

REVIEW STUDY OF THE DENIM JEANS FABRIC CHARACTERISTIC PERFORMANCE

Himanshi Dhyani¹, Ramratan², Sukhvir Singh

^{1&2}Department of Textile Technology, National Institute of Technology, Jalandhar 144 011, India

³School of Fashion and Design, Mody University, Lakshmanagarh (Sikar), Rajasthan, 332311, India

Abstract: Denim is a type of twill fabric variation in terms of weave & structure. It is generally indigo dyed (for blue) or Sulphur dyed (for black) so that when it is washed it gives a partially faded signature look. Denim Jeans finishing is an important operation for value addition of the final products in the apparel business. Denim fabric itself made out of the defect. The main problem can occur in denim fabric i.e. shade, shrinkage, before and after wash weight. The weave of the denim can influence comfort. A looser weave can be more comfortable. In this paper, our main focus is to find out the best material, finishing, washing process for the better characteristic performance of denim fabric such as physical, mechanical properties, durability, and comfort of product which are crucial for preference end-use performance. Determination of the optimum finishing process is important as denim finishing is conducted on sewn products and any performance loss will lead to higher economic losses.

Keywords: Denim fabric, Characteristic performance, Washing & finishing process.

1. Introduction

The traditional denim is hard-wearing, heavy fabric made from 100% cotton and woven from coarse indigo dyed warp and grey undyed weft yarn. Traditional denim fabric is high density fabrics with a high mass per unit area and a 3/1 or 2/1 -twill weaves construction [1]. Denim has always been used for very durable outdoor work clothing because of its weight, rigidity, and thickness, denim is chosen for casual jackets, skirts, and jeans. Now that so many garment-finishing techniques are applied to denim, its use has broadened into different lifestyles. Now days lycra yarn is added to denim to make the denim elastic [2, 3]. The performance and comfort factors of garments during usage are very important. Generally, the comfortable stretching of fabrics according to body movements as well as recovery after stretching, are good desirable properties [4,5]. Denim Jeans finishing is one of the most extensively used finishing treatments that have enormous practice, because of its effects on appearance and comfort [6]. There are almost countless variations of dry and wet processing techniques used by designers and textile chemists to achieve fashionable looks that are distinctive and desirable [7-11]. With the increasing awareness about and concern for environmental issues, such as large amounts of effluents produced and high consumption of water and energy, wet processes related to denim washing are considered as not environmentally friendly. To address the environmental concerns, some finishing techniques (Laser, Ozone and Water Jet) have been introduced as an alternative to the conventional wet processing [12].

2. Characteristics and parameters of denim

- Warp yarns are colored usually with Vat or Sulphur dyes.
- Weft yarns are always white in color.
- Structure: warp dominating right hand or left-hand twill i.e. Z/S-twill of 2/1 or 3/1 construction
- Usually made of cotton yarns of coarser count (7S, 10S, 14S, 16S, etc.)
- Rotor yarns are usually used.
- Coarser cloth (weight lies between 6 – 14 oz/sq. yds.) and used for pant and warm jacket

2.1 Weave design of denim

- We all know that the denim fabric is constructed with Twill Design. Now, let us take a brief look about Twill construction.
 - A distinct design for the twill weave is it forms a diagonal line.
 - In the right-hand twill, the diagonals run towards to the right.
 - In the left-hand twill, the lines run towards to the left.
 - Denim, gabardine are well-known twill weave fabrics.
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- The simplest twill weave is either 1/2 or 2/1 twill (three-leaf twill).
- 3/1 or 1/3 twill is called four-leaf twill.

2.2 Dry denim

Dry denim refers to raw denim that has not been exposed to washing or other treatments. For wearing it is a bit uncomfortable at the start. On the one hand denim is washed to make it softer, but on the other hand to reduce the shrinkage. By some time, dry denim will fade into similar colour as the factory distressed denim. However, such fading is very personal; they are affected by the body of the person who wears the product. This kind of product is related with premium denim and represents a small part of the market [13].

2.3 Denim from polyester-cotton blends

In such fabric the polyester warp used is usually kept low (20-25% max) because this blend is harder to dye than the cotton. Polyester-cotton fabrics are very popular on the market, because they are usually cheaper, and consumers love to wear them, because of their easy care, and great feeling while wearing.

2.4 Poly Denim

Polyester can be used in denim in certain percent, or in a higher percentage. So-called poly denim does not just “look like denim” but in their appearance can be confusing alike the “real ones”. Their advantages are that they are strong and durable, wash & dry quickly. The super high-quality ones are the result of the latest developments. For instance, denim used for collections of famous brand G-star raw, which is made from fabrics that contain polyester fibre made from recycled plastic [14].

