Proceedings of the
International Conference on Mechanical Engineering and Renewable Energy 2019
(ICMERE2019) 11 – 13 December, 2019, Chittagong, Bangladesh

ICMERE2019-PI-011

ANALYSIS OF THE INFLUENCE OF DIFFERENT DRY PROCESSES ON THE PROPERTIES OF DENIM GARMENTS

Md. Shamsuzzaman[1], **Joy Sarkar**[2]

[1]Department of Textile Engineering, World University of Bangladesh, Bangladesh
[2]Department of Textile Engineering, Khulna University of Engineering and Technology, Bangladesh
shamsuzzaman_tex@yahoo.com, joy.sarkar@te.kuet.ac.bd

Abstract- *The application of dry processes plays a significant role in the utmost satisfaction of customer since these processes improve the outlook, appearance, comfort as well as adds value to the denim garments In this research, PP spray, hand scraping, and laser engraving processes were applied on different types of denim samples (based on their construction) and the changes in different functional properties of that samples were assessed and compared. The treated denim garments exhibit significant differences in the properties than the untreated samples. Samples weight, tensile strength, tear strength, abrasion and pilling resistance properties have been recorded lowered after each dry process, especially after hand brushing; however, water absorbency property developed well. Besides, samples pH value, color change, color staining, etc. properties found little bit changed or similar to the original samples.*

Keywords: Denim garment, hand brushing, p.p. spray, laser fading and properties

1. INTRODUCTION

Garment washing is the newest technology for changing or modifying the outlook, appearance, comfortability, and design of the garments. This process is applied to the solid or printed garment to make faded effects on it. As a result, the physicomechanical properties of both knit [1] and denim [2] garment has been modified and becomes more appealing to the customer. There are wet/ chemical and dry processes are available for both types of garment [3]. For the design variability, the development of denim production has become prominent and widens the global market with newer finishes [4]. The denim without finishes becomes stiff and uncomfortable to wear because of the different manufacturing processes than other fabrics. That's why the application of the garment wash becomes crucial to make denim garment softer, suppler, smooth and comfortable [5]. For denim garment finishing a large no. of processes are available in the industry and modifying the existing technology and process with newer ones [5]. The most common application of chemical washing on denim garment are enzyme wash, bleach wash, acid wash, stone wash, etc. [6-7] whereas the most important dry process are tagging, grinding, destroy, whiskering, permanent wrinkle, p.p. spray, hand scrapping and some other finishing process [8].

In this research, hand brush, p.p. spray and laser process were applied on different (construction based) denim garment and its properties were analyzed.

1.1. Objectives of the Research

- To apply and check different dry process on denim garment.
- To measure how the dry processes affect the properties of denim garment

2. MATERIALS AND METHODS

2.1. Materials

The following four (4) different types of denim garments (different construction) have been taken for the research.

Sample 1: $\frac{79 \times 60}{90\ E \times (12{+}40D)}$

Sample 2: $\frac{100 \times 64}{10\ rs{+}12\ rs{+}10\ r \times (12{+}40D)}$

Sample 3: $\frac{70 \times 60}{90\ E \times (12{+}40D)}$

Sample 4: $\frac{95{\times}66}{12\ rs{+}12r \times (200{+}70D)}$

2.2 Methods

2.2.1 Application process of Potassium per Manganate (P.P.) spray

At first, a stock solution was prepared by mixing Potassium permanganate (6 gm/L) and acetic acid (30 ml/L). Then by using a spray gun liquid was applied to the denim garments. The indigo-dyed garments turned pink and then grey color. Finally, all the samples were washed and dried.

2.2.2. The application procedure of hand brushing

In this process, a 220 number emery paper was directly applied by hand to get the faded effects until desired looks were achieved without damaging the denim garments.

2.2.3 The application procedure of laser fading

A CO_2 laser fading machine was used to fade all the samples. DPI was 10 and the time of fading was 5 sec for each individual sample.

