



**Daffodil**  
*International*  
**University**

Faculty of Engineering  
Department of Textile Engineering

## **Study on Physical Changes of Denim Garments after Washing**

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A thesis submitted in partial fulfillment of the requirements for the degree of

**Bachelor of Science in Textile Engineering**

Advance in Apparel Manufacturing Technology

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## Letter of Approval

April 04, 2018

To

The Head

Department of Textile Engineering

102, Shukrabad, Mirpur Road, Dhaka 1207

Subject: Approval of Project Report of B.Sc. in TE Program.

Dear Sir,

I am just writing to let you know that this project report titled as “Study on Physical Change of Garments after Denim Washing” has been prepared by the student bearing IDs 142-23-3866 and 142-23-3869 are completed for final evaluation. The whole report is prepared based on the proper investigation and interruption through critical analysis of empirical data with required belongings. The student were directly involved in their project activities and the report become vital to spark of many valuable information for the readers.

Therefore it will highly be appreciated if you kindly accept this project report and consider it for final evaluation.

Yours Sincerely

.....

Mr. Md. Mominur Rahman,

Assistant Professor

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## Declaration

We hereby declare that, this project has been done by us under the supervision of Mr. Md. Mominur Rahman, Assistant Professor, Department of Textile Engineering, Faculty of Engineering, Daffodil International University. We also declare that, neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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## **Abstract**

Denim is a well establish fashion in garments industry. Its demand is still increasing due to different outlook of different wash. Enzyme-stone wash and Bleach wash are one of those types of wash. This thesis is done to find out the Physical changes of denim garments after these two washing process. This study is done without high facilities. But the output of this study was fine. We have found the Shrinkage %, weight loss and EPI & EPI. And the comparison between enzyme-stone and bleach wash also refracted in this paper.

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# **Chapter -1**

## **Introduction**

## 1.1 Background of the Study

Denim washing have a different physical change, given on the buyer requirement. In garments after sewing denim garments are sending to the wash. The measurements of the garments are changed due to wash. But we have to make sure that garments quality and measurement have to be equal to the buyer's requirements. That's why this these has written to understand the changes of the denim garments before & after wash. Some types of analytical data have taken to find out the outer physical changes of garments such as weight loss, EPI & PPI variation, Shrinkage etc. By this Thesis it will help to understand the allowance required for a denim five pocket pant before wash and also help to understand the changes of physical appearance after wash.

## 1.2 Objectives

- To know about Enzyme-stone wash and Bleach wash.
- To know about the shrinkage %, changed after wash the garments.
- To know the required Plan before Planning for denim garments production to full fill the buyer requirement.
- To know about the physical properties of a denim garments such as PPI, EPI, Weight and fabric behavior.
- To know the types of color fading of garments.

## 1.3 Significant

As a fresher textile engineer it is very important to know about the behavior of garments before and after wash. This knowledge will support us some times in planning, sometime in production, some time to full fill the buyer requirement. On the other hand now days we have a great opportunity to work under denim Manufacturer Company. So washing knowledge for denim will be very helpful for our future carrier.

## **1.4 Limitation**

There are some limitations to complete the study. This experiment was taken under a newly established washing company named Zihan Washing Plant. This factory works under subcontract order. They only receive the garments and wash according to the given recipe. There have no lab facility and no way to take a sample to calculate the GSM and bring out a sample to another lab.

## **Chapter -2**

### **Literature Review**

## 2.1 Denim Wash

In the textile sector garment washing is one of the major processes followed in industry. Dust, dirt and infectious materials can be removed from garments by industrial garments washing. A variety of wash techniques can be followed as per fashion requirement, for improving special look on garments [1]. Normally after stitching garment washing is done. Buyers ask for garment washing according to customer demand and fashion trend. For the washing garment buyers always mention accurately what types of garment washing they want for the order. Here we can give an example that, Tom Tailor buyer asked for wash look like – Acid wash, Vintage wash, softener wash or Cloud wash. On the fabric surfaces different types of appearance are seen in each wash. Physical Changes of Garment wash types are mainly depends on the product types [2].

