it as “ferments”. The term “enzyme” was first used by German physiologist Wilhelm Kühne in 1877. Later the word enzyme is used for only non-living substance and ferments for living substance. [Britannica] In 1897 at University of Berlin, Eduard Buchner experimented that sugar can be extracted from yeast even when there are no living organisms. He named the organism “zymase”. The discovery of “Cell-free fermentation” awarded Eduard Buchner “Nobel Prize” in 1907. By Buchner’s example, enzyme was named according to the substrate or the type of reaction. Despite all the biochemical identity of enzymes was still unknown upto early 1900s. In 1926, James B. Sumner discovered, enzyme “urease” was a pure protein. In 1937, he discovered similar nature at “catalase” enzyme. Later complete demonstration of pure protein enzyme in pepsin, trypsin and chymotrypsin was shown by John Howard Northrop and Wendell Meredityh Stanley. For their outstanding work, these three scientists were awarded Nobel Prize in 1946. Finally in 1965, David Chilton Phillips discovered that, by x-ray crystallography enzymes structured and working procedures could be observed in detail. The experiment was first done on the enzyme “lysozyme”. This breakthrough perused the biological field to acquire knowledge of enzymes nature and working procedure from atomic level of detail.

2.2 Flow chart of textile industry





2.3 Fabric

Basic textile materials can be produced by interloping, interlacing or networking natural or artificial yarn or fiber to produce a supple sheet material.

2.4 Fabric types

There are four types of fabric.

i. Woven
ii. Non- woven
iii. Knitted
iv. braided

2.5 Yarn

Linear assembles of fiber or filament that are twisted in order to make strong or laid together to form a continuous strand, which are suitable to manufacture fabric. It can also define as arrangement of fibers uniformly to continuous mass of fiber bound together by twist.

2.6 Types of yarn

Yarn can be classified into various types. Some commonly used examples are,

i. Length of fiber
a. Spun yarn
b. Filament yarn

ii. Type of fiber
a. Single fiber
b. Multi fiber

iii. Number of strand
a. Single yarn
b. Ply yarn
c. Cable yarn

iv. Formation of yarn
a. Ring yarn
b. Rotor yarn
c. Air jet yarn
d. Vortex

v. Use of yarn
a. Woven
b. Knit

vi. Process sequence of manufacturing
a. Carded yarn
b. Combed yarn

2.7 Knit fabric

Knit fabric is produced by making yarn interloping or inter-mashing with each other. It is lees strong and has less stable structure compared to woven fabric. It has a variety of usage. Such as, polo shirt, socks, jeans, jogger, sweater and other delicate products.

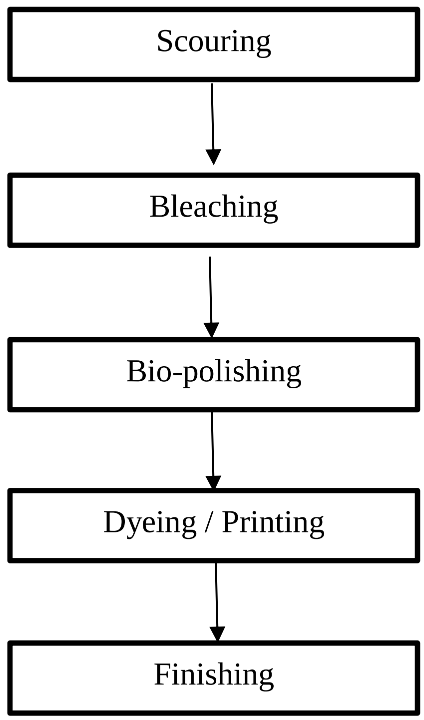
2.8 Classification of knit fabric

Knit fabric is commonly classified into four types. These are,
a. Single jersey fabric
b. Rib fabric
c. Interlock fabric
d. Purl fabric

2.9 Wet processing

The process which is carried out on aqueous stages on textile substrate for various wet processing stages such as scouring, bleaching, mercerizing and dyeing is called wet processing. It is the most important part of textile industry. It enhances fabrics quality and gives an aesthetic value.

2.10 Flow chart of wet processing for knit fabric



2.11 Pre-treatment

The process which is carried out before dyeing on textile substrate is called pre-treatment process. [textileapex.blog] It is called the heart of wet processing. It increases fabrics strength and ensure good absorbency. Some examples of pre-treatment process are, scouring, bleaching, mercerizing and bio-polishing.

2.12 Enzyme

The term enzyme comes from the Greek word "Enzymos "means from or in the cell. The first enzyme was discovered by French chemist Anselme Payen. In 1897, Eduard Buchner discovered the enzyme “zymase” from the yeast cell. It is naturally available, high molecular weight and most of them are proteins made up to more than 250 amino acid groups. It works similar to catalyst in the living organism. [Infinitabiotech] Enzyme activity can be controlled by temperature and pH. The first enzyme application on textile industry was done in Japan in 1989. Now-a-days, the usage of enzyme in textile industry is increasing. Currently a lot type of enzyme has been using on various textile wet processing stages.

2.13 Advantages of enzyme

i. Eco-friendly and biodegradable.
ii. Reduce water, chemical, and energy.
iii. Easily controllable.
iv. Can be used for a longer period of time.

2.14 Disadvantages of enzyme

i. May cause allergic reaction.
ii. Production cost is expensive.
iii. Easily denatured to the environment.
iv. May damage substrate.

2.15 Enzymes working procedure

Enzyme's working procedure is compared to lock and key. The enzyme has an active site, where the enzyme and substrate molecule reaction take place. During the reaction, the enzyme molecule changes its shape according to the shape of substrate molecule. [Infinitabiotech] After so enzyme and substrate molecule get closer to each other and create enzyme-substrate compound. After reaction completion, products leave the active side of the enzyme and thus enzymes are regenerated.

2.16 Commonly practiced enzyme in textile industry

Serial No.	Name of enzymes	Effects
01.	Cellulase	Remove hairy fibers from fabric surface
02.	Protease	Used as bio-scouring agent to remove protein and wax substance
03..	Catalase	Kills peroxide
04.	Amylase	Remove size material from fabric surface
05.	Pectinase	Decompose pectine
06.	Lipase	Hydrolyses oil and fat
07.	Collagenase	Remove wool skin parts
08.	Nitrilase	Provide better coloration
09.	Ligninase	Separate plant parts from wool

2.17 Bio-polishing enzyme

Bio-polishing is a wet processing stage applied on cotton fabric to enhance fabric's quality by reducing pill formation tendency of the fabric. It is mainly done by cellulase enzyme. The process is 100% eco-friendly and bio-degradable. [Textile learner]

2.18 Advantages of bio-polishing

i. Improve fabric handle properties

ii. Smoothen fabric surface.

iii. Reduce hairiness and pilling tendency

iv. Increase fabric luster.

2.19 Disadvantages of Bio-polishing

i. Reduce fabric weight.

ii. Decrease fabric strength.

iii. Too much usage may end up damaging the fabric.

2.20 Factors affecting enzyme reaction

2.20.1 Temperature

Enzyme works at a temperature of 37˚-45˚C. In this region it has the highest reactivity. Its reactivity started to decrease after 55˚C. It cannot sustain after 80˚C.