2.2.4 Determination of Colorfastness to Washing Test (BS EN ISO 105 C06)

The samples were tested according to BS EN ISO 105 C06 standard where multifibre from James Heal was used. The washing liquor ratio (liquor/sample) is 20:1. Sample fabric, white paper, and multifibre fabric were attached and cut edges straightly. Then it was boiled for 20 minutes at a temperature of $70°C$ in a dye bath. Finally dried out and continued washing for all the samples individually [9].

2.2.5 Determination of Fabric Weight

According to the ASTM D 3776 method samples fabric weight was measured. Samples were cut by using GSM cutter and weighed on an electric balance and multiplied by 100to get the fabric weight [10].

2.2.6 Determination of pH (AATCC 81-2006)

The pH value of denim samples was measured by AATCC 81 method. 10 gm of fabric samples were cut into small pieces and boiled for 10 minutes at 250 ml distilled water. Then allowed it for cooled down and by using pH meter value of pH were measured for all the samples separately [11].

2.2.7 Determination of Rub Property

According to AATCC 8 standards, both the dry and wet rub test was done [12].

2.2.8 Determination of Absorbency

According to AATCC 79 method fabric absorbency property was measured. Samples were placed in an embroidery hoop. A burette dispenses a drop of water onto the surface of the fabric from a distance of 9.5 mm. Time was recorded until the water drop absorbs completely [13].

2.2.9 Determination of colorfastness to light/ Xenon arc fading lamp test

According to ISO 105-B02:2013 test method, light fastness property was measured. A sample fabric was placed in the testing chamber with a standard blue scale reference fabric sample. This wool fabric consists of 8 dark to light blue shades for standard measurement. After a certain time, colors fading of the samples were measured by comparing with another standard scale [14].

2.2.10 Determination of tearing strength of samples

The tear strength was measured as per ASTM D412 standard test method where the pendulum lever principle was followed. At first specimen was cut to 100 ×75 mm from the fabric and further cut according to the template. The cut piece was clamped and fixed on the frame and raised the pendulum from the starting position. The specimen transferred between the two clamps that tear by slit cut. Finally the amount of force was recorded from the frame [15].

2.2.11 Determination of tensile strength of samples

The tensile/ breaking strength of the sample was measured by ASTM D5034 – 09 standard test methods. At first, the fabric sample was cut according to (60mmx300mm) and then frayed down to (50mmx300mm). Then sample was clamped in the jaws and a CRE 500mm per minute loading was applied until fabric breaks [16].

2.2.12 Determination of crease recovery of samples

Fabric wrinkle property was measured by AATCC 128 method where samples were cut 15x28cm size and fold in half and placed between two glass plates and adding to 500gm weight on it. After 1 min load was removed and placed on the machine till to recover the crease of the sample. The recovery angle was read from the engraved scale. Similarly, all the samples were tested and the recovery angle was measured [17].

2.2.13 Determination of pilling resistance of samples

According to ASTM D4970 standard method fabric, pilling resistance was measured. Specimens were cut and placed on the top of the specimen holder. A Lissajous figure is used to perform cycle and the test was carried out for 12000 cycles. Finally samples were individually compared with the standard scale to measure the amount of pill formation [18].

2.2.14 Determination of abrasion resistance of samples

The abrasion resistance of the fabric samples was measured by ASTM D4966 standard method which is also known as Martindale abrasion test. The sample fabric was mounted on the machine and run for 12000 cycles. Then samples were compared with the rating scale to find the abrasion resistance properties of the fabric [19].