Without denim today's fashion is totally incomplete. Denim garments comes in all forms, looks and washes to match with every dress. For making denim the fashion icon that it is today a huge number of technological factors have contributed– including vast improvements in spinning, weaving, finishing etc. The most important part of creation of the fashionable denim jeans is the washing. Now washing plays such a vital part in the denim sector just because of so many effects that the consumers are looking for on their jeans. Every little step in denim garment washing makes a huge difference because indigo dye has a dry rubbing and very poor wet fastness. All the parameters are very critical to maintain for repetitive results [3]. Denim washing technique now a day's creates new fashion such as blasting, tagging, whickering, permanent wrinkle, destroy, grinding, hand crapping , deep dye , tie dye, potassium permanganate spray, potassium permanganate sponging etc. These washing techniques have some significant physical change in denim garments [2].

Enzyme wash, bleach wash, acid wash, normal wash, stone wash, etc are the most commonly denim washing methods. Among these washing methods, bleach washing method is widely used method in the industry especially for denim washing by hypochlorite bleaching to get the required color shade. The process of denim Bleach can be used to decolorize indigo from denim [4].

This paper investigates the impact of stone-enzymes & bleach on the physical and mechanical properties of knit garments as these properties determine the wearers feel and life of the end product. The paper also investigates the optimum use of enzyme with the fixed proportion of pumice stones.

### **2.1.1 Physical Appearance after Different Types of Denim Wash**

Denim wash gives aesthetic finish. It enhances the appeal. It also provides strength. With the time being the fabric will be faded in such a manner similar to that way which is artificially obsessed denim trends to ditto. With dry denim, however, such type of fading is influenced by the person's body who wears the denim garment and also their daily life activities. This can create what many people feel to be a more unique, natural look than the pre-distressed denim.

Garment made from denim processed like jeans can go through so many processes in order to get realist fading effect or different types of special wash effects [6].

### **2.1.2 Bleach Wash**

Bleach wash is ordained to fade a high degree of color among various techniques of garments washing. In such a higher degree it is very difficult, to fade the color from all over the garments at one wash without bleach wash. But having some disadvantage such as- bleach destroys the fabric as it decomposes the cellulose, tends to make the fabric yellowish, needs to be neutralized hence increases cost and includes more step to the processing time the bleach wash cannot be concealed. Besides all of these drawbacks, bleaching agents like chlorine bleaches are injurious for health and the process sequences are hazardous to the environment, to control the process is very tough and all time it is not possible to get the same results in every batch even after following the same recipe [5]



Figure 1: Random Bleach Wash Effect (Front Side)[13]

Tensile strength, stiffness, elongation at break, weight loss, dimensional stability, color fading, water absorption and moisture regain properties of the treated and untreated garment were examined. According to the results, bleach washing and without washing revealed big differences in tensile strength, stiffness, GSM, color fading and surface roughness [10].

### 2.1.3 Enzyme wash

The cellulose treatment decreases the strength of the properties of the tensile strength and elongation to break [10]. The enzyme works as a catalyst in the washing process which is a living biochemical substance. At first step in the washing process enzyme hydrolysis the cellulose and also remove the projecting fibers from yarn, by this wash therefore faded effects are found. To get the right fading effect on denim garments, the most essential wash is enzyme wash in the



garment industry [5]. Enzyme wash is done on the garments which are made from heavy fabrics just like jeans and denims. Enzyme wash removes the size materials from the garments and remove the starch presents on the garments fabric. By this wash can achieve the high- low abrasion (stone effect) on garment and also seam abrasion in sewing area. Enzyme attacks not mechanically, it attacks chemically and for this reason low damage/wastage then stone wash. For achieve the soft feeling to wear the denim garment. To achieve the buyer's requirement sample. To increase the rubbing fastness and color fastness performance, specially develop the "Bio-Polishing" effect of cotton/denim. Enzyme develops the properties of garments anti-pilling. Enzyme assaults more on the fabrics surface and also gives a very smooth surface [9].