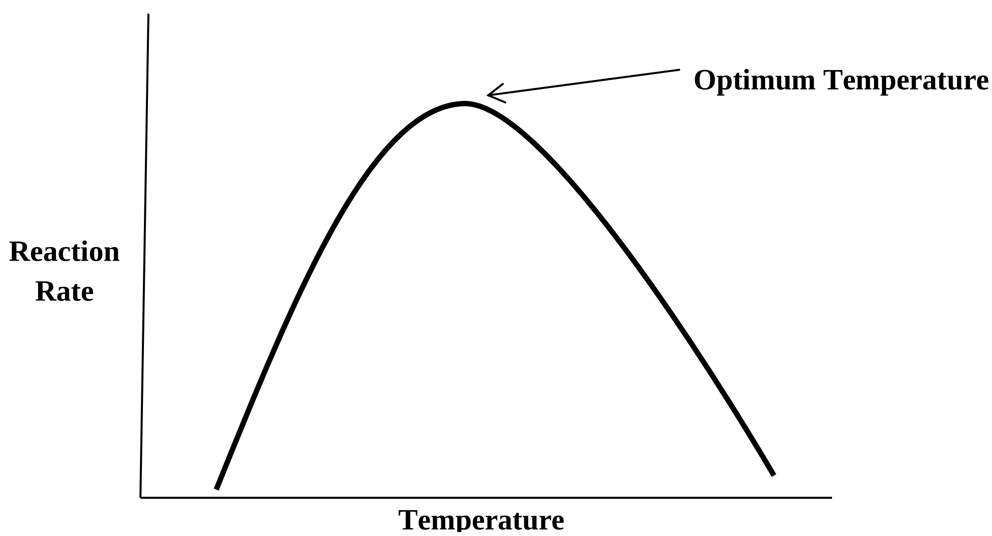


Fig 3.1: Enzyme effect on temperature

2.20.2 pH

Different types of enzymes require maintaining different types of pH conditions. If pH value is higher or lower than optimum value its activity power will also change. For example, pepsin works at acidic condition but trypsin works at alkali condition.

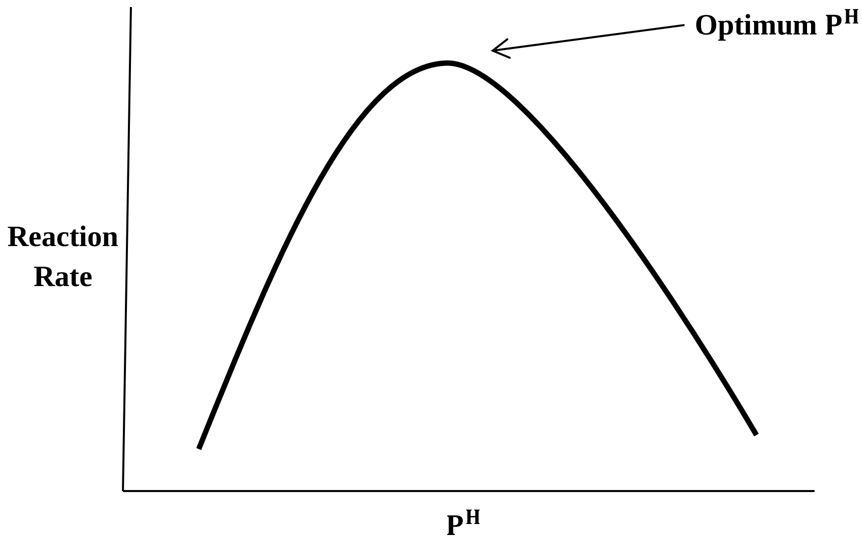


Fig 3.1: Enzyme effect on pH

2.20.3 Concentration

Enzyme's concentration also controls its reaction rate. Higher concentration will have higher reaction rate. On the other hand, lower concentration will have lower reaction rate.

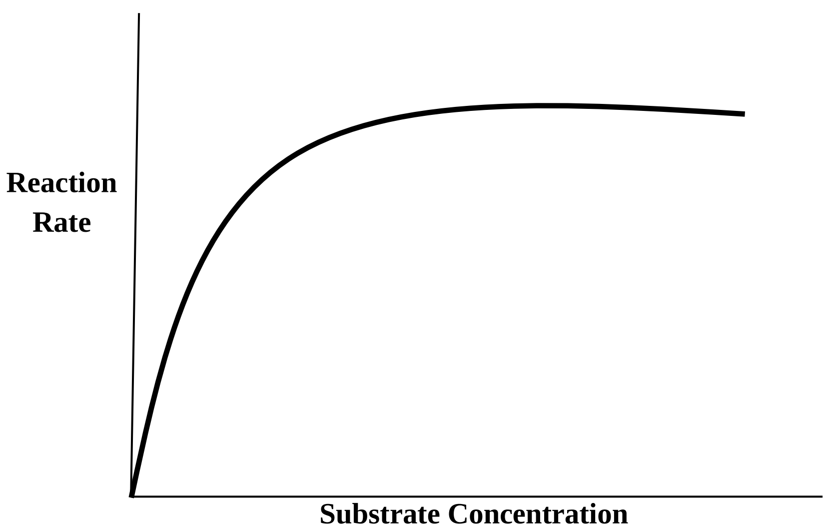


Fig 3.1: Enzyme effect on concentration

CHAPTER-03

Experimental and survey details

3 Experimental Details

The project was conducted at “Sadma Knit Composit Ltd.” according to the recipe commonly practiced for bio-polishing stages.

For the experiment, we have collected 8 sample grey knit fabric from fabric store. We measured its GSM, stitch length, WPI and CPI before bio-polishing process.

Fabric Name	GSM	Stitch Length	Count
S/ Jersey (100% cotton)	160	2.77	28s
S/ Jersey (60% cotton 40% polyester)	160	2.90	26s
1X1 Rib (100% cotton)	150	2.65	36s
1X1 Rib (60% cotton 40% polyester)	180	2.85	30s
Terry (100% cotton)	250	3.1	24s
Terry (60% cotton 40% polyester)	220	3.11	24s
Single lacost (100% cotton)	200	2.80	24s
Single lacost (60% cotton 40% polyester)	220	3.1	24s

3.1 Recipe

Enzyme : 0.03%

Acetic Acid : 0.65%

Temperature : 45^0C - 55^0C

pH : 4.5- 5.5

M: L : 1: 8

3.2 Calculation

Total Liquor = (Fabric weight x liquor ratio)