3. RESULTS AND DISCUSSION

3.1 Dry processing effects on the color change of denim garments

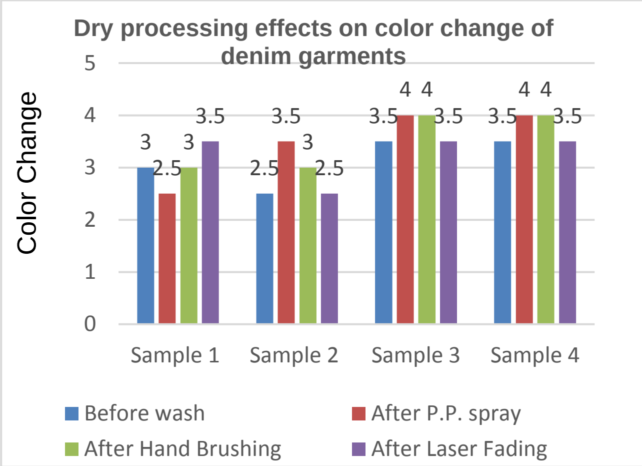

Fig. 1: Dry process effects on the color change of denim garments

After all the dry treatment, colorfastness to change remains steady or a little bit fluctuation. Samples 3 and 4 had developed tendency whereas samples 1 and 2 had a mixed behavior. From this, it can be further said that the property of denim samples has little or no effects after wash.

3.2 Dry processing effects on color staining of denim garments

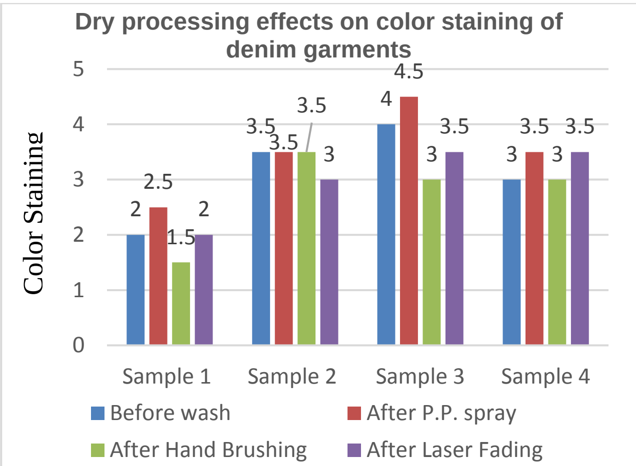

Fig. 2: Dry process effects on the color stain of denim garments

From graph 3.2, it is seen that the colorfastness to stain has been remaining same or developed further after dry process for all the denim samples except some individual cases. For all the cases, hand brushing had the significant impacts that the others where value reduced sharply, however, it should not impact too much on the final garment. On the other hand, for all the case, effects of P.P. spray remains developed after dry process.

3.3. Dry processing effects on Colorfastness to Rubbing (Dry rub) of denim garments

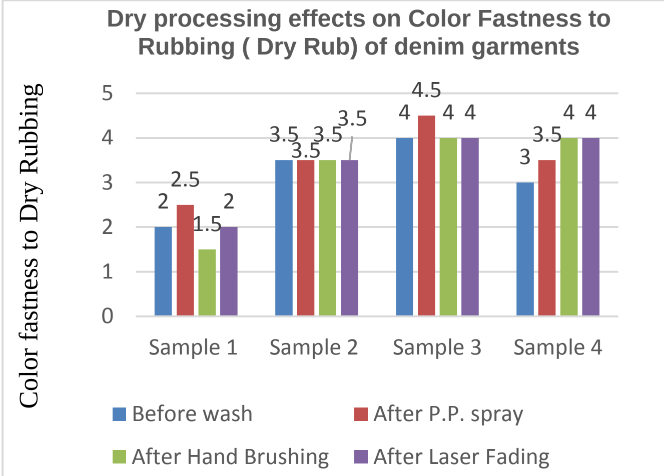

Fig. 3: Dry process effects on dry rub fastness of denim garments

A better dry rub fastness property has been recorded after all the dry treatment to all the selected samples. Effects of P.P. spray on all the samples had developed values whereas others have quite similar tendencies. Moreover, property increased best for sample 4 after treatment.

