TECHNOLOGY OF INDUSTRIAL DENIM WASHING: REVIEW

DAKURI ARJUN¹, J. HIRANAYEE² & M. N. FARHEEN³

¹Assistant Professor, University College of Technology, Osmania University, Hyderabad, Andhra Pradesh, India
²³University College of Technology, Osmania University, Hyderabad, Andhra Pradesh, India

ABSTRACT

Denim is a most popular dress material that has acclaimed most popularity in the past three decades. From special wear to regular wear, denim has barged into the acceptance of kid, women and men. The present day trend indicates that consumer is interested to wear denim and feels that denim is comfortable dress material. When denim was introduced into the market, an attempt was made to produce cotton denim style using 100% Polyester threads in 1980’s period. However, denim, today also is a most preferred dress material in cotton and the ensuing period may witness the role of blends in denim.

KEYWORDS: Denim, Stone Washing, Acid Washing, Denim Bleaching

INTRODUCTION

Denim is a rugged cotton twill textile, in which the weft passes under two (twi- “double”) or more warp threads. This twill weaving produces the familiar diagonal ribbing of the fabric, which distinguishes denim from cotton duck. It consists of dyed warp and grey weft. Most of the Denim fabric construction is either 2/1 or 3/1 construction of either left or right handed twill.

DENIM WASHING

It is the aesthetic finish given to the denim fabric to enhance the appeal and to provide strength. The emphasis is on Comfort and Softness. Fashion Trends Favor the Broken-in Look and Worn/Faded seams that can only be achieved through garment processing. Much of the appeal of dry denim lies in the fact that with time the fabric will fade in a manner similar to that which artificially distressed denim attempts to replicate. With dry denim, however, such fading is affected by the body of the person who wears the jeans and the activities of their daily life. This creates what many feel to be a more natural, unique look than pre-distressed denim. Usually, finishing is applied for already sewn garments, therefore, it is very important to know the impact made by particular washing on the sewing garment fabric in order to preserve the quality of a sewing garment. This will be considered even in the phase of garment Design. In modern sewing industry, washing is applied to articles of cotton, linen and other fabrics. Many of the recently published papers analyze the change in colour of textiles after applying to them different finishing methods as clients upon choosing an item at shop always pay attention to its colour. One or another shade has a great influence on the buying decision of a customer. In the course of wear, mechanical properties of fabric that determine durability and aesthetical view of an article are also important.

THE HISTORY OF DENIMS

The story goes that “jean” derives from the word Genoa. It refers to the material that sailors from Genoa used in their pants. This was a coarse cotton wool and/or linen blend. It originally came from Italy, and is evidence of the custom of naming a material for its place of origin. By the late 16th century, jean was already being produced in Lancashire, England. The composition eventually evolved to 100% cotton by the 18th century. ‘Jeans’ today usually refer to a garment
that has 5 pockets (two in the front, two in the back and a small change pocket on the front right pocket) and this style can be made using any kinds of fabrics be it corduroy, twills, or bull denim. Historic brands include Levi's and Wrangler. On the other hand, the origin of the term “denim” can be traced to late 16th century France where a fabric known as “serge de Nimes” (Twill from Nimes) was very popular. Some doubt remains as to whether the contraction “denim” actually came from this French fabric or twill called “nim”, also used in France at the time. “Serge de Nimes” was a blend of silk and wool, which leads some historians to doubt if this was truly the origin of modern day denim. Either way, the history of jeans goes this far back in history. Both fabrics (jeans & denim) grew in popularity, denim being the stronger and more expensive of the two. The major difference between them was that denim was woven with one colored thread (the warp) and the other white (the weft), while jean was woven with two colored threads.

Jean and denim remained two very different fabrics, and were used for different types of clothing. Denim was used mainly for workers clothes and jean for lighter clothes that did not have such high durability requirements. By the late 19th century, weavers in America were making twills in the same fashion as the European denim, adapting to the more readily available and locally produced cotton fibers. The material had a reputation for being very strong and not wearing out quickly, in spite of many washes.

CHARACTERISTICS 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

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.
- 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.

CLASSIFICATION OF DENIM

The weight/unit area of Denim is

- **Light Weight**: 4.5 to 7 oz/sq.yd
• **Medium Weight**: 7 to 10 oz/sq.yd
• **Heavy Weight**: 11 and above

The hue/tone and color of Denim is

- Indigo vat
- Sulphur black

The fabric structure/design of Denim is

- Plain
- Twill (S-twill, Z-twill, herringbone or Zigzag twill)

There are two methods of garment finishing.

- Dip process
- Tumbling process

**MACHINES REQUIRED FOR GARMENTS WASHING/DYEING**

A garments dyeing and washing factory needs the following machines

- Garments dyeing/washing machine for- Sample & Bulk
- Hydro extractor
- Dryer

Basically there are two types of machines used for garments dyeing

- Pedal Type machine
- Rotary Type machine

Pedal Type garments dyeing machine is the first and oldest type of garment dyeing machine still used in the European countries. Peal type garments dyeing machines are two types that are overhead pedal type and side pedal type.