= (8000x8) ml

= 64000 ml

Acetic Acid = (Total liquor x Required amount of chemical) / 100

= (64000 x 0.65) / 100 ml

= 416 ml

Enzyme = (Total Liquor x Required amount of chemical) / 100

= (64000 x 0.03) / 100 ml

= 19.2 ml

3.3 Process curve:

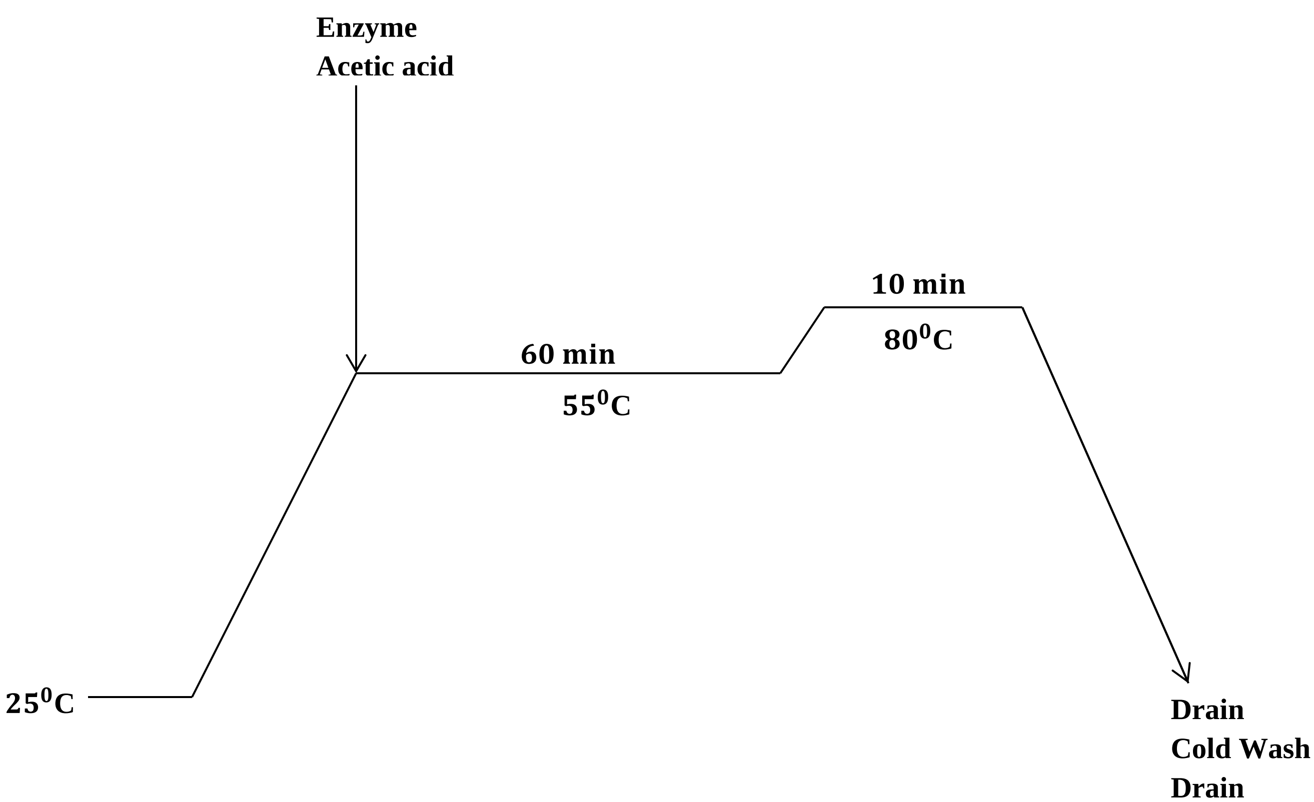


Figure 3.1: Process curve of bio-polishing

3.4 Process description of bio-polishing

1. Firstly ensured the fabric is well-scoured and bleached.
2. Next load the fabric on the machine.
3. Then took the solution and according to recipe and set the bath.
4. Raise the temperature to 45^0C - 55^0C and run it for 60 minutes.
5. After 60 minutes, raise temperature to 80^0C and run the bath for 5 minutes.
6. Drained the bath.
7. Again took water and wash the fabric at 60^0C.
8. Unload the fabric from machine.
9. Dry the fabric in dryer and finally bio-polishing process is complete.

3.5 Pilling test:

3.5.1 Standard name

For pilling test followed the ISO-12945-1 method.

3.5.2 Process

1. Cut the sample fabric to 12cm X 12cm using template.
2. Sew the both edge of the fabric parallel to fabric's grain line by sewing machine.
3. Worn the sewn fabric to polyurethane tube and add tape perpendicular to fabric's grain line on both side of the fabric.
4. Cleaned the pilling tester.
4. Load four polyurethane tubes on each box of the pilling box.
5. Run the machine at 60 rpm for 18000 cycles.
6. After process completion, unload the fabrics from machine.
7. Viewed its pilling condition at pilling viewing cabinet and compared it with pilling scale.

3.6 Experimental Calculation

3.6.1 Weight loss calculation

For calculating weight loss change percentage, used below formula,

Change percentage = $\frac{\text{Before weight} - \text{After weight}}{\text{Before weight}}$ x 100%

Fabric weight = Fabric GSM X Fabric length (cm) X Fabric width (cm)

3.6.2 Stitch length percentage calculation

For calculating stitch length change percentage, used below formula,

Change percentage = $\frac{\text{Before stitch legth} - \text{After stitch length}}{\text{Before stitch length}}$ x 100%

3.6.3 Yarn count calculation

For calculating yarn count change percentage, used below formula,

Change percentage = $\frac{\text{Before stitch legth} - \text{After stitch length}}{\text{Before stitch length}}$ x 100%

Sample attachment

Samples before and after bio-polishing

Table: Samples of 100% cotton S/Jersey before and after bio-polishing:

Single Jersey	
Before bio polishing	**After bio polishing**
	

Table: Samples of 60% cotton 40% polyester S/Jersey before and after bio-polishing:

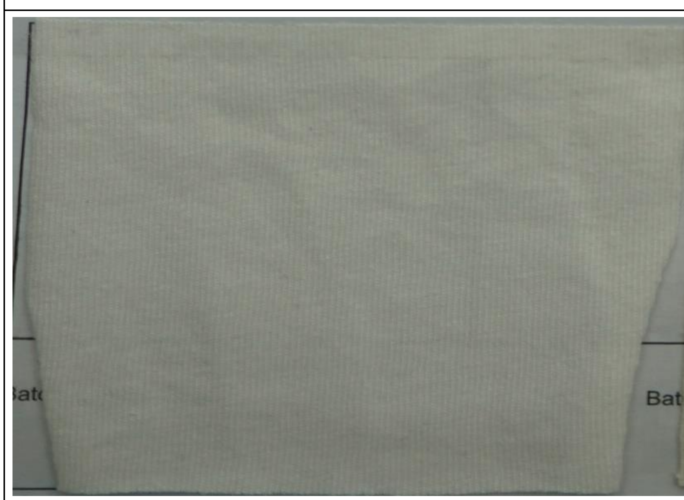
Single Jersey	
Before bio polishing	**After bio polishing**
	

Table: Samples of 100% cotton 1X1 Rib before and after bio-polishing:

1X1 Rib	
Before bio polishing	**After bio polishing**
	

Table: Samples of 60% cotton 40% polyester 1X1 Rib before and after bio-polishin

1X1 Rib	
Before bio polishing	**After bio polishing**
	

Table: Samples of 100% cotton Terry before and after bio-polishing:

Terry	
Before bio polishing	**After bio polishing**
	

Table: Samples of 60% cotton 40% polyester Terry before and after bio-polishing:

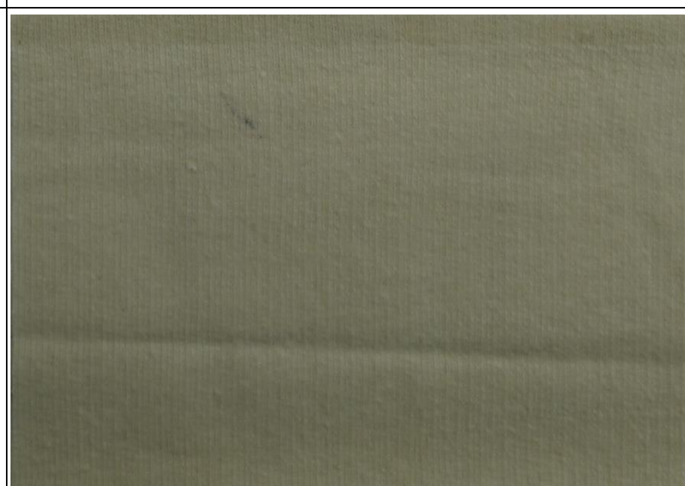
Terry	
Before bio polishing	**After bio polishing**
	

Table: Samples of 100% cotton Single lacost before and after bio-polishing:

Single lacost	
Before bio polishing	**After bio polishing**
	

Table: Samples of 60% cotton 40% polyester Single lacost before and after bio-polishing:

Single lacost	
Before bio polishing	**After bio polishing**
	

CHAPTER-04

RESULT ANALYSIS & DISCUSSION

RESULT ANALYSIS & DISCUSSION

Bio-polishing enzyme removes hairy fibers from fabric's surface. It only works on cotton fabric. As a result, it is found that, there are noticeable appearance changes for 60%cotton and 40% polyester mixed fabrics. On the other hand, the changes are mild for 100% cotton fabric.

Other changes such as, GSM, stitch length and yarn count results are also varies heavily depends on fabric's composition.