3.4 Dry processing effects on Colorfastness to Rubbing (Wet rub) of denim garments

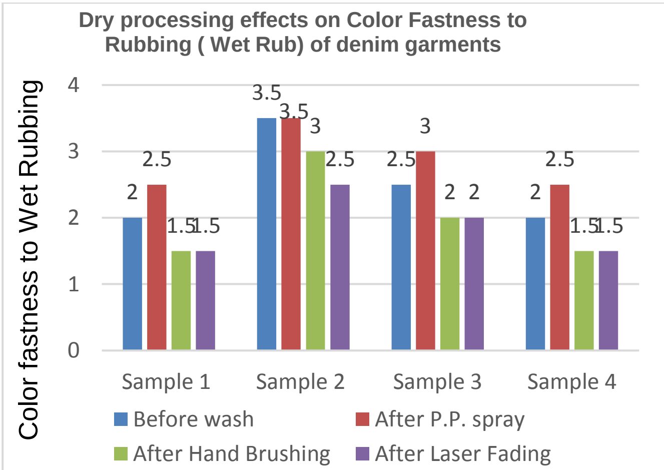

Fig. 4: Dry process effects on wet rub fastness of denim garments

From graph 3.4, it has been observed that the wet rub property of the denim samples had both upward and downward tendency after dry process. Upward property has been found after P.P. spray on the samples. On the other hand, downward property has been recorded for both the hand brushing and laser fading process.

3.5. Dry processing effects on Colorfastness to the light of denim garments

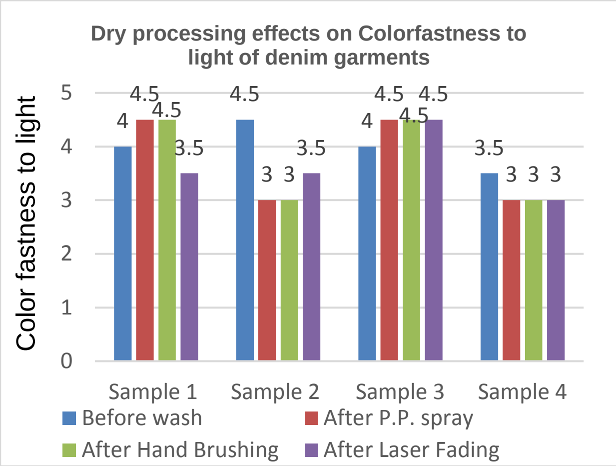

Fig. 5: Dry process effects on colorfastness to light of denim garments

Colorfastness to light after dry treatment improved for samples 1 and 3 whereas samples 2 and 4 had a vice versa impact. For first case samples light fastness property increased after dry treatment; surprisingly this property reduced a lot after treatment, the reason behind this is unknown.

3.6 Dry processing effects on Tearing strength (warp way) of denim garments

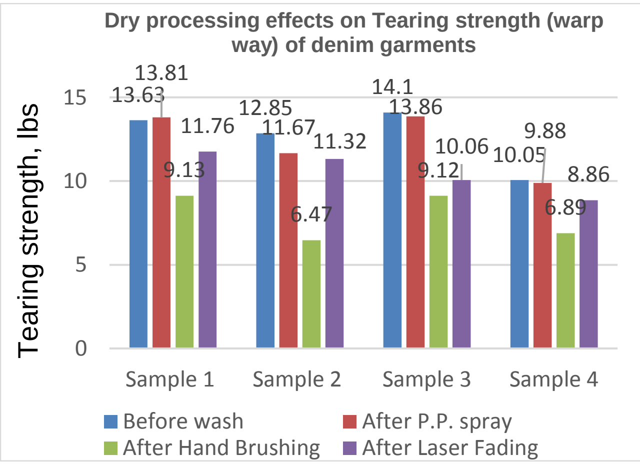

Fig. 6: Dry process effects on Tearing strength of denim garment

A common phenomenon has been observed for all the samples where samples warp way tearing strength reduced significantly. The major impact has been recorded for the samples which had brushing effects. The reason might be such that during brushing the fibre and the yarn portion damaged seriously. Similar effects have also found after laser fading where the ray of laser destroy the surface of the samples and lower the strength of the samples. Therefore, P.P. spray has little or no effect on tear strength warp way.

