International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 10 | Oct -2017 www.irjet.net p-ISSN: 2395-0072

Changes in Mechanical Properties of Denim Due to Different Washing Processes

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Abstract – *The paper is on "changes in mechanical properties of denim due to different washing processes" here 100% cotton denim fabrics were selected to carry out the experiment, and different washing process; Bleach Wash, Enzyme wash, PP wash applied on 100% cotton twill, weave 2/1, construction 80 × 64 / 10 × 9, indigo dyed denim fabric leg panels as per lab standard recipe. Pretreatment was Desizing and after treatment is silicon softener. After washing different samples from different washing are going to express different mechanical properties. Finding out the different expression of denim for different wash is the major part of that research.*

Key Words: Denim fabrics, Twill, Enzyme, Bleach, PP, Desizing, softener, Mechanical properties.

1. INTRODUCTION

Denim is one of the world's oldest fabric's which is most commonly associated with jeans. It is very strong, stiff and hard wearing fabrics [1]. Denim is a cotton and twill-weave fabric that uses colored warp and white weft yarn and used for jeans and work clothes. It is normally dyed with indigo, vat and sulfur dyes which remain on yarn surface [2]. Among these, indigo share is 67%. Indigo dyes are used for fashion dyeing; in denim, fibers dyed with indigo are not included in fiber-transfer examinations, remains surface dyeing [3].

1.1 Denim Washing

Industrial washing is very important applied finishing methods on fabric or apparel. Different washing methods can be applied for denim fabric finishing. Such as bleach wash, enzyme wash, stone wash, acid wash, detergent wash, silicon washes etc. [4]. As a result new outlook and appearance is produced in the garments, which is not possible in any other method. Moreover, due to washing, starch present in the garments is removed [5]. As a result washed garments could be worn after purchase directly from the store or shop. Some garments shrink after wash, hence washed garments could be purchased as per required size [6].

2. MATERIAL & METHODOLOGY

2.1 Materials:

2.1.1 Fabric

All specimens are made from one shell fabric 100% cotton twill left hand twill, weave 2/1, construction 80 × 64 / 10 × 9, indigo dyed denim fabric , GSM-225 is used in this work. Leg panels were made using the stated denim fabric. We collected it from CIPL-Epic group.

2.1.2 Chemicals

Detergent (Hostapur, BASF, Germany), Acetic acid (china), desizing agent (Luzyme, BASF, Germany), softener (silicon softener, china), Cryltane DTS 40 (china), Sodium metabisulfite (neutralization agent).Enzyme (acid enzyme, Bangladesh), Bleaching agent ((Bleach KCI, India), $KMNO_4$ (Acid & PP wash, Bangladesh).

2.2 Methods

2.2.1 Desizing Treatment

Denim leg panels were desized using desizing agent. This pretreatment was conducted in liquor containing desizing agent, detergent and material to liquor ratio 1:20 in a small scale front loading industrial washing machine .This treatment was carried out at temperature 60°C for 15 min. After desirable time the liquor was dropped out. Then treated denim leg panels were rinsed two times.

2.2.2 Bleach Wash

Desized denim leg panels were treated using bleaching agent (KCI).This treatment was carried out at liquor ratio 1:20, at temperature 60°C for 10 min. Though it is bleached, it contains chlorine that we have to remove so we have to neutralize it. We make two rinsed wash then make a liquor contains Sodium metabisulfite(neutralize agent) with the same liquor ratio 1:20 and we also use DTS 40 ,that treatment take 5 minutes then the treated denim leg panels were rinsed twice with clean water.

2.2.3 Enzyme Wash

Desized denim leg panels were treated with using acid enzyme. In case of acid enzyme we had to use acetic acid to maintain pH in the range of 4.5-5.5 .This enzyme treatment was carried out at liquor ratio 1:20, at temperature 45°C for 40 min. Then the treated denim leg panels were rinsed twice with clean water.