Figure2: Random Stone enzyme stone wash [13]

#### 2.1.4 Stone wash

This is still the most famous of all washings. The jeans are washed with oval or round pumice stones which should all have roughly the same format. The pumice stones are very light with a rough surface. Sometimes, when the final quality inspectors at the jeans factory forget to clean the pockets, you may even find some residue of these stones in the pockets of your new jeans. During the washing process these stones will scrap off a thin layer of the denim thus showing

some of the white threads from the part of the cloth where the indigo dyeing stuff was not able to penetrate[10]. It also creates the effect called brilliance. One may also encounter words like deep stone or super stone wash, which are an indication of how long the jeans have been stone-washed. The longer the wash, the lighter the jeans.



Figure3: Pumice stone in washing machine.

## **CHAPTER – 03**

### **Survey Details, Methods and Materials**

## 3.1 Materials

### 3.1.1 Garments Samples

Garment samples were collected from Beximco Apparels Limited. Same garments ordered for different wash, Enzyme-stone wash and bleach wash.

### 3.1.2 Chemicals

Powder enzyme, Acetic Acid, Antistain, Bleaching powder, Pumic stone, Soda Ash, Sodium Hyposulphite Acetic Acid, Softner & De sizing agent.

### 3.1.1 Washing Machine

Prriya Metal Engineering Works Ltd, M/C capacity-70 kg, heating source- Steam. Hydro extractor & Gas dryer.

## 3.2 Methods

### 3.2.1 Stone-Enzyme wash

Process sequences:

De sizing  
▼  
Rinse 2 times  
▼  
Stone-Enzyme  
▼  
Neutral wash  
▼  
Soft wash  
▼  
Hydro extractor  
▼  
Drying

### 3.2.2 Bleach wash

Process sequences:

De sizing  
▼  
Rinse 1 times with hot water  
▼  
Bleaching  
▼  
Neutral  
▼  
Soft wash  
▼  
Hydro extractor  
▼  
Drying

### 3.2.3 Drying

Hydro extracting for 2-2.5 minutes & Drying for 45-50 minutes at 75°C.

### 3.2.4 Determination of Shrinkage %

Shrinkage percentage was calculated by using these formulas;

$$S\% = \frac{B-A}{A} \times 100$$

B= dimension after treatment, A= original dimension.

### 3.3 Recipe

#### 3.3.1 Stone –Enzyme wash

##### First Step: De-sizing

Batch size.....60 kg denim long pant  
 L:R.....1:9.....540 litter  
 Temperature.....60°C  
 Desizing agent .....324gm  
 Antistain.....540 gm.

##### Second step: Hot wash

L:R.....1:9.....540 litters  
 Temperature .....60°C  
 Time.....5 min

##### Third step: Stone-Enzyme

L:R.....1:8.....480 litters  
 Pumic stone.....half weight of garments  
 Enzyme .....720 gm.  
 Acetic Acid.....288 gm.  
 Antistain.....384 gm.  
 Temperature.....50°C  
 Time.....70 min

Temperature has to rise up to 90°C for 2 minutes

**Fifth step: Neutral wash**

L:R.....1:8.....540 liters  
 Sodium Hyposulphite.....1620 gm.  
 Temperature.....40°C  
 Time.....12 min

**Sixth step: Soft wash**

L:R.....1:8.....480 liters  
 Acetic Acid.....288gms  
 Cationic Softener.....480 gm.  
 Time.....5 min

**3.3.2 Bleach wash**

**First Step: De-sizing**

Batch size..... 60 kg Denim Long Pant.  
 L: R = 1: 9..... 540 liters.  
 Temperature..... 60°c  
 Desizing agent 0.6 gm. / liters ..... 324 gm.  
 Antistain ..... 540 gm.  
 Time..... 25 min.