3.7 Dry processing effects on Tearing strength (weft way) of denim garments

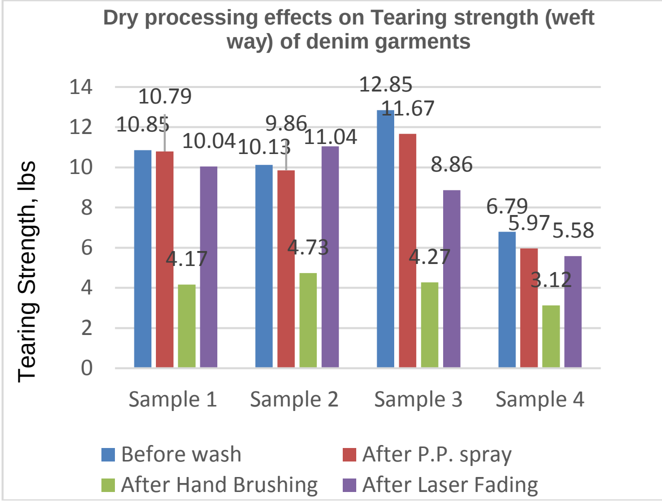

Fig. 7: Dry process effects on Tearing strength (weft way) of denim garments

More than 100% of the tear strength weft way reduced after hand brushing, the reason is the same as brushing effects on samples surface. P. P. spray has lower impacts on strength whereas laser fading reduced a smaller amount of the strength of the samples.

3.8 Dry processing effects on Tensile strength (Warp way) of denim garments

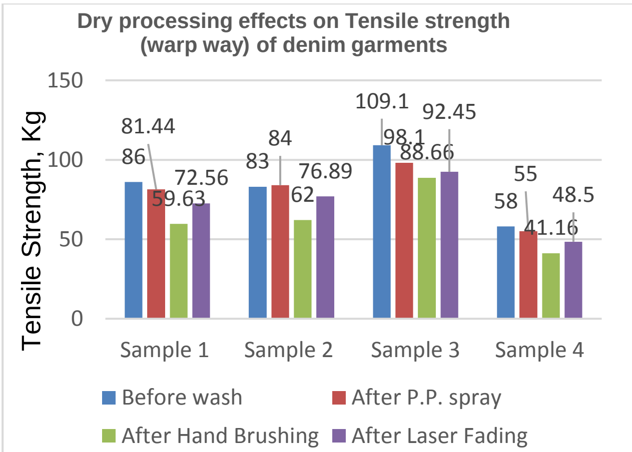

Fig. 8: Dry process effects on Tensile strength (warp way) of denim garments

After the dry process, the values of breaking strength warp way reduced for the entire sample significantly. Severe effects have been recorded after hand brushing since brushing destroyed the fiber and yarn portion from the surface of the denim samples than other processes. It also noted that the laser fading lessened the value of breaking strength as laser rays do the same thing as it was done by hand brush. After analysis above sample and treatment process breaking strength (tensile strength) reduced.

3.9 Dry processing effects on Tensile strength (Weft way) of denim garments

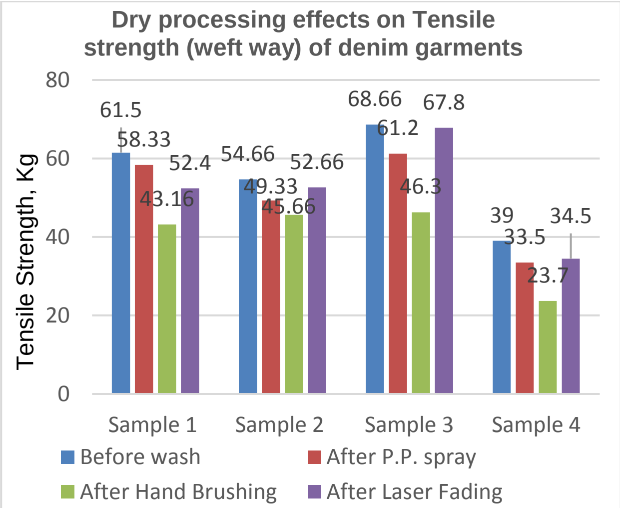

Fig. 9: Dry process effects on Tensile strength (weft way) of denim garments

The effects on tensile strength are lower in weft way direction than in warp way direction. Similar to the reason the strength reduced much for hand brushing than others whereas P.P. sprays have a lower impact on this issue.