2.2.4 PP Wash

For the PP wash we use potassium per manganite ($KMnO_4$), first we make a solution of 1:20 liquor ratio with $KMNO_4$ then we put the leg panels into the washing machine and start the process for 10 minute with the temperature 60°C. after that we take out the garments with two rinse wash and the neutralization solution and put the garments there and run the process for five munities. After it finished, we put two rinse wash again and take the panels out of from the machine.

2.2.5 Softener

Softener is the treatment that improves the hand feel of the garments. First we took the entire specimen from the wash we make before and put into the solution where we put silicon softener then we run this treatment for 10 min and after that we make one rinse wash and then take the panels out.

2.2.6 Hydro Extracting and Drying Processes

Now in this stage of our study we have five different washed denim leg panels. We apply Enzyme, Bleach, PP wash to the leg panels. We had made 15 leg panels for our study and wah five panels for each wash. Now we have 15 panels that we have to dry these for our next process. washed denim leg panels were squeezed to a wet pick-up of 70% at 200 rpm for 3-4 min in laboratory scale hydro-extractor machine (Zanussi, Roaches International Limited, England), then dried at 75°C for 35-40 min in a steam drier (Opti-Dry, Roaches International Limited, England).Treated denim leg panels were then evaluated through different fastness properties, physical properties and visual observations.

2.2.7. Testing Methods

All treated denim leg panels were conditioned in 65% Relative humidity (RH%) and 20°C for 24h before testing according to BS EN 20139 and ASTM D1776.

GSM was calculated for measuring the difference in fabric weight before and after the treatment according to ASTM D 3776.

Samples were evaluated by crock meter to measure color fastness to crocking according to AATCC Test Method 8.

Tearing strength of the samples evaluated by tear testing machine according to ISO-13934-1 standard.

Tensile strength of the samples evaluated by tensile testing machine according to ISO 13937-2 standard.

The dimensional stability of the leg panels are assessed according to the ISO 6330 standard.

3. RESULTS & DISCUSSIONS

3.1 Changes in GSM

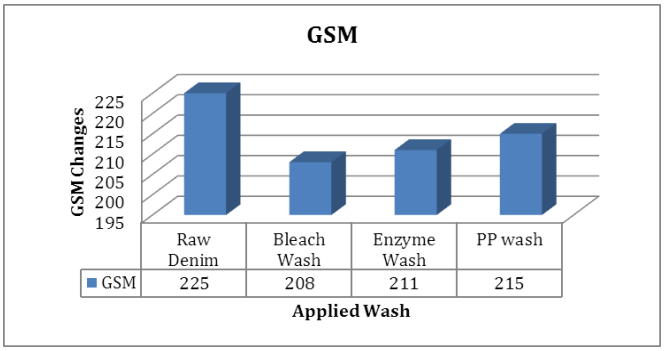

Figure-1: GSM changes for washing

GSM is stands for Gram per Square Meter. Figure-1, shows that GSM of raw denim was 225 and it decreases after washing. So, we can say that denim washing can plays a significant changes in GSM.

3.2 Changes in Color Fastness to Crocking

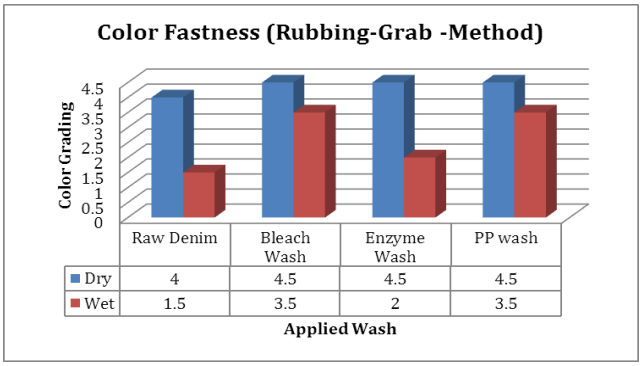

Figure-2: Changes occur due to color fastness to crocking

From figure-2, it is clear that each wash shows excellent color fastness to crocking both in dry and wet state because color fastness to rubbing was increased significantly after the treatment. So, it can say different washing treatment is very effective to improve the color fastness to rubbing.