**Second Step: Hot Wash**

L: R = 1: 9..... 540 liters.  
 Temperature..... 60°c.  
 Time..... 5 min.

**Third Step: Bleaching**

L: R = 1: 8..... 480 liters.  
 Bleaching powder 10 gm./liter..... 4800 gm.  
 Soda ash 5 gm./liter..... 2400gm.  
 Temperature..... 60°c.  
 Time..... 15 min..

**Fourth Step: Neutral Wash**

L: R = 1: 9..... 540 liters.  
 Sodium hyposulphite 3 gm./liter ..... 1620 gm..  
 Temperature ..... 40°c.  
 Time ..... 12 min.

**Fifth Step: Soft Wash**

L: R = 1: 8..... 480liters.  
 Acetic Acid 0.6 gm./liters ..... 288 gm.  
 Cationic softener 1 gm./liters ..... 480 gm.  
 Time..... 5 min



### 3.4 Survey Report

#### 3.4.1 Determination of Inseam Length & Side seam length

Seam length of the sample garments was measured by using measuring tape in Centimeter (cm).

Table (1) Effect of garments properties for using Enzyme-Stone wash.

Measurement Area	Before Wash	After Wash	Difference	Average	Shrinkage %	Average %
Side Seam	98	93.5	-4.5	-4.3	-4.812834225	-4.812834
	98	94	-4		-4.255319149	
	98	93.5	-4.5		-4.812834225	
	98	93.5	-4.5		-4.812834225	
	98	94	-4		-4.255319149	
Inseam	78	74	-4	-3.9	-5.405405405	-5.405405
	78	74	-4		-5.405405405	
	78	74.5	-3.5		-4.697986577	
	78	74	-4		-5.405405405	
	78	74	-4		-5.405405405	

This above table shows that the enzyme- stone washing imparts significant change in the garment properties. A significant change has been experienced in the garment shrinkage, most significantly in the side seam way which is measured to indicate warp shrinkage is up to 4.8%, and in the inseam way which is also measured to indicate warp shrinkage that is up to 5.4%. In side seam areas have experienced before wash and after wash difference average were 4.3. The inseam areas have experienced before wash and after wash difference average were 3.9. This proves the fact is that the garment length is reduced after wash

Table (2) Effect of garments properties for using Bleach wash.

Measurement Area	Before Wash	After Wash	Difference	Average	Shrinkage %	Average %
Side Seam	90	86.5	-3.5	-3.7	-4.046242775	-4.046243
	90	86	-4		-4.651162791	
	90	86.3	-3.7		-4.287369641	
	90	86.5	-3.5		-4.046242775	
	90	86	-4		-4.651162791	
Inseam	70	67.5	-2.5	-2.8	-3.703703704	-3.703704
	70	67	-3		-4.47761194	
	70	67.5	-2.5		-3.703703704	
	70	67	-3		-4.47761194	
	70	67	-3		-4.47761194	

This above table shows that the bleach washing imparts significant change in the garment properties. A significant change has been experienced in the garment shrinkage, most significantly in the side seam way which is measured to indicate warp shrinkage is up to 4.04%, and in the inseam way which is also measured to indicate warp shrinkage that is up to 3.7%. In side seam areas have experienced before wash and after wash difference average were 3.7. The inseam areas have experienced before wash and after wash difference average were 2.8. This proves the fact is that the garment length is reduced after bleach wash.

### 3.4.2 Determination of PPI and EPI

Make a square of one square inch on the sample and Counted number of ends and Picks inside those squares.

Table (3) Effect of PPI & EPI properties for using Enzyme-Stone wash.