3.10 Dry processing effects on Crease recovery of denim garments

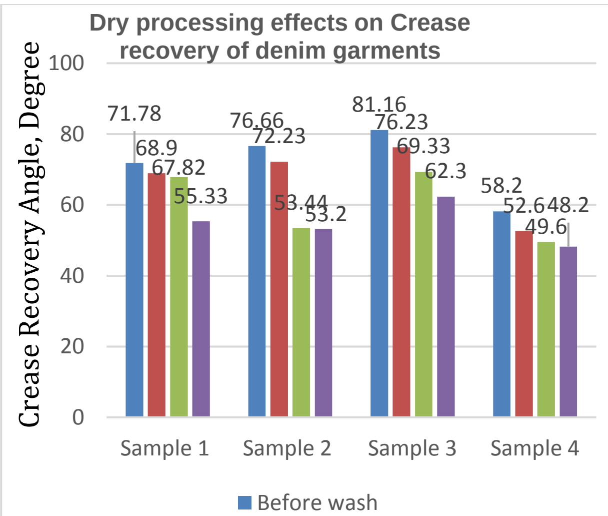

Fig. 10: Dry process effects on crease recovery of denim garments

After the P.P. spray process, the tendency of recovery of the crease angle is better than others that indicate the lower impact of P.P. spray on denim samples. This also means that the ability to recover the crease is better after this process. On the other hand, the lowest ability to recover crease form the denim has been found after laser fading process.

3.11 Dry processing effects on pH value of denim garments

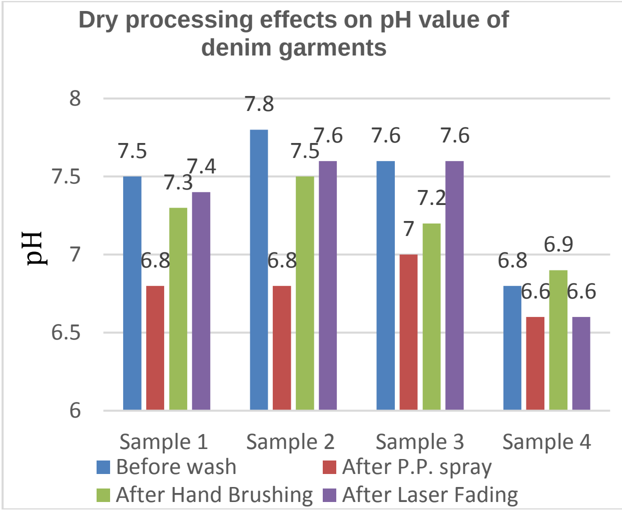

Fig. 11: Dry process effects on the pH value of denim garments

From graph 11, it is seen that all the samples were at neutral or slightly alkaline conditions before treatment. The pH value reduced after all the treatment processes. The samples become most acidic after P.P. spray process where others do remains same or a little bit lower than the before treated samples.

3.12 Dry processing effects on Fabric weight (GSM) of denim garments

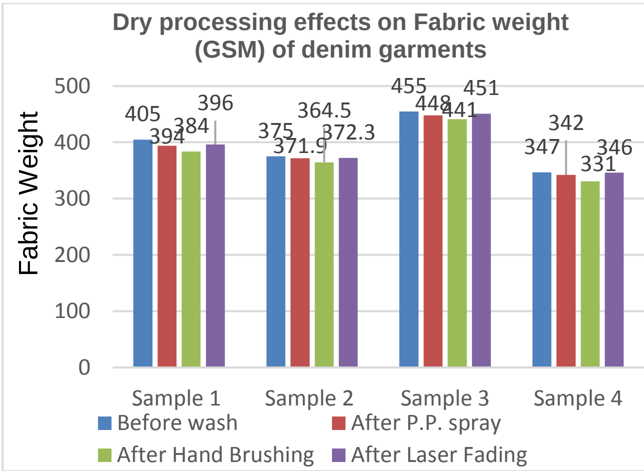

Fig. 12: Dry process effects on GSM of denim garments

After treatment fabric weight reduced, however, impacts were not too acute. The value reduced more after hand brushing than any other dry process.