3.3 Changes in Tearing Strength

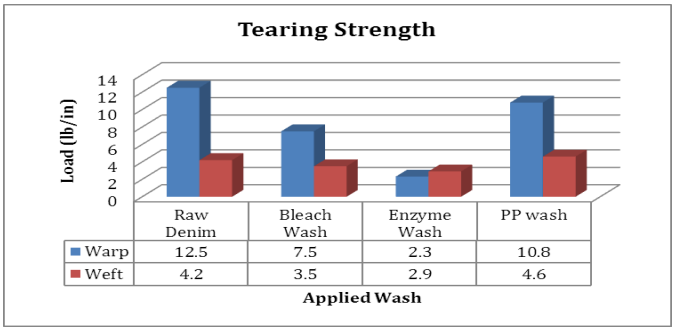

Figure-3: Changes of Tear strength due to washing

In figure-3, we see that tearing strength changes drastically with washing and it decreases. Enzyme washed sample was very much affected both it warp and weft direction it is because enzyme hydrolyzed the cotton.

3.4 Changes in Tensile Strength

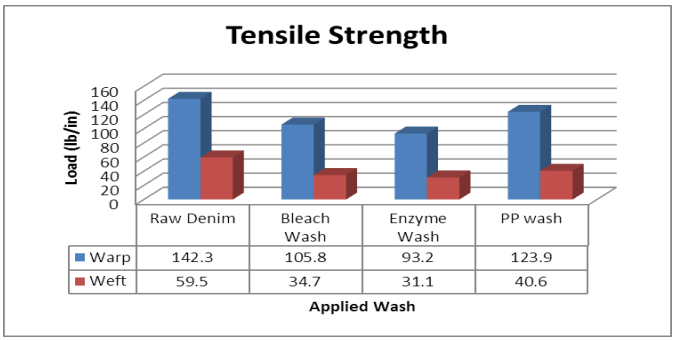

Figure-4: Changes of Tensile strength along with washing

All the washes influences adversely on to the samples. Figure-4 represents that, tensile strength falls after washing in both warp and weft wise direction. Enzyme wash sample shows the lowest result. On the other hand tensile strength of PP washed sample is much better than other samples.

3.5 Changes in Dimensional Stability

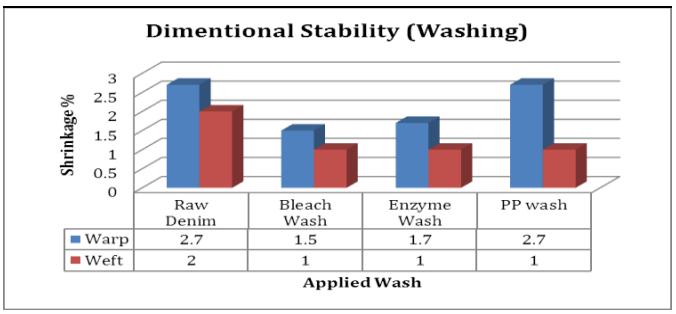

Figure-5: Dimentional stability changes due to washing

To check the changes in dimentional stability, we measure the shrinkage % of before and after wash samples and we found that there is a little bit change in dimention and the rate is higher for bleach wash samples than others. On the other hand shrinkage % is almost same of original or raw denim and PP wash denim. And this is the reason why strength decreases after washing.

3. CONCLUSIONS

Finding out the influences of different washing methods on the mechanical properties of denim fabrics was the main focus of this study and findings are-
GSM decreases due to washing.

Color fastness to crocking improves as well in both dry and wet state.

Tearing strength falls after washing both in warp and weft way.

Tensile strength also decreases for all wash samples.

There is a little change in dimensional stability of denim which is measured by evaluating shrinkage%.

It is already mentioned that changes are very low for PP wash samples compare to other washing.

Though industrial washing is very much important to give a fancy and worn look on denim but it also brings remarkable changes on different mechanical properties of denim fabrics.

ACKNOWLEDGEMENT

I acknowledge to all the members of CIPL-Lab Epic group and also want to give a heart-felt thanks to Mr. Abdullah Al Rahi, Bahni Sen, Ananya Dasgupta Mou for their endless support and cooperation.

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