Measurement Area	Before Wash	After Wash	Difference	Average
PPI	52	54	2	2
	52	54	2	
	52	55	3	
	52	53	1	
	52	54	2	
EPI	96	100	4	3.6
	96	100	4	
	96	99	3	
	96	99	3	
	96	100	4	

This above table shows that the PPI increased after garment wash. Increasing PPI average difference is up to 2, where before wash PPI number was 52 and then it is increased after wash up to 54. EPI is also increased after garment wash. The average garments wash difference is up to 3.6. Before wash EPI was 96 and then it increased up to 100. Fact is that after enzyme stone wash denim garments EPI and PPI number is increased more because of shrinkage.

Table (4) Effect of PPI & EPI properties for using Bleach wash.

Measurement Area	Before Wash	After Wash	Difference	Average
PPI	44	46	2	1.4
	44	45	1	
	44	46	2	
	44	45	1	
	44	45	1	
EPI	90	93	3	3
	90	92	2	
	90	93	3	
	90	93	3	
	90	94	4	

This above table shows that the EPI increased after bleach garment wash. Increasing EPI average difference is up to 3, where before wash EPI number was 90 and then it is increased after wash up to 93. PPI is also increased after garment wash. The average garments wash difference is up to 1.4. Before wash PPI was 44 and then it increased up to 46. Fact is that after bleach wash denim garments EPI and PPI number is increased less because of shrinkage.

### 3.4.3Determination of weight

Weight of the garments was measured by manual method; where full garments were measured by using electric balancer in gram (gm.)

Table (5) Effect in weight of denim garments for using Enzyme-Stone wash

Measurement Area	Before Wash	After Wash	Difference	Average
Weight of the garments	620	605	-15	-17
	620	600	-20	
	620	605	-15	
	625	610	-15	
	630	610	-20	

The changes in the garment weight (GSM) before enzyme- stone washing are represented in the above figure is 620, 625, 630, and after doing enzyme stone washing are 605, 610, and 610, respectively. The difference between before wash and after wash was 15, 15, and 20. The average difference is 17. It proves that after enzyme stone wash weight of the denim garment is reduced.

Table (6) Effect in weight of denim garments for using Bleach wash

Measurement Area	Before Wash	After Wash	Difference	Average
Weight of the garments	580	570	-10	-11.6
	575	562	-13	
	580	565	-15	
	570	560	-10	
	580	570	-10	

The changes in the garment weight (GSM) before bleach washing are represented in the above figure is 580, 575, 570, and after doing bleach washing are 570, 562, and 560, respectively. The difference between before wash and after wash was 10, 13, and 10. The average difference is 11.6 which prove that after bleach wash weight of the denim garment is reduced.

### 3.4.4 Determination of Garments body measurement (Half Thigh)

Body width of garments was taken by measuring tape in Centimeter (cm)

Table (7) Change in width of denim garments for using Enzyme-Stone wash

Measurement Area	Before Wash	After Wash	Difference Cm	Average	Shrinkage %	Average %
Half Thigh (width)	22.5	22	-0.5	-0.72	- 2.272727273	- 2.272727
	22.5	22	-0.5		- 2.272727273	
	22.5	21.4	-1.1		5.140186916	
	22.5	21.5	-1		- 4.651162791	
	22.5	22	-0.5		- 2.272727273	

The change in width of denim garment for enzyme stone wash is obvious from the above table no.7 that before enzyme stone wash the area half thigh was 22.5. After doing the enzyme stone wash the half thigh became 22, 21.5. The average difference between before wash and after wash is 0.72, which proves that after enzyme stone wash half reduced and shrinkage increased.

Table (8) Change in width of denim garments for using Bleach wash

Measurement Area	Before Wash	After Wash	Difference	Average	Shrinkage %	Average %
Half Thigh (width)	20.5	20	-0.5	-0.5	-2.5	-2.5
	20.5	20.1	-0.4		-1.9	
	20.5	19.8	-0.7		-3.5	
	20.5	19.8	-0.7		-3.5	
	20.5	20	-0.5		-2.5	

The change in width of denim garment for bleach wash is obvious from the above table no.8 that before bleach washes the area half thigh was 20.5. After doing the bleach wash the half thigh became 20, 20.1, and 19.8. The average difference between before wash and after wash is 0.5, which proves that after bleach wash half thigh is reduced and shrinkage increased.