**Advantages of Garments Washing**

The followings advantages could be gained from garments washing:

- Removal of starch or size materials makes the garments soft hand feel.
- Softness could be increased by the addition of softener just at the last stage of washing.
- Dirt, spots, impurities, gums, etc. if accumulated in garments during their manufacturing, could be removed.
- During washing shrinkage takes place, therefore, after washing there is no possibility to create such problem.
- Washed garments could be worn directly after purchase.
- Faded or worn out effects could be introduced to the garments which creates new fashion.
• Comparatively lower capital is required to set up a washing plant.
• Lower land space and least manpower cost are required to run a washing plant

Limitation of Garments Washing

Like other processes Garments washing is also not without some limitations. They include as below:

• Garments Size Change: The change takes place due to shrinkage properties of fabric. The amount of shrinkage properties of fabric determines the size changes of the garments.
• Size Material is Partly Removed: Size materials applied during preparation of fabric are removed partially during washing though complete removal is possible if desired.
• Color is Partly Removed: Unfixed dyes may remain on the surface of the garments and it is necessary to remove them completely. They might not be removed completely after washing.

DENIM WASHING

It is of two types. They are

Mechanical Washes

• Stone wash
• Micro sanding

Chemical Washes

• Denim bleaching
• Enzyme wash
• Acid wash

CHEMICAL WASHES

Denim Bleach

In this process a strong oxidative bleaching agent such as sodium hypochlorite or KMnO4 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.

Enzyme Wash

In order to minimize the adverse effect of stone-washing, the denim garments is 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.

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.

In recent years, there has been increasing interest in the use of environmentally friendly, nontoxic, fully biodegradable enzymes in the modern textile technology finishing process. Enzymatic treatment can replace a number of mechanical and chemical operations, which have been applied to improve the comfort and quality of fabrics by now. In the textile industry enzymes are applied mainly to get a cleaner fabric surface with less fuzz, to reduce tendency to pill formation, to improve handle, to smooth the surface combining with traditional softeners. The development studies of this area have been focused on applying enzymes on cellulose materials based on cotton, linen, viscose and their blends with synthetics fibres.

**LOCK AND KEY THEORY**

The Lock and Key analogy first postulated in 1894 by Emil Fischer. Here the lock is the enzyme and the key is the substrate. Only the correctly sized key (substrate) fits into the key hole (active site) of the lock (enzyme). Larger keys, smaller keys, or incorrectly positioned teeth on keys (incorrectly shaped or sized substrate molecules) do not fit into the lock (enzyme). Particular lock can only be open by correctly shaped key. Key fits lock-turns, it thus opening the door for reaction to proceed. Enzymes reject dissimilar substance and accept substrate -reaction proceed.

**APPLICATION OF ENZYMES IN TEXTILE INDUSTRY**

- **Amylases**: Used for desizing.
- **Cellulase**: Used for bio-polishing and denim finishing.
- **Protease**: Used for wool finishing.
- **Catalase**: Used for bleach cleanup.
- **Laccase**: Used for discoloration of indigo dyes.

**Acid Wash**

Acid wash on denim jeans is becoming very popular due to its significant contrasts and attractive Appearance in color. Acid wash can be carried on Indigo & Sulphur base fabric garments. Acid Wash was a chemical wash process on denim which stripped the top layer of color and makes a White surface while the color remained in the lower layers of the material, giving it a faded look.
Acid was first launched in 1980’s as a new innovative finish on denim garments. This wash was being carried out by soaking stones in bleach and then followed by neutralization.

Acid wash of denim garment is normally carried out by tumbling the garments with pumice stones presoaked in a solution which contains sodium hypochlorite (5 to 10%) or potassium permanganate (3 to 6%). This causes localized bleaching which produce non uniform sharp blue/white contrast.

**Acid Wash Denim**

In this wash addition of water is not required. The color contrast can be increased by optical brightening treatment.

**Limitations of Acid Wash**

- Acid washed, indigo dyed denim has a tendency to yellow after wet processing.
- The major cause is residual manganese due to incomplete neutralization, washing or rinsing.