3.13 Dry processing effects on Fabric absorbency of denim garments

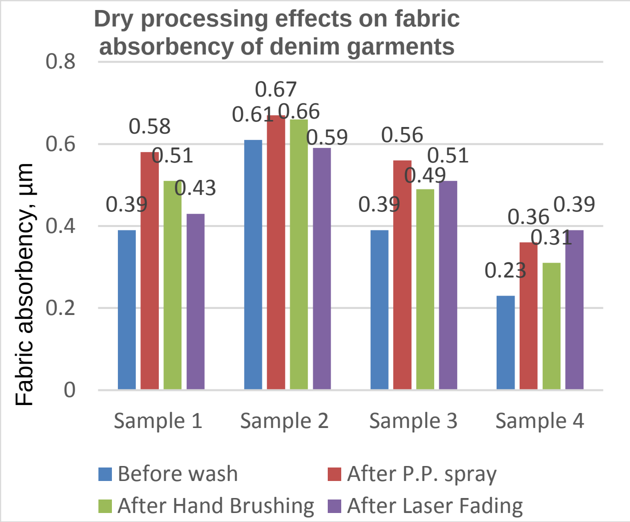

Fig. 13: Dry process effects on absorbency properties of denim garments

The fabric becomes more absorbent after all the dry process to the denim samples. It is because of the surface of the samples destroy by different process which makes the samples more hydrophilic to water. After P.P. spray fabric becomes more absorbent than others.

3.14 Dry processing effects on Pilling resistance (after 12000 cycles) of denim garments

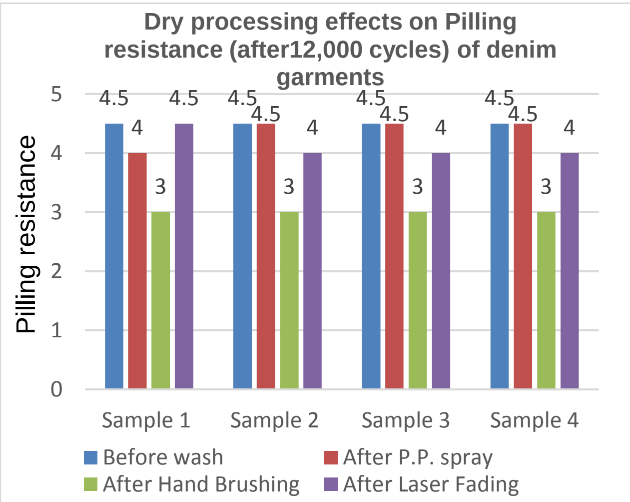

Fig. 14: Dry process effects on pilling resistance of denim garments

Since brushing destroy fiber and yarn portion of the garments so after 12,000 cycles fabric pilling resistance becomes lowest than others. Other processes have little or no effects on the denim samples.

3.15. Dry processing effects on Abrasion resistance (Color Change) (after12000 cycles) of denim garments

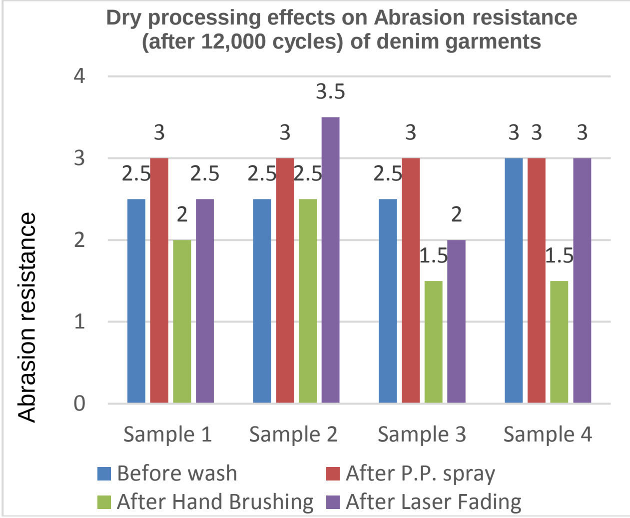

Fig. 15: Dry process effects on abrasion resistance of denim garments

After hand brushing fabric abrasion property reduced a lot for all the samples. The reason behind this is similar to the pilling resistance. However, property developed after P.P. spray and property remains constant after laser fading.