## 3.5 Out look

### 3.5.1 Stone-Enzyme wash



Figure 4: Stone –Enzyme wash effect on the garments.



### 3.5.2 Bleach wash



Figure 5: Bleach wash effect on the garments.

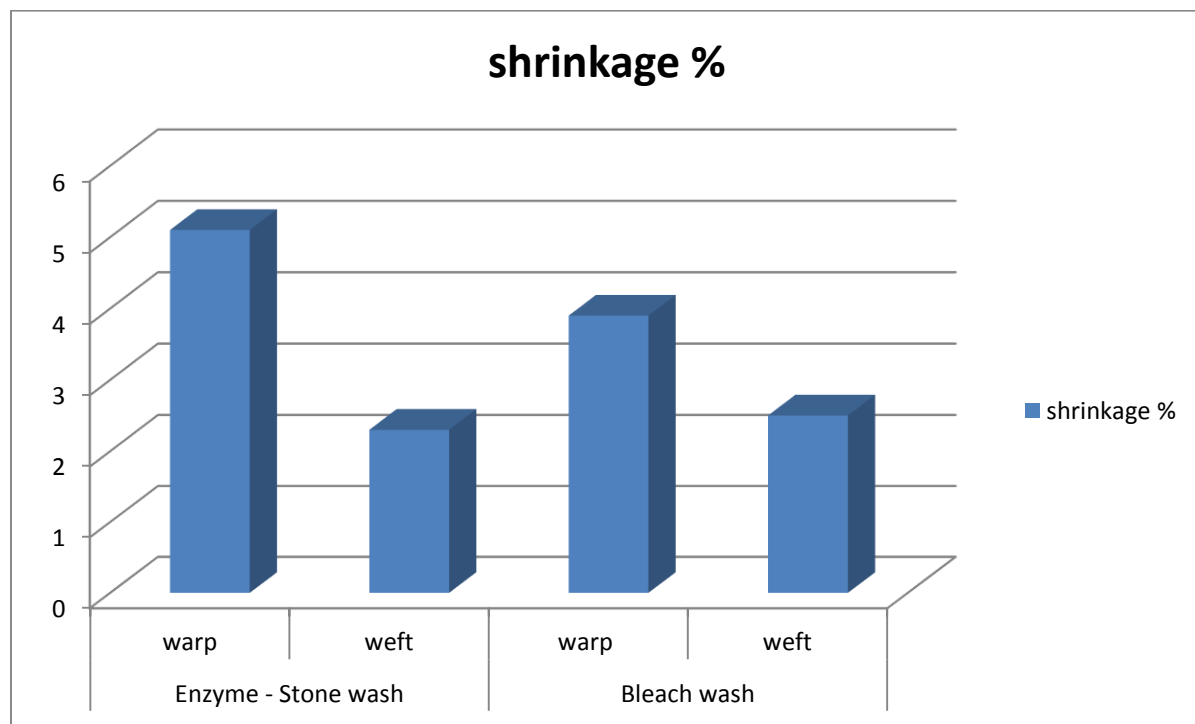
## **Chapter -04**

### **Discussion & Result**

To investigate the physical properties of denim garments for enzyme-stone wash and Bleach wash for both warp and weft are evaluated. At table (1) and table (2) Seam length measurement was considered to calculate the shrinkage percentage for the warp wise for both enzyme-stone & bleach wash. At table (3) and table (4) was considered to evaluate the EPI & PPI variation for the enzyme-stone & bleach wash. Approximately table (5) and Table (6) to evaluate weight variation, table (7) and table (8) to evaluate the weft wise shrinkage.