2.5 Stretch denim

There is usually around 98% cotton and 2% elastic blend in fabrics that are very popular not just for women, but for men too. The spandex blend that is used allows great ease of movement, “shaping the trouble spots” around the hips or thighs at the same time. Stretch jeans are still the biggest segments of the women’s jeans market for the manufacturers. Despite the trends suggest some classic, baggy, boyfriend or loose styles, slim fit keeps its leading place on the market, giving the big support to stretch denim production. There are many new improvements, like some super stretch qualities that are fresh and extremely flexible, so the denim never gets saggy. They offer incredible comfort experience, containing an innovative fibre mix. Some elastane, like the Cognitive Stretch make the denim stretch to extreme dimensions while polyester ensures that jeans keep their shape.

2.6 Blue Gold

The traditional colour of the fabric is almost always blue [10]. Although there has always been and will be some beige, grey and khaki shades of denim, as well as some hot and bright colours every season, but the typical colour of the iconic garment has ever been indigo blue. The unique look of denim comes from the indigo dye which was originally made with tincture extracted from plants⁸. However, a large percentage of indigo dye produced today is synthetic. During the weaving only the warp threads used are dyed, and the weft threads remain plain white. The shade of the blue colour changes according to the latest fashion trends, and fashion designers define it. Chemistry designers all over the world compete with the rapid trends to get even more beautiful shades for the colour of heaven [15].



Figure 1: Different colours of denim, indigo dye and fibres of denim under microscope

Information about the type of the colour used for fabric dye can help solving the debates on its achieved tone, and mistakes made in finishing. For example, usage of hot acids to lighten the colour can have an adverse impact on the fabric quality, especially if containing elastane.

2.7 Crafted Jeans

Jeans today are authentic because of the unique “craft” that is applied. Most of the denim articles are artificially faded and distressed to achieve a chic, worn-in look. This intervention can be creating honeycombs (faded lines that are found behind the knees), whiskers (faded streaks surrounding the crotch area), baffies (faded lines at the thigh), holes, abrasions, etc. Making of such fading patterns and disasters on jeans are a way of "personalizing" the garment. It is usually made with hand (can be done with mechanical equipment, even with laser, but it looks like very artificial), and requires a high level of dexterity and practice [16]. This kind of personalization is a significant part of customization, and it requires lots of time for improving.



Figure 2: Natural fading (left: honeycombs, right: whiskers) and making them artificial (middle)

2.8 Washing & Finishing Process

Finishing is a treatment, when after applying of different crafting technologies on the denim product, it is completed with adjustment technologies. The first denim finishes were developed in the '70 -80s, and together with it the manufacturing process was developed on a more sophisticated level. Depending on the type and quality of the indigo dye, a wide range different of tones can be achieved, by adding different chemicals. The recipe is the intellectual property right of the manufacturer, kept in secret.



Figure 3: Jeans developed by a well-known domestic fashion brand

3. Chemical Washes Process

3.1 Denim Bleach

In this process a strong oxidative bleaching agent such as sodium hypochlorite or $KMnO_4$ is added during the washing with or without stone addition. Discoloration produced is usually more apparent depending on strength of the bleach liquor quantity, temperature and treatment time. It is preferable to have strong bleach with short treatment time. Care should be taken for the bleached goods so that they should be adequately

antichlored or after washed with peroxide to minimize yellowing. Materials should be carefully sorted before processing for color uniformity.

3.2 Enzyme Wash

In order to minimize the adverse effect of stone-washing, the denim garments are washed with enzymes. The enzyme breaks the surface cellulose fibers of the denim fabric and removes during Washing. During enzyme washing certain amount of indigo dye and cellulose fibers from the surface of the fabric are removed [17].

3.3 Enzyme Wash Denim

Enzymes are proteins, found in all living organisms, plants, as well as animals and microorganism. All organisms produce a wide range of enzymes. Enzyme washing is ecologically friendly due to the natural origins of enzymes. Enzymes basically catalyze specific chemical reactions and are known as 'bio-catalysts'. Enzymes act on living cells and can be work at atmospheric pressure and in mild temp and pH.

4. Denim Jeans Mechanical Washes Process

4.1 Stone Washing

In the process of stone washing, freshly dyed jeans are loaded into large washing machines and tumbled with pumice stones to achieve a soft hand and desirable look. Variations in composition, hardness, size shape and porosity make these stones multifunctional. The process is quite expensive and requires high capital investment. Pumice stones give the additional effect of a faded or worn look as it abrades the surface of the jeans like sandpaper, removing some dye particles from the surfaces of the yarn.

4.1.1 Selection of Stone

Stone should be selected of the proper hardness, shape, and size for the particular end product. It should be noted that large, hard stones last longer and may be suited for heavy weight fabrics only.