4. CONCLUSION

The application of different dry process directly attacks the surface of denim, precisely fiber surface, and yarn portion. These processes improve the softness and comfortability of denim garment, however, degrade to some extent. From the above analyses, it is clearly noticed that

- The type of dry process has more effect on the properties of the treated fabric regardless of the fabric type.
- Color change, rub fastness, color strain, light fastness, and fabric weight (GSM) properties remain unchanged or change a little.
- Both tearing and tensile strength changes with the change in dry process type, but hand brushed garments showed the worst results in every case.
- Hand brushed samples displayed poor performance in case of abrasion-resistant and pilling resistance of the treated garments.

5. REFERENCES

[1] Solaiman, Abdur Rouf, Shamsuzzaman Rasel, Elias Khalil (2015) Investigation of Different Washing Effects on Physical and Mechanical Properties of Cotton Knitted Garments. *Journal of Textile Science and Technology*,**01**,101-109. doi: 10.4236/jtst.2015.13011

[2] Sarkar, J., & Khalil, E. (2014). Effect of industrial bleach wash and softening on the physical, mechanical and color properties of denim garments. *IOSR Journal of Polymer and Textile Engineering*, *1*(3), 46-49.

[3] Kashem, M.A., Garments Merchandising, 1st Edition, Lucky one traders (2008) 69-71

[4] Mee-Yong Yoon, “Denim finishing with Enzymes” of Genecer International, USA Dyer International 11 (2005).
[5] Hossain, M., Rony, M. S. H., Hasan, K. F., Hossain, M. K., Hossain, M. A., & Zhou, Y. (2017). Effective Mechanical and Chemical Washing Process in Garment Industries. *American Journal of Applied Physics*, *2*(1), 1-25.
[6] Buchert, J. and Heikinheimo, L., “New cellulose processes for the textile industry” Carbohyde. Eur. 22(1998) 2-4.
[7] Duran, N. and Marcela, D., “Enzyme applications in the textile industry” Review progress in Coloration 30(1) (200) 41-44
[8] Dakuri Arjun, Hiranmayee J, Farheem MN. Technology of industrial denim washing: Review.
[9] ISO 105-C10:2006 (2006) Textiles—Tests for Colour Fastness—Part C10: Colour Fastness to Washing with Soap or Soap and Soda.
[10] ASTM D3776/D3776M-09a (2013) Standard Test Methods for Mass per Unit Area (Weight) of Fabric. ASTM International,West Conshohocken.
[11] AATCC Test Method 81-2006 (2006) pH of the Water Wet Processed Textiles. American Association of Textile Chemists and Colorists, AATCC Technical, Research Triangle Park, North Carolina.
[12] ISO 105-X12:2001 (2001) Textiles—Tests for Color Fastness—Part X12: Color Fastness to Rubbing.
[13] AATCC Test Method 79 (2009) Absorbency of Textiles. American Association of Textile Chemists and Colorists, AATCC Technical Manual, Research Tri U.S.A.
[14] ISO 105-B02:2013 Textiles- Tests for color fastness to light/xenon arc fading lamp test
[15] ASTM D412 standard (2010) Standard test method for tear strength of fabric. ASTM International,
[16] ASTM D5034 – 09(2017) Standard test method for breaking strength of woven fabric. ASTM International.
[17] AATCC 128 Test Method (2012) Wrinkle crease recovery of fabric. American Association of Textile Chemists and Colorists, AATCC Technical Manual, Research Tri U.S.A.
[18] ASTM D4970 (2011) Standard test method for measuring the pilling resistance of fabric. ASTM International.
[19] ASTM D4966 (2011) Standard test method for measuring abrasion resistance of fabric. ASTM International.