### 4.1. Shrinkage

In this investigation for enzyme-stone wash the Shrinkage % is higher in warp direction than weft direction. Where warp direction shrinkage is about 5.1% and weft shrinkage is about 2.3%. On the other hand for Bleach wash the shrinkage % in warp direction is about 3.9% where the weft shrinkage % is about only 2.5%.

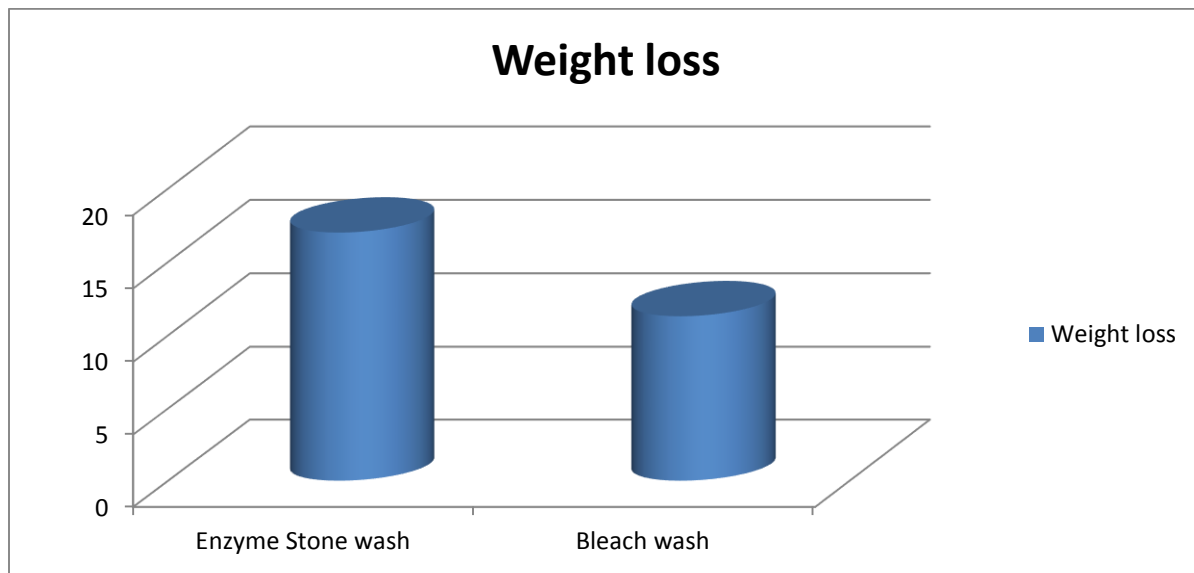


Graph 1: Shrinkage variation for enzyme-stone and bleach wash

This investigation shows that warp direction shrinkage is higher for both wash and Enzyme-stone wash causes more shrinkage.

## 4.2. Weight loss

Enzyme-stone wash causes more weight loss than bleach wash due to more abrasion with pumice stone. In this experiment the weight loss of the garments was 17g for enzyme-stone wash where only 11.6 g weight loss occurred due to bleach wash. Enzymes attack the surface area of the garments and remove the protruding fibers and dyes stuff.