4.1 Results of various types of tests performed for bio-polishing

S/ Jersey (100% cotton):

Pilling test:

Condition	Result
Before bio-polishing	2-3
After bio-polishing	4

GSM:

Before bio-polishing	After bio-polishing	Change %
160	157	1.8%

Stitch length:

Before bio-polishing	After bio-polishing	Change %
2.77	2.80	3.7%

Yarn count:

Before bio-polishing	After bio-polishing	Change %
28s	30s	7.14%

S/ Jersey (60% cotton 40% polyester):

Pilling test:

Condition	Result
Before bio-polishing	1-2
After bio-polishing	2

GSM:

Before bio-polishing	After bio-polishing	Change %
160	158	1.25%

Stitch length:

Before bio-polishing	After bio-polishing	Change %
2.90	2.95	1.72%

Yarn count:

Before bio-polishing	After bio-polishing	Change %
26s	27s	3.84%

1X1 Rib (100% cotton):

Pilling test:

Condition	Result
Before bio-polishing	2
After bio-polishing	4-5

GSM:

Before bio-polishing	After bio-polishing	Change %
150	146	2.66%

Stitch length:

Before bio-polishing	After bio-polishing	Change %
2.65	2.55	3.77

Yarn count:

Before bio-polishing	After bio-polishing	Change %
36s	38s	5.5%

1X1 Rib (60% cotton 40% polyester):

Pilling test:

Condition	Result
Before bio-polishing	1-2
After bio-polishing	2-3

GSM:

Before bio-polishing	After bio-polishing	Change %
180	177	1.66%

Stitch length:

Before bio-polishing	After bio-polishing	Change %
2.85	2.91	2.10%

Yarn count:

Before bio-polishing	After bio-polishing	Change %
30s	32s	6.67%

Terry (100% cotton):

Pilling test:

Condition	Result
Before bio-polishing	3-4
After bio-polishing	4-5

GSM:

Before bio-polishing	After bio-polishing	Change %
230	223	3.04%

Stitch length:

Before bio-polishing	After bio-polishing	Change %
3.1	3.5	12.9%

Yarn count:

Before bio-polishing	After bio-polishing	Change %
24s	26s	8.33%

Terry (60% cotton 40% polyester):

Pilling test:

Condition	Result
Before bio-polishing	1-2
After bio-polishing	3

GSM:

Before bio-polishing	After bio-polishing	Change %
220	215	2.27%

Stitch length:

Before bio-polishing	After bio-polishing	Change %
3.1	3.9	25.80%

Yarn count:

Before bio-polishing	After bio-polishing	Change %
24s	26s	8.33%

Single lacost (100% cotton):

Pilling test:

Condition	Result
Before bio-polishing	4
After bio-polishing	4-5

GSM:

Before bio-polishing	After bio-polishing	Change %
200	195	2.5%

Stitch length:

Before bio-polishing	After bio-polishing	Change %
2.80	2.94	5%

Yarn count:

Before bio-polishing	After bio-polishing	Change %
24s	26s	8.33%

Single lacost (60% cotton 40% polyester):

Pilling test:

Condition	Result
Before bio-polishing	1-2
After bio-polishing	2-3

GSM:

Before bio-polishing	After bio-polishing	Change %
220	214	2.72%

Stitch length:

Before bio-polishing	After bio-polishing	Change %
3.1	3.13	0.96%

Yarn count:

Before bio-polishing	After bio-polishing	Change %
24s	26s	8.33%

4.2 Comparison

4.2.1 Pilling test:

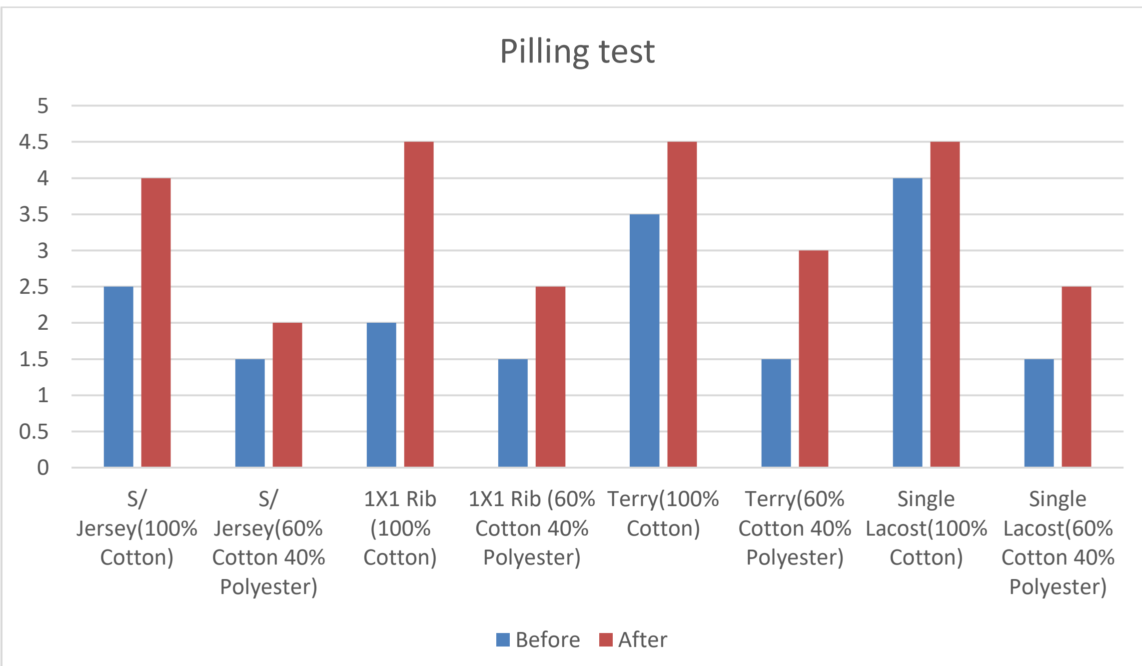


Chart-1: Pilling test

Chart-1 indicates appearance test result of tested sample. It shows, the test result of 100% cotton knitted single lacost fabric before and after bio-polishing was very good. On the other side poor result was found for 60% cotton 40% polyester knitted single jersey. Similar to 100% cotton knitted single lacost fabric the pilling test result was also good for 100% cotton knitted terry fabric. The chart-1 also shows that, the highest pilling test variation on before and after bio-polishing was found on 100% cotton knitted rib fabric and the lowest variation on before and after bio-polishing was found on 100% cotton knitted single lacost fabric.

4.2.2 GSM change%

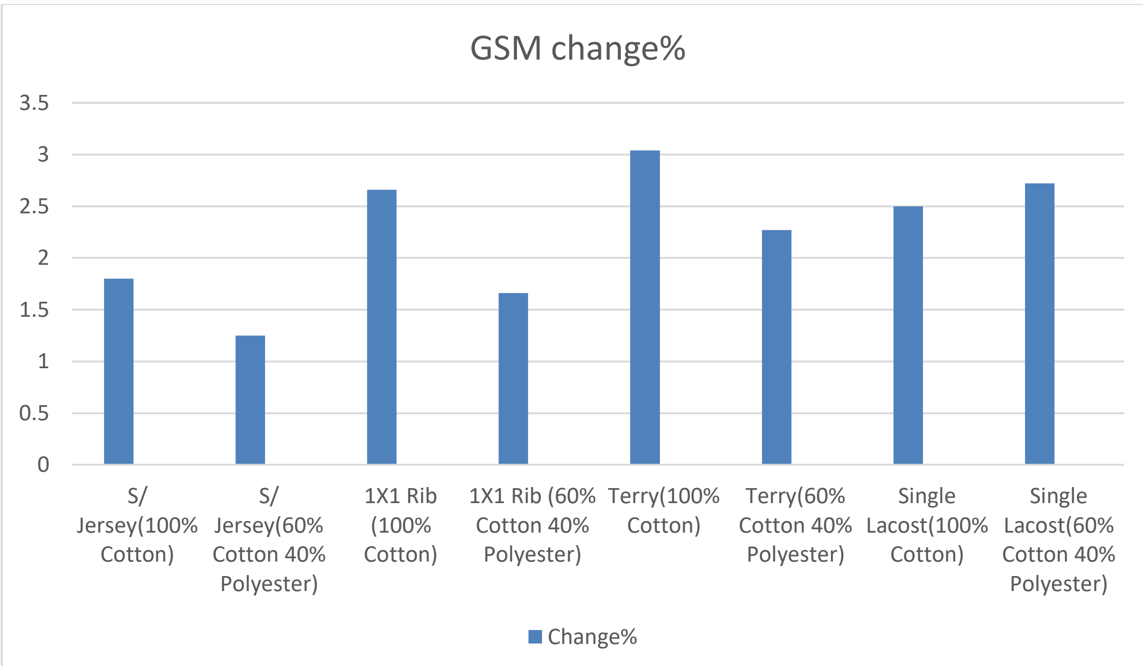


Chart-2: GSM change%

Chart-2 GSM change% of the tested sample. The result shows, the percentage was highest for 100% cotton terry fabric. The percentage was lowest for 60% cotton 40% polyester knitted single jersey. The chart also shows, between 100% cotton and 60% cotton 40% polyester tested sample fabrics, the variation was highest for 1x1 rib fabric and it was lowest for single lacost fabric.