**Remedy**

- Manganese is effectively removed during laundering with addition of ethylene- diamine-tetra acetic acid as chelating agent.
- Acid washing jeans avoided some of problems of stone wash, but came with added dangers, expenses, and pollution

**MECHANICAL WASHES**

**Denim Hand Sand / Scraping**

- Hand sand is step which is generally being done in rigid form of garments to get distress look.
- Locations can be front thigh & back seat or it can be overall / global application as per Standard. Emery paper is being used to scrape the garments in particular placement & design.
- Emery paper comes in different number generally starts from 40 till 600 and above, higher the number finer the emery paper, lower the coarseness of the paper. In garment industry from 220, 320 & 400 number papers are most popular & widely used.
- The most important factor is to select right number of paper according to the fabric strength & intensity need.
- Scraping can be done on inflated rubber balloons for better effect (horizontal or vertical it’s up to operator’s convenience), even it can done on plain wooden board of garment size & hand pressure should be uniform in order to get better results.
- Hand sanding must be started from intense part & feathering out on less intense part gradually.

**Stone Wash**

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.

**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.

**Problems Caused by Stones**

- Damage to wash machineries and garment due to stone to machine and machine to stone abrasion
- Increase in labor to remove dust from finished garments.
- Water pollution during disposal of used liquor.
- Back staining and re deposition

**Back Staining or Re-Deposition**

The dye removed from denim material after the treatment with cellulose or by a conventional washing process may cause “back staining” or "redeposit ion". Re-coloration of blue threads and blue coloration of white threads, resulting in less contrast between blue and white threads.

**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 distressed/ abraded/used look.
- 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

**WHISKERING**

- On denim, Whiskers/moustaches, chevrons are nothing but the worn out lines / impression generated by natural wearing on hip & thigh area. There are many designs & pattern available.
- This is being done manually with help of sharp edge emery paper roller on fine wood stick or pasted on plastic material. Before starting execution placements.
• Also known as ‘Cat's Whiskers’
• Industrially done with laser, sandblasting, machine sanding, hand sanding and abrasive rods.

**Potassium Permanganate Spray / Rub & Bleach Spray**

Potassium permanganate spray is done on jeans to take a bright effect on sand blast area. One important thing about potassium permanganate spray is this is usually a sporting process to increase the effect of sand blast. Potassium permanganate solution is sprayed on blasted area of jeans garment with the help of normal spray gun. This potassium permanganate spray appears pink on garment when fresh and turns to muddy brown on drying. Potassium permanganate spray concentrations range from 0.25 gm per liter to 15.00 grams per liter depending to required results and fabric types. Usually indigo died fabrics are treated with low concentrations whereas Black Sulfur Fabric requires high concentrations to treat with. Sulfur is not much affected with potassium permanganate and hence requires high concentrations and even sometime multiple spray operations.

The variables in spray process are as follow:

• Distance of spray gun to garment - less distance will give more defined and sharp effect where as distant spray will result to more mild and merged effect.
Distance ranges from one foot to two and a half foot.

• Air to Water Ratio of Gun - this is to be set very carefully. Low air pressure possibly will through KMn04 drop on garment resulting too bright white spots whereas high pressure will produce very low bright effect spray effect to areas where it is not required.

• Potassium Permanganate Solution Concentration - of course, this will control the extent to brightness.

**Tie and Dye Effect**

In this effect, the fabric of the garment is tied after folding using plastic pins and then washed. The pins are detached / broken after washing and the fabric in the folded areas is less washed as compared to the edges created by folding and contained relatively high intensity of original colors.
Tear Effect

The garment is given torn effect after washing. Two cuts are made horizontally and garment is washed. After washing, threads come out of the garment. Vertical threads are taken out of the garment leaving horizontal threads to produce this effect.

Tint Effect

Tint means fainted color spread over a surface. In this effect, the garment is rinsed with color solution, giving the garment same color at the bottom and back of the fabric. The same color is visible at the front of the fabric but with mixed shade. This color is more prominent on back side of the fabric.

Diesel Effect

This effect gives oil stained look on the garment, with the intensity defined by the buyer.

Grinding Effect

This effect is made on the pocket lining, a roughing effect after washing the garment.

Ozone Fading

By using this technique, the garment can be bleached. Bleaching of denim garment is done in washing machine with ozone dissolved in water. Denim garments can also be bleached or faded by using ozone gas in closed chamber. In the presence of UV light, there is an interaction between the hydrocarbons, oxides of nitrogen and oxygen that causes release of ozone. Indigo dyestuff tends to fade or turn yellow due to ozone reaction.

Water Jet Fading

Hydro jet treatment is used for enhancing the surface finish, texture, durability of denim garment. This treatment involves exposing one or both surfaces of the garment through hydro jet nozzles. The degree of colour 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. As this process is not involved with any chemical, it is pollution free.

Laser 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. With the popularity of special effects surging, it’s a good time to check-out laser engraving. The laser technology utilizes a beam of light, to produce a non-contact mark on the denim fabric. When engraving denim, the laser burns away the indigo dye to produce a worn look.

FEATURES

- 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 non considerable;

CONCLUSIONS

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.

REFERENCES

2. Supriya Paul “Washing techniques of Denim” Fibre2fashion.com November, 2010
5. Harmindar Kothari-Slideshare.net