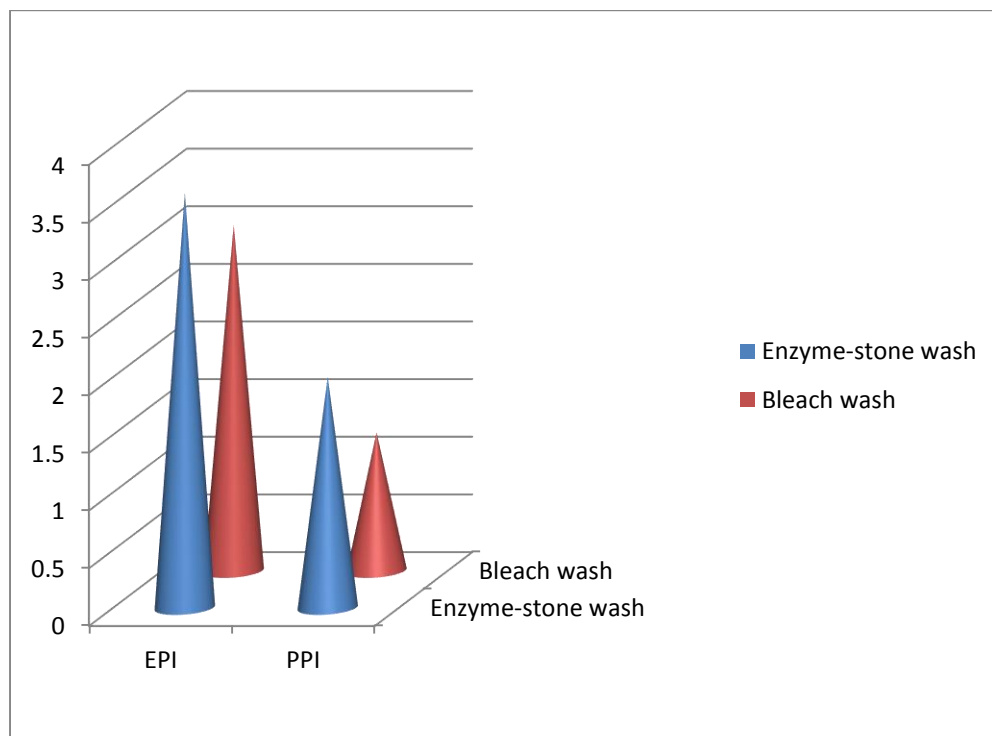


Graph 2: Weight loss curve for enzyme-stone wash & Bleach wash

During denim weaving cotton fabrics are required tension on the warp direction. After that in finishing section this subsequent stretch is increased for calendaring [11]. As a result the fabric becomes in a state of dimensional stability. When this fabric is cut and sewn for garments and sent for wash, it wetted in bleach, it tends to revert its more stable dimensions which causes contraction of yarn. And it is higher in warp direction than weft direction and causes relaxation shrinkage. Due to this PPI increased and causes weight loss. Weight loss provides the better hand feel and improves the better abrasion resistance.

### 4.3. EPI & PPI

As we know EPI and PPI can be changed due to shrinkage. We also found that in our investigation, where the average EPI variation was 3.6 for enzyme-stone wash and 3 for bleach wash. And the average PPI variation was 2 & 1.2 approximately for enzyme-stone wash and bleach wash. Already we have found that enzyme-stone wash causes more shrinkage than bleach wash. As a result its EPI and PPI variation is also have a significant change. And EPI variation is higher than PPI variation.



Graph 3: EPI & PPI variation for enzyme-stone and Bleach wash

Cellulose is hydrolyzed by enzyme at the time of enzyme wash. At first it attacks the having projecting fiber and hydrolyzed them. Then it attacks the yarn portion inside fabric then partly hydrolyzed the yarn portion and fading appearance is produced [12]. Stone causes irregular fading and higher weight loss as it brush the garments at the time of washing. Higher weight loss

is gained for the using for pumice stone in enzyme wash then the bleach wash. And .better hand feel provide by compact position of warp and yarn as they shrink or EPI & PPI increased.

## **Chapter-5**

### **Conclusion**

Denim garments quality mainly depends on the finishing, that means washing section. This report showed some analytical data for shrinkage, EPI & PPI and weight loss of denim garments.

They are:

- The enzyme stone washing imparts significant change in the garment is, the garment length is reduced after wash.
- Due to the abrasion garments weight is reduced in both bleach wash and enzyme stone wash.
- In garments after washing EPI and PPI is increased more in enzyme stone wash but it minimizes pilling tendency.
- Due to shrinkage EPI and PPI number is increased in garments after bleach washing due to shrinkage.
- The change in width of the garment is reduced because shrinkage is increased.

In our internship period we tried our level best to collecting the original data for completing the report. Due to some limitations we didn't get the all information but we think further research will come in this topic.



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