4.2.3 Stitch length change%

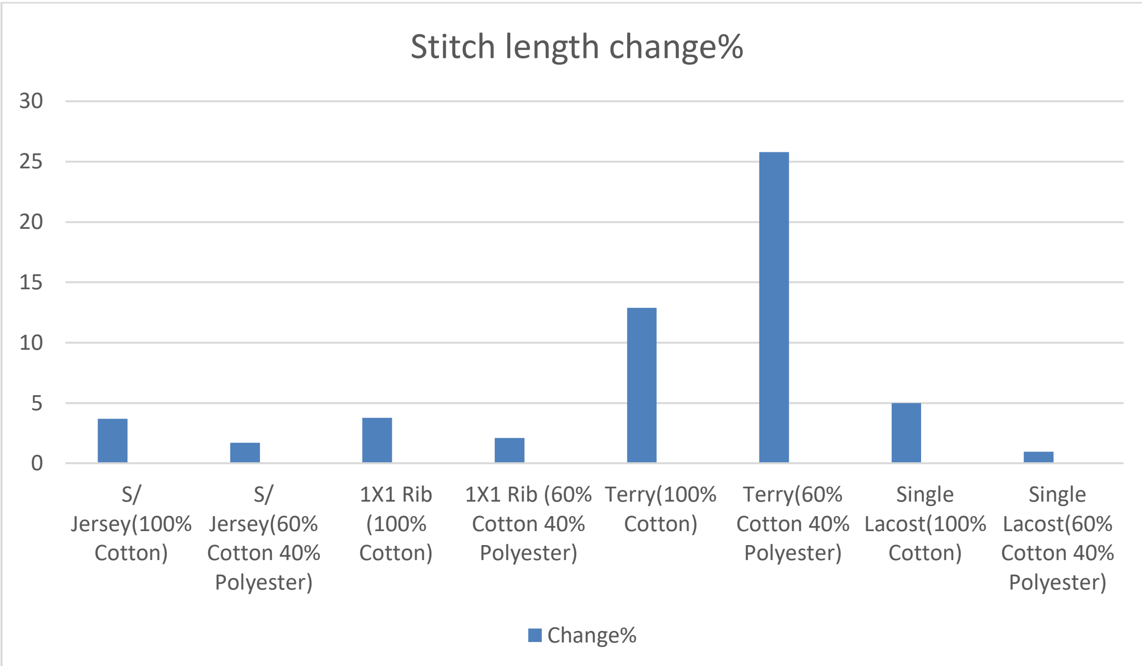


Chart-3: Stitch length change%

Chart-3 stitch length change% of the tested sample. The result shows, the percentage was highest for 60% cotton 40% polyester terry fabric. The percentage was lowest for 60% cotton 40% polyester knitted single lacost fabric. The chart also shows, between 100% cotton and 60% cotton 40% polyester tested sample fabrics, the variation was highest for terry fabric and it was lowest for single jersey fabric.

4.2.4 Yarn count change%

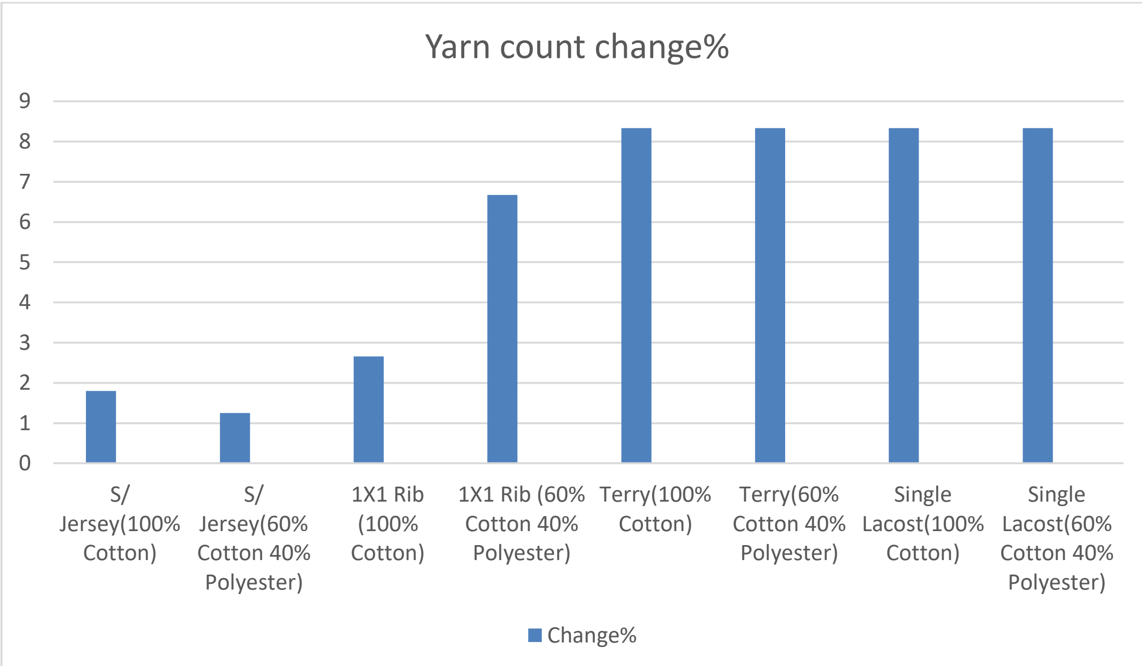


Chart-4: Yarn count change%

Chart-4 yarn count change% of the tested sample. The result shows, the percentage was highest for 60% cotton 40% polyester terry fabric, 100% terry fabric, 60% cotton 40% polyester single lacost fabric and 100% cotton single lacost fabric . The percentage was lowest for 60% cotton 40% polyester knitted single jersey fabric. The chart shows, similar test result was found for for 60% cotton 40% polyester terry fabric, 100% terry fabric, 60% cotton 40% polyester single lacost fabric and 100% cotton single lacost fabric. The chart also shows between 100% cotton and 60% cotton 40% polyester tested sample fabrics, the variation was highest for 1x1 rib fabric and it was lowest for terry and single lacost fabric.

CHAPTER-05

CONCLUSION & REFERENCE

5.1 Conclusion

Bio-polishing is a used commonly wet processing stages gives permanent effect on cotton fiber. Now –a-days, this is an essential process used as part of daily pre-treatment process of fabric wet processing at dye house.

According to test result it shows, bio-polishing significantly develop fabric appearance by reducing hairiness and enhancing hand feel. But too much usage may create deleterious effect on the fabric. Regarding to this, it creates several effects on fabrics, GSM, stitch length and yarn count. The research specifies, the result varies based on fibers composition and fabrics construction.

