Investigation on Effect of Ozone Fading on Physical & Mechanical Properties of Denim Pant.

A report submitted to the Department of Textile Engineering, World University of Bangladesh in partial fulfillment of the requirements for award of the degree of Bachelor of Textile Engineering (4 Years)

Submitted by

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LETTER OF TRANSMITTAL

28/10/2016

Elias Khalil

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Subject: Letter regarding the submission of a dissertation on **"Investigation on Effect of Ozone Fading on Physical & Mechanical Properties of Denim Pant"**

Dear Sir,

We are pleased to submit the project on **"Investigation on Effect of Ozone Fading on Physical & Mechanical Properties of Denim Pant".** It was a great pleasure to work on such an important topic. This project was assigned to us in partial fulfillment of the requirements for the award of the degree of the Bachelor of Textile Engineering (4 Years) from World University of Bangladesh.

We believe that this project will certainly help you in evaluating our work. We would be very happy to provide any assistance in interpreting any part of the paper wherever necessary.

Sincerely yours,

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DECLARATION

We hereby declare that the work presented in this project has been carried out by us and has not been previously submitted to any other University/ College/ Organization for academic qualification or professional degree.

We hereby assure that the work that has been presented here does not breach any existing copyright.

We further undertake to indemnity the University against any loss or damage arising from breach of the forgoing obligation.

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CERTIFICATE

This is to certify that the project on **"Investigation on Effect of Ozone Fading on Physical & Mechanical Properties of Denim Pant"** is the bonafide record of project work done by Md. Habib Ullah (ID: WUB-08/12/16/427), Sakib Mostak Niloy (ID: WUB-08/12/16/434), Moin Ahmed (ID:WUB-08/12/16/441), Abdul Motin Nahid (ID:WUB-08/12/16/448), Textile 16th Batch in partial fulfillment of the requirements for the award of the degree of Bachelor of Textile Engineering (4Years) from World University of Bangladesh.

I do hereby certify that the project work has been carried out under my direct supervision and guidance.

Faculty Guide

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ACKNOWLEDGEMENT

At the very beginning we want to express thanks from our core of heart and gratefulness to almighty Allah for divine blessing which makes us possible to complete this project successfully.

We are delighted that we had a kind association as well as supervision of our supervisor **Elias Khalil,** Lecturer, Department of Textile Engineering, World University of Bangladesh, whose valuable support with proper direction acted as necessary resource to carry out our research and hence to prepare this study whenever we were in dilemma.

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ABSTRACT

Washing is considered as one of the most desirable finishing process in denim jeans manufacturing industry. Numerous dry and wet process are executed on the denim jeans for acquiring final fading outlook. This study represents the recent environment friendly ozone fading on denim pant. The pant (leg panel) was processed with ozone gas of different concentration. The physical and mechanical properties of the leg panel were investigated after each concentration and compared with untreated sample. It was found that GSM, EPI, PPI & Shrinkage increased with the increased of ozone concentration in wet ozone process while decreased these values in dry processing. Color fastness properties and absorbency also increased with higher concentration of ozone gas. One the other hand, tensile strength reduced and pH of the sample increased a little bit with increasing ozone concentration.

Table of Content

Lists of Tables

List of Figures

CHAPTER – ONE

INTRODUCTION

1.1 Introduction

Ozone, a gas consisting of molecules in which three oxygen atoms are bound together, is poisonous to most living organisms. But its natural presence in the stratosphere serves as a shield against dangerous ultraviolet radiation from the sun. Ozone is found in two different layers of the atmosphere - the troposphere and the stratosphere. The stratospheric ozone, or "good ozone," protects life on earth from harmful effects of the sun's UV rays. We have good reason to be concerned about the thinning of the ozone layer in the stratosphere. Tropospheric ozone, or "bad ozone," is an air pollutant that damages human health, vegetation, and many common materials. We have good reason to be concerned about the buildup of ozone in the troposphere. In this and the following sections, we will explore the various aspects of ozone to help your students better understand this complex, and sometimes seemingly contradictory, molecule. Although simplistic, the saying "Good up high and bad near by," sums up ozone in the atmosphere.

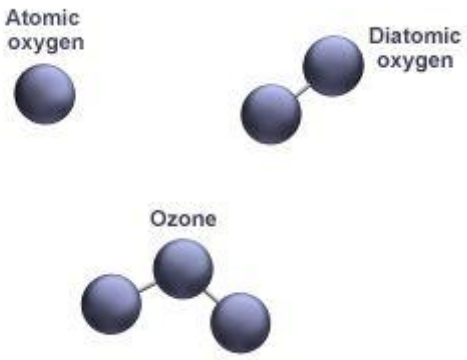


Figure 1.1: Ozone Gas

When enough ozone molecules are present, it forms a pale blue gas. It is an unstable molecule that readily combines with other atoms. Ozone has the same chemical structure whether it is found in the stratosphere or the troposphere. [1]

1.2 Objectives of the study

The aim of this study is to make a practical investigation on the effect of Ozone Fading on physical & Mechanical properties of Denim Pant.

The main objectives of this study are –

1. To know the process of ozone fading on denim pant.
2. To find out the changes of physical and mechanical properties on denim pant after ozone fading.
3. To know the effects of ozone gas on denim pant.
4. To produce different effect on denim pant.
5. To know the fabric properties by ozone fading of different concentration.