4.2 SAND BLASTING

Sand blasting technique is based on blasting an abrasive material in granular, powdered or other form through a nozzle at very high speed and pressure onto specific areas of the garment surface to be treated to give the desired

- It is purely mechanical process, not using any chemicals.
- It is a water free process therefore no drying required.
- Variety of distressed or abraded looks possible.
- Any number of designs could be created by special techniques

Advantages

Pure chemical process, Water free process therefore no need drying, Variety of distresses or abraded looks possible, any number of designs could be created by special finishes

4.3 Laser Finishing Technology

It is a computer-controlled process for denim fading. This technique enables patterns to be created such as lines and/or dots, images, text or even pictures. It is water free fading of denim. Being an automatic system, chances of human error are slim. Also called spray painting in denims. This technique has relatively high

cost. The classic jean is strong, durable, comfortable and so fashionable. Manufacturers are keeping this classic on the fashion radar by stoning, icing, burning and drilling the beloved jean to create novel and unique effects. There's a new technology that is producing some amazing looks on denim. The laser works by creating extensive heat. Within the focused region, the material is subject to very intensive heating within a very small region. Laser energy is absorbed as heat and the material rapidly heats leading to melting as a phase change from solid to liquid takes place. Some of the molten liquid tries to move, driven by surface tension of the liquid. The remaining liquid heats very rapidly, boiling and releasing vapours another phase change takes place from liquid to gas [18]. Laser Fading Mechanism is shown in figure.

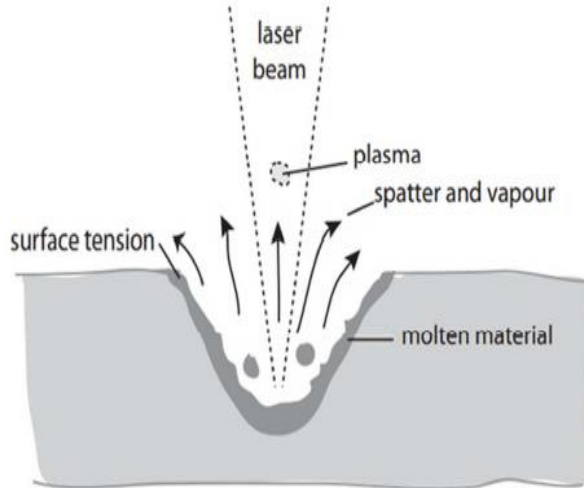


Figure 4: Laser Fading Mechanism on Denim Jeans

4.4 Ozone Fading Technology

Ozone typically acts as a mild bleaching agent as well as a sterilizing agent. In this technique of denim washing, the garment is bleached (figure 5) with ozone dissolved in water in a washing machine. However, this technique can also be carried out in a closed chamber by using ozone gas. The advantages of this method are: (a) a minimum loss of strength and (b) it is a simple method (c) water- and chemical-free that is environment friendly (d) processing low energy costs (e) short treatment time. The ozonized water after laundering can easily be deozonised by ultraviolet radiation. Nowadays, ozone fading can also be achieved by plasma equipment [19]. Under the influence of plasma treatment, high energy electrons are formed. Some of the high energy electrons react with moisture in air and a mixture of radicals is generated [20].



Figure 5: Range of Bleach down on Jeans with ozone finishing (Ozone Denim Systems).

4.5 Water Jet Fading Technology

Hydro jet treatment has been developed for patterning and enhancing the surface finish, texture, durability and other characteristics of denim garments [21]. Hydro jet treatment generally involves exposing one or both surfaces of the garment through hydro jet nozzles. The degree of color washout, clarity of patterns and softness of the resulting fabric are related to the type of dye in the fabric and the amount and manner of fluid impact energy applied to the fabric. Particularly good results are obtained with blue indigo dyed denim. As this process does not involve any chemical, it is pollution free. A water recycling system can make this a very

economical and environmentally friendly way of denim processing. Color washout of dye in the striped areas produces a faded effect without blurring, loss of fabric strength or durability, or excessive warp shrinkage [22-23]. An example of water jet fading effect on denim jeans is shown in figure 6.



Figure 6: Water jet fading effect on denim jeans

5. Conclusions

The finishing of denim garments gives them self-identity and therefore add value for the final consumer. These reduced water techniques are those that can obtain a washed look and excellent handle using a minimum quantity of water. The integration of such technologies into the conventional washing lines will ensure that vintage looks and other fashion effects can be created on jeans with much less water. In such cases, the effluent output is reduced to a negligible quantity, thus transforming denim washing to an environmentally friendly process. The present-day trend indicates that consumer is interested to wear denim and feels that denim is comfortable dress material. Comfort properties can be imparted into the Denim fabric by various means. So, an Attempt has been made to discuss the types of denim and machines used in Denim washing and its limitations in detail. Also, various techniques involved in denim washing, their effect and limitations on the fabric quality.

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6. Corresponding Address

Ms. Himanshi Dhyani

M. Tech Scholar

Department of Textile Technology,

Dr. B. R. Ambedkar National Institute of Technology Jalandhar, INDIA

Pin: 144 011

E-Mail: himanshid.tt.18@nitj.ac.in