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DAFFODIL INTERNATIONAL UNIVERSITY Faculty of Engineering Department of Textile Engineering Thesis paper on STUDIES ON THE EFFECT OF BIO-POLISHING ON KNIT FABRIC PROPERTIES Authorized By: NAME ID E-MAIL Enamul Hasan Abir 181-23-5270 enamul23-5270@diu.edu.bd Md. Abir Khan 181-23-5276 abir23-5276@diu.edu.bd Supervised by Tanvir Ahmed Chowdhury Assistant Professor Department of Textile Engineering Daffodil International University A project submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Textile Engineering Advance in Wet Processing Technology Fall- 2021 DECLARATION We hereby declare that, this thesis paper has been done 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 thesis paper nor any part of this paper has been submitted elsewhere for award of any degree or diploma. Enamul Hasan Abir ID: 181-23-5270 Department of Textile Engineering Daffodil International University Md. Abir Khan ID: 181-23-5276 Department of Textile Engineering Daffodil International University LETTER OF APPROVAL This project report prepared by Enamul Hasan Abir (ID: 181-23-5270) and Md. Abir Khan (ID: 181-23 -5276), is approved in Partial Fulfillment of the Requirement for the Degree of BACHELOR OF SCIENCE IN TEXTILE ENGINEERING. The said students have completed their project work under my supervision. During the research period I found them sincere, hardworking and enthusiastic. TANVIR AHMED CHOWDHURY ASSISTANT PROFESSOR DEPARTMENT OF TEXTILE ENGINEERING FACULTY OF ENGINEERING DAFFODIL INTERNATIONAL UNIVERSITY iii | P a g e ACKNOWLEDGEMENT I would like to start by thanking Tanvir Ahmed Chowdhury, (Assistant Professor) for his tremendous inspiration and support to encourage me in writing. Truly this writing would remain incomplete without his foresight and kindness. Special thanks must also go to my parents for their kind support and staying my side to recognize my talents. I am also thankful to God for my health and knowledge. I am also grateful to my co-author Md. Abir Khan for his hardship and support. I am also grateful to Textile Department of Daffodil International University for the opportunity gave to earn knowledge. I am truly in debt to all my teachers. I am thankful to Ahsan Sourav (CR) for his hard work and right instruction to always keep me courageous and in high spirit to keep my hopes high. This report wouldn't be possible without the following people: Ani Biswas, Saffat kamal Niloy, Sakib Hossain, Nihab Rahaman, Abu Rayhan, Pranta Khan, Afia Mubassira and Ismail Hossain Nayem. Thank you for putting faith on me. Lastly special thanks to Yeasin Arafat for all the pep talk and believe in me in my report. I appreciate it more than I can say. ABSTRACT The main purpose of this paper is to investigate the quality improvement based on before and after bio-polishing process on different types of fabrics. The research was done on s/jersey, 1x1 rib, single lacost and terry fabric. Carefully monitoring has been done on fabrics GSM, stitch length, pilling test and yarn count. Comparison been done on each fabric made of 100% cotton yarn and CVC yarn. The outcome illustrates after bio-polishing process at certain temperature, concentration and time, fabrics quality gotten significantly improved. Not only it decreases fabrics pill formation tendency but also makes it more lustrous. The four aspects has been evaluated with table and graphs. The results obtained has been showed separately in different sections and subsections according to topic. TABLE OF CONTENT Content page CHAPTER-01

vii | P a g e viii | P a g e CHAPTER-01 INTRODUCTION 1. Introduction: 1.1. Background Textile industry is among the most important industries around the world. This industry provides one of the five basic needs of human. Textile industry also plays a significant role in building the economic block of a country. Nowadays, its importance is growing more and more all over the world. Along with it its demand is increasing further. Textile industry has a lot of classes. The industry provides different sorts of category products. Starting from clothing and protective gear to blanket and sheet for worming. They also produce products other than human comforting and aesthetic purposes such as equipment filter, protective covering for planting, covering, harvesting and covering crops, geo-tube for soil embankment, single sheet covering for construction purposes and so on. They are also playing active roles in medical field providing artificial veins, heart valves and other medical implants to improve lifespan of many people. The industry also playing leading role in economic solution of the country. Textile industry is giving billion dollar solution of a country along the unemployment solution with offering millions of job openings leading major role in GDP of the country. One of the most important parts of textile industry is dyeing industry. There are a lot of processes involved in dyeing industry. Bio-polishing is one of them. Hairy fiber degrades fabrics quality. It increases fabrics pill formation tendency and makes it less lucrative and lustrous. As a result it degrades fabrics quality and demand. Bio-polishing is one of the most commonly practiced wet processing stages applied on knit fabric which creates a permanent effect on fabric's surface. It is similar to singing process. Unlike singing process, bio-polishing is a chemical process only applied on cotton fabric. The process can be done before or after dyeing process. It is generally done after bleaching process. For bio-polishing, cellulase enzyme is used as chemical. It is done by hydrolysis action of enzyme. The process is eco-friendly and bio- degradable. It makes fabric more lustrous and enhances handle properties. It is performed at specific temperature, time and concentration. The process removes hairy fibers from fabric surface. As a result, reduces fabrics weight. As well as it also slightly effects fabrics strength by reducing it to a certain level. After bio-polishing, fabrics surface become smoothens so rubbing properties also improved. Besides, it also improves fabrics quality. As a result, it increases fabrics aesthetic value and increase its demand. 1.2 Project Objective: The main objective of the project is to compare with the different types of physical properties of knit fabric on before and after bio-polishing process. Besides the physical properties the research was done, ? To check different types of fabrics surface change after bio-polishing. ? To check yarn count, GSM and stitch length. ? To compare result between 100% cotton and CVC fabrics. ? To compare results among different types fabrics. CHAPTER-02 LITERATURE REVIEW 2. Literature Review: 2.1 History of enzyme: The term enzyme comes from the Greek word "Enzymos "means from or in the cell. [Wikipedia] Up to early 18th century, mechanism of meat digestion by stomach sercretions and converting startch to sugar was still unknown. The first enzyme "diatase" was discovered by the French chemist Anselme Payen in 1833. Few decades later, another French chemist Luis Pasteur while studying fermentation of sugar by yeast concluded that fermentation of yeast is caused by a vital force. He named it as "ferments". The term "enzyme" was first used by German physiologist Wilhelm Kühne in 1877. Later the word enzyme is used for only non-living substance and ferments for living substance. [Britannica] In 1897 at University of Berlin, Eduard Buchner experimented that sugar can be extracted from yeast even when there are no living organisms. He named the organism "zymase". The discovery of "Cell-free fermentation" awarded Eduard Buchner "Nobel Prize" in 1907. By Buchner's example, enzyme was named according to the substrate or the type of reaction. Despite all the biochemical identity of enzymes was still unknown upto early 1900s. In 1926, James B. Sumner discovered, enzyme "urease" was a pure protein. In 1937, he discovered similar nature at "catalase" enzyme. Later complete demonstration of pure protein enzyme in pepsin, trypsin and chymotrypsin was shown by John Howard Northrop and Wendell Meredityh Stanley. For their outstanding work, these three scientists were awarded Nobel Prize in 1946. Finally in 1965, David Chilton Phillips discovered that, by x-ray crystallography enzymes structured and working procedures could be observed in detail. The experiment was first done on the enzyme "lysozyme". This breakthrough perused the biological field to acquire knowledge of enzymes nature and working procedure from atomic level of detail. 2.2 Flow chart of textile industry Fiber Yarn spinning Yarn Yarn Fabric manufacturing Grey fabric Grey fabric Wet processing Finished fabric Finished fabric Garment manufacturing Garment 2.3 Fabric Basic textile materials can be produced by interloping, interlacing or networking natural or artificial yarn or fiber to produce a supple sheet material. 2.4 Fabric types There are four types of fabric. i. Woven ii. Non- woven iii. Knitted iv. braided 2.5 Yarn Linear assembles of fiber or filament that are twisted in order to make strong or laid together to form a continuous strand, which are suitable to manufacture fabric. It can also define as arrangement of fibers uniformly to continuous mass of fiber bound together by twist. 2.6 Types of yarn Yarn can be classified into various types. Some commonly used examples are, i. Length of fiber a. Spun yarn b. Filament yarn ii. Type of fiber a. Single fiber b. Multi fiber iii. Number of strand a. Single yarn b. Ply yarn c. Cable yarn iv. Formation of yarn a. Ring yarn b. Rotor yarn c. Air jet yarn d. Vortex v. Use of yarn a. Woven b. Knit vi. Process sequence of manufacturing a. Carded yarn b. Combed yarn 2.7 Knit fabric Knit fabric is produced by making yarn interloping or inter-mashing with each other. It is lees strong and has less stable structure compared to woven fabric. It has a variety of usage. Such as, polo shirt, socks, jeans, jogger, sweater and other delicate products. 2.8 Classification of knit fabric Knit fabric is commonly classified into four types. These are, a. Single jersey fabric b. Rib fabric c. Interlock fabric d. Purl fabric 2.9 Wet processing The process which is carried out on aqueous stages on textile substrate for various wet processing stages such as scouring, bleaching, mercerizing and dyeing is called wet processing. It is the most important part of textile industry. It enhances fabrics quality and gives an aesthetic value. 2.10 Flow chart of wet processing for knit fabric Scouring Bleaching Bio-polishing Dyeing / Printing Finishing 2.11 Pre-treatment The process which is carried out before dyeing on textile substrate is called pre-treatment process. [textileapex.blog] It is called the heart of wet processing. It increases fabrics strength and ensure good absorbency. Some examples of pre-treatment process are, scouring, bleaching, mercerizing and bio-polishing. 2.12 Enzyme The term enzyme comes from the Greek word "Enzymos "means from or in the cell. The first enzyme was discovered by French chemist Anselme Payen. In 1897, Eduard Buchner discovered the enzyme "zymase" from the yeast cell. It is naturally available, high molecular weight and most of them are proteins made up to more than 250 amino acid groups. It works similar to catalyst in the living organism. [Infinitabiotech] Enzyme activity can be controlled by temperature and pH. The first enzyme application on textile industry was done in Japan in 1989. Now-a-days, the usage of enzyme in textile industry is increasing. Currently a lot type of enzyme has been using on various textile wet processing stages. 2.13 Advantages of enzyme i. Eco-friendly and biodegradable. ii. Reduce water, chemical, and energy. iii. Easily controllable. iv. Can be used for a longer period of time. 2.14 Disadvantages of enzyme i. May cause allergic reaction. ii. Production cost is expensive. iii. Easily denatured to the environment. iv. May damage substrate. 2.15 Enzymes working procedure Enzyme's working procedure is compared to lock and key. The enzyme has an active site, where the enzyme and substrate molecule reaction take place. During the reaction, the enzyme molecule changes its shape according to the shape of substrate molecule. [Infinitabiotech] After so enzyme and substrate molecule get closer to each other and create enzyme-substrate compound. After reaction completion, products leave the active side of the enzyme and thus enzymes are regenerated. 2.16 Commonly practiced enzyme in textile industry Serial No. Name of enzymes Effects 01. Cellulase Remove hairy fibers from fabric surface 02. Protease Used as bio-scouring agent to remove protein and wax substance 03.. Catalase Kills peroxide 04. Amylase Remove size material from fabric surface 05. Pectinase Decompose pectine 06. Lipase Hydrolyses oil and fat 07. Collagenase Remove wool skin parts 08. Nitrilase Provide better coloration 09. Ligninase Separate plant parts from wool 2.17 Bio-polishing enzyme Bio-polishing is a wet processing stage applied on cotton fabric to enhance fabric's quality by reducing pill formation tendency of the fabric. It is mainly done by cellulase enzyme. The process is 100% eco-friendly and bio-degradable. [Textile learner] 2.18 Advantages of bio-polishing i. Improve fabric handle properties ii. Smoothen fabric surface. iii. Reduce hairiness and pilling tendency iv. Increase fabric luster. 2.19 Disadvantages of Bio-polishing i. Reduce fabric weight. ii. Decrease fabric strength. iii. Too much usage may end up damaging the fabric. 2.20 Factors affecting enzyme reaction 2.20.1 Temperature Enzyme works at a temperature of 37°-45°C. In this region it has the highest reactivity. Its reactivity started to decrease after 55°C. It cannot sustain after 80°C. Optimum Temperature Reaction Rate Temperature 2.20.2 pH Fig 3.1:

Enzyme effect on temperature Different types of enzymes require maintaining different types of pH conditions, If pH value is higher or lower than optimum value its activity power will also change. For example, pepsin works at acidic condition but trypsin works at alkali condition. Optimum PH Reaction Rate PH Fig 3.1: Enzyme effect on pH 2.20.3 Concentration Enzyme's concentration also controls its reaction rate, Higher concentration will have higher reaction rate, On the other hand, lower concentration will have lower reaction rate, Reaction Rate Substrate Concentration Fig 3.1: Enzyme effect on concentration CHAPTER-03 Experimental and survey details 3 Experimental Details The project was conducted at "Sadma Knit Composit Ltd." according to the recipe commonly practiced for bio-polishing stages. For the experiment, we have collected 8 sample grey knit fabric from fabric store. We measured its GSM, stitch length, WPI and CPI before bio-polishing process, Fabric Name GSM Stitch Length Count S/ Jersey (100% cotton) 160 2.77 28s S/ Jersey (60% cotton 40% polyester) 160 2.90 26s 1X1 Rib (100% cotton) 150 2.65 36s 1X1 Rib (60% cotton 40% polyester) 180 2.85 30s Terry (100% cotton) 250 3.1 24s Terry (60% cotton 40% polyester) 220 3,11 24s Single lacost (100% cotton) 200 2,80 24s Single lacost (60% cotton 40% polyester) 220 3,1 24s 3,1 Recipe Enzyme : 0,03% Acetic Acid : 0,65% Temperature : 450C - 550C pH : 4.5- 5.5 M: L : 1: 8 3.2 Calculation Total Liquor = (Fabric weight x liquor ratio) = (8000x8) ml = 64000 ml Acetic Acid = (Total liquor x Required amount of chemical) / 100 = (64000 x 0,65) / 100 ml = 416 ml Enzyme = (Total Liquor x Required amount of chemical) / 100 = (64000 x 0,03) / 100 ml = 19,2 ml 3,3 Process curve: Enzyme Acetic acid 00 mim 50 mim 800C 550C 050C Figure 3.1: Process curve of bio-polishing Drain Cold Wash Drain 3.4 Process description of bio-polishing 1. Firstly ensured the fabric is well-scoured and bleached. 2. Next load the fabric on the machine. 3. Then took the solution and according to recipe and set the bath. 4. Raise the temperature to 450C - 550C and run it for 60 minutes. 5. After 60 minutes, raise temperature to 800C and run the bath for 5 minutes. 6. Drained the bath. 7. Again took water and wash the fabric at 600C. 8. Unload the fabric from machine. 9. Dry the fabric in dryer and finally bio-polishing process is complete. 3.5 Pilling test: 3.5.1 Standard name For pilling test followed the ISO-12945-1 method, 3,5,2 Process 1, Cut the sample fabric to 12cm X 12cm using template, 2, Sew the both edge of the fabric parallel to fabric's grain line by sewing machine, 3, Worn the sewn fabric to polyurethane tube and add tape perpendicular to fabric's grain line on both side of the fabric. 4. Cleaned the pilling tester. 4. Load four polyurethane tubes on each box of the pilling box, 5, Run the machine at 60 rpm for 18000 cycles, 6, After process completion, unload the fabrics from machine, 7, Viewed its pilling condition at pilling viewing cabinet and compared it with pilling scale. 3.6 Experimental Calculation 3.6.1 Weight loss calculation For calculating weight loss change percentage, used below formula, Change percentage = Before weight—After weight x 100% Before weight Fabric weight = Fabric GSM X Fabric length (cm) X Fabric width (cm) 3,6,2 Stitch length percentage calculation For calculating stitch length change percentage, used below formula, Change percentage = Before stitch legth—After stitch length x 100% Before stitch length 3.6.3 Yarn count calculation For calculating yarn count change percentage, used below formula, Change percentage = Before stitch legth—After stitch length x 100% Before stitch length Sample attachment Samples before and after bio-polishing Table: Samples of 100% cotton S/Jersey before and after bio-polishing: Single Jersey Before bio polishing After bio polishing Table: Samples of 60% cotton 40% polyester S/Jersey before and after bio-polishing: Single Jersey Before bio polishing After bio polishing Table: Samples of 100% cotton 1X1 Rib before and after bio-polishing: 1X1 Rib Before bio polishing After bio polishing Table: Samples of 60% cotton 40% polyester 1X1 Rib before and after bio-polishin 1X1 Rib Before bio polishing After bio polishing Table: Samples of 100% cotton Terry before and after bio-polishing: Terry Before bio polishing After bio polishing Table: Samples of 60% cotton 40% polyester Terry before and after bio-polishing: Terry Before bio polishing After bio polishing Table: Samples of 100% cotton Single lacost before and after bio-polishing: Single lacost Before bio polishing After bio polishing Table: Samples of 60% cotton 40% polyester Single lacost before and after bio-polishing: Single lacost Before bio polishing After bio polishing CHAPTER-04 RESULT ANALYSIS & DISCUSSION RESULT ANALYSIS & DISCUSSION Bio-polishing enzyme removes hairy fibers from fabric's surface. It only works on cotton fabric. As a result, it is found that, there are noticeable appearance changes for 60%cotton and 40% polyester mixed fabrics. On the other hand, the changes are mild for 100% cotton fabric. Other changes such as, GSM, stitch length and yarn count results are also varies heavily depends on fabric's composition. 4.1 Results of various types of tests performed for bio-polishing S/ Jersey (100% cotton): Pilling test: Condition Result Before bio-polishing 2-3 After bio-polishing 4 GSM: Before bio-polishing After bio-polishing Change % 160 157 1.8% Stitch length: Before bio-polishing After bio-polishing Change % 2.77 2.80 3.7% Yarn count: Before bio-polishing After bio-polishing Change % 28s 30s 7.14% S/ Jersey (60% cotton 40% polyester): Pilling test: Condition Result Before bio-polishing 1-2 After bio-polishing 2 GSM: Before bio-polishing After bio-polishing Change % 160 158 1,25% Stitch length: Before bio-polishing After bio-polishing Change % 2,90 2,95 1,72% Yarn count: Before bio-polishing After bio-polishing Change % 26s 27s 3,84% 1X1 Rib (100% cotton): Pilling test: Condition Result Before bio-polishing 2 After bio-polishing 4-5 GSM: Before bio-polishing After bio-polishing Change % 150 146 2.66% Stitch length: Before bio-polishing After bio-polishing Change % 2,65 2,55 3.77 Yarn count: Before bio-polishing After bio-polishing Change % 36s 38s 5,5% 1X1 Rib (60% cotton 40% polyester): Pilling test: Condition Result Before bio-polishing 1-2 After bio-polishing 2-3 GSM: Before bio-polishing After bio-polishing Change % 180 177 1.66% Stitch length: Before bio-polishing After bio-polishing Change % 2,85 2,91 2,10% Yarn count: Before bio-polishing After bio-polishing Change % 30s 32s 6,67% Terry (100% cotton): Pilling test: Condition Result Before bio-polishing 3-4 After bio-polishing 4-5 GSM: Before bio-polishing After bio-polishing Change % 230 223 3.04% Stitch length: Before bio-polishing After bio-polishing Change % 3.1 3.5 12.9% Yarn count: Before bio-polishing After bio-polishing Change % 24s 26s 8.33% Terry (60% cotton 40% polyester): Pilling test: Condition Result Before bio-polishing 1-2 After bio-polishing 3 GSM: Before bio-polishing After bio-polishing Change % 220 215 2,27% Stitch length: Before bio-polishing After bio-polishing Change % 3,1 3,9 25,80% Yarn count: Before bio-polishing After bio-polishing Change % 24s 26s 8.33% Single lacost (100% cotton): Pilling test: Condition Result Before bio-polishing 4 After bio-polishing 4-5 GSM: Before bio-polishing After bio-polishing Change % 200 195 2,5% Stitch length: Before bio-polishing After bio-polishing Change % 2,80 2,94 5% Yarn count: Before bio-polishing After bio-polishing Change % 24s 26s 8.33% Single lacost (60% cotton 40% polyester): Pilling test: Condition Result Before bio-polishing 1-2 After bio-polishing 2-3 GSM: Before bio-polishing After bio-polishing Change % 220 214 2.72% Stitch length: Before bio-polishing After bio-polishing Change % 3,1 3,13 0,96% Yarn count: Before bio-polishing After bio-polishing Change % 24s 26s 8.33% 4.2 Comparison 4.2.1 Pilling test: 5 4.5 4 3.5 3 2.5 2 1.5 1 0.5 0 Pilling test S/ S/ Jersey(100% Jersey(60% Cotton) Cotton 40% Polyester) 1X1 Rib 1X1 Rib (60% Terry(100% Terry(60% Single Single (100% Cotton) Cotton 40% Polyester) Cotton) Cotton 40% Lacost(100% Lacost(60% Polyester) Cotton) Cotton 40% Before After Polyester) Chart-1: Pilling test Chart-1 indicates appearance test result of tested sample, It shows, the test result of 100% cotton knitted single lacost fabric before and after bio-polishing was very good. On the other side poor result was found for 60% cotton 40% polyester knitted single jersey. Similar to 100% cotton knitted single lacost fabric the pilling test result was also good for 100% cotton knitted terry fabric, The chart-1 also shows that, the highest pilling test variation on before and after bio-polishing was found on 100% cotton knitted rib fabric and the lowest variation on before and after bio-polishing was found on 100% cotton knitted single lacost fabric. 4.2.2 GSM change% 3.5 3 2.5 2 1.5 1 0.5 0 GSM change% S/ S/ Jersey(100% Jersey(60% Cotton) Cotton 40% Polyester) 1X1 Rib 1X1 Rib (60% Terry(100% Terry(60% Single Single (100% Cotton 40% Cotton) Cotton 40% Lacost(100% Lacost(60% Cotton) Polyester) Polyester) Cotton) Cotton 40% Polyester) Change% Chart-2: GSM change% Chart-2 GSM change% of the tested sample. The result shows, the percentage was highest for 100% cotton terry fabric. The percentage was lowest for 60% cotton 40% polyester knitted single jersey. The chart also shows, between 100% cotton and 60% cotton 40% polyester tested sample fabrics, the variation was highest for 1x1 rib fabric and it was lowest for single lacost fabric. 4.2.3 Stitch length change% 30 25 20 15 10 5 0 Stitch length change% S/ S/ Jersey(100% Jersey(60% Cotton) Cotton 40% Polyester) 1X1 Rib 1X1 Rib (60% Terry(100% Terry(60% Single Single (100% Cotton 40% Cotton) Cotton 40% Lacost(100% Lacost(60% Cotton) Polyester) Polyester) Cotton) Cotton 40% Polyester) Change% Chart-3: Stitch length change% Chart-3 stitch length change% of the tested sample. The result shows, the percentage was highest for 60% cotton 40% polyester terry fabric. The percentage was lowest for 60% cotton 40% polyester knitted single lacost fabric, The chart also shows, between 100% cotton and 60% cotton 40% polyester tested sample fabrics, the variation was highest for terry fabric and it was lowest for single jersey fabric. 4.2.4 Yarn count change% 9 8 7 6 5 4 3 2 1 0 Yarn count change% S/ S/ Jersey(100% Jersey(60% Cotton) Cotton 40% Polyester) 1X1 Rib 1X1 Rib (60% Terry(100% Terry(60% Single Single (100% Cotton 40% Cotton) Cotton 40% Lacost(100% Lacost(60% Cotton) Polyester) Polyester) Cotton) Cotton 40% Polyester) Change% Chart-4: Yarn count change% Chart-4 yarn count change% of the tested sample, The result shows, the percentage was highest for 60% cotton 40% polyester terry fabric, 100% terry fabric, 60% cotton 40% polyester single lacost fabric and 100% cotton single lacost fabric . The percentage was lowest for 60% cotton 40% polyester knitted single jersey fabric, The chart shows, similar test result was found for for 60% cotton 40% polyester terry fabric, 100% terry fabric, 60% cotton 40% polyester single lacost fabric and 100% cotton single lacost fabric. The chart also shows between 100% cotton and 60% cotton 40% polyester tested sample fabrics, the variation was highest for 1x1 rib fabric and it was lowest for terry and single lacost fabric, CHAPTER-05 CONCLUSION & REFERENCE 5.1 Conclusion Bio-polishing is a used commonly wet processing stages gives permanent effect on cotton fiber. Now –a-days, this is an essential process used as part of daily pre-treatment process of fabric wet processing at dye house. According to test result it shows, bio-polishing significantly develop fabric appearance by reducing hairiness and enhancing hand feel. But too much usage may create deleterious effect on the fabric. Regarding to this, it creates several effects on fabrics, GSM, stitch length and yarn count. The research specifies, the result varies based on fibers composition and fabrics construction. 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