CHAPTER – TWO

LITERATURE REVIEW

2.1 Denim Fabric and Its History

Denim is a type of cotton twill textile, in which the weft passes under two or more warp threads. Warp threads of denim fabric are dyed in indigo while weft threads remain plain white. That is why denim is blue on the one side and white on the other. When used for jeans, denim is turned blue on the outside and because of the way it is made it fades in a characteristic way. Word “denim” comes from fabric "serge de Nimes" made in France city of Nimes from where it originates. It has been used in America since the late 18th century, colored blue with indigo dye to make blue "jeans", a type of cotton pants. Jeans come from "Genes" - a name given by French to Genoa and the people from Genoa where the cotton trousers were made. In the 1800s, in the time of the Gold Rush, American gold miners needed clothes that were strong, lasted longer and did not tear easily. Levi Strauss, a businessman, and Jacob Davis, a tailor, supplied miners with denim pants that were made from durable material and reinforced with rivets at the places where pants tended to tear which prolonged life of pants. This marked the beginning of the legend of jeans and brand Levi Strauss is still hugely successful today. Denim was first used for clothes worn by workers because of its high durability. Then it became widely popular in the 1930s when Hollywood started making cowboy movies in which actors wore jeans. With the beginning of the World War 2, production of the jeans drops but world meet denim when American soldiers started wearing them when they were on the leave. When the war ended, other companies that made denim started appearing like Wrangler and Lee. Young people started wearing denim in the 1950s a mean of rebellion. This fashion was also inspired by Hollywood with by Marlon Brando with his 1953 film “The Wild One” as well James Dean’s movie “Rebel Without a Cause” from 1955. Some public places like schools and theaters banned jeans because of what they symbolized. Denim crossed from counterculture to fashion in the 1960s and 1970s when manufacturers started to make different styles of jeans. Original denim was dyed with dye from plant Indigo fera tinctoria. Modern denim is dyed with synthetic indigo. Denim is often dyed with indigo and dried many times over to get a stronger color that will not fade quickly. After the denim is made into clothing it as most often washed to make it softer and to reduce or eliminate shrinkage. Denim that is not washed is called dry or raw denim. Denim fades in time and gets a worn out look which is often desired as a fashion detail. Some denim is artificially distressed so a worn-out look can be got even before wearing. Denim that is not made of pure cotton but also has an

elastic component is stretch denim. Beside indigo dyeing, denim can be colored with sulfur dyeing which is used for dyeing of denim in colors other than indigo[2].

Figure 1.1: Denim Fabric

2.2 Properties of Denim Fabric:

Denim fabric follows some properties; those are mentioned in the following:

1. Denim fabric creases easily.
2. It is very strong and durable.
3. It is feeling hard during wearing.
4. It is used for long time wearing.
5. It resists tears and snags.

2.3 Types of Denim Fabric:

There are mainly eight types of denim fabric, those are-

1. Colored denim,
2. Bubble gum denim,
3. Denim from fox fiber,
4. Crushed denim,
5. Vintage denim,
6. Ecru denim,
7. Marble denim,
8. Reverse denim

2.3.1. Colored denim:

Colored denim fabrics are woven, manufacturing with dyed yarn either warp or weft. This kind of fabric can be obtained by piece dyeing process.

2.3.2. Bubble gum denim:

Bubble gum denim fabric is lycra containing denim, that has between 35 to 50% lycra or stretch

2.3.3. Denim from fox fiber:

This kind of denim fabric is manufactured by colored cotton fiber that grows naturally developed and patented by California cotton breeder sally fox.

2.3.4. Crushed denim:

n Crushed denim fabrics, textured effect achieved through a special fabric construction coupled with wet processing, where the effect can also be improved by using stone and bleach. This kind of denim fabric is woven with an over twist weft yarn.

2.3.5. Vintage denim:

For achieving old and worn outlook, a denim treatment that applies heavy stone wash or a cellulose enzyme wash with bleach or without bleach is called vintage denim.

2.3.6. Ecru denim:

Ecru denim fabric is that, which is not having any dyed yarn, contains only grey yarn in warp and weft.

2.3.7. Marble denim:

Marble denim has another name is acid wash. If the fabric is strongly bleached then it is called marble denim.

2.3.8. Reverse denim:

Reverse denim fabric is that, where the face side and reverse side look alike. [3]

2.4 Garment Washing

In the readymade garments sector garments washing is a new technology. After making garments from solid color dyed or pigment printed fabrics, the garments are washed. By garments washing, color and outlook of garments are modified. As a result new outlook and appearance is produced in the garments, which is not possible in any other method. More over due to washing, starch materials present in the garments are removed, as a result washed garments could be wearing after purchase directly from the store or shop.

Some garments hrinks after wash, hence washed garments could be purchased as per required size. [4]

Normally garments washing means cleaning of dirty garments with soap or detergent. But it is not that garments washing. Industrial garment washing is a technology. The technology which is used to modify the outlook, appearance, comfort ability and design of the readymade garments made from solid color dyed or pigment printed fabric is called garments washing. In our country garments washing technology started from 1988 and popularity of garments washing is increasing day by day. [5]

2.5 Objects of Garment Washing

Garment washing is the best touch of a garment. Same type of garments can produce several effects for several wash, like this:

1. To create wash look appearance, seems the new touch of fashion.
2. By the washing technique, faded/old, color or tinted affect.
3. Washing technique creates new fashion such as tagging, grinding, destroy, blasting, whickering, permanent wrinkle, deep dye, tie dye, p.p spray, hand crapping, p.p sponging etc.
4. To reduce size materials that imports soft hand feels.
5. To attraction the customers/buyer by different types of fashionable washing and market development.
6. Due to washing, shrinkage occurs in the garments. There is no possibility of further shrinkage of the wash garments.[6]

2.6 Advantages of Garment Washing

Advantages of garment washing are given below-

1. Starch materials is present in the new fabrics of the new garment are removed, hence feels soft during use.
2. Softness feeling of garments could be further increased washed garment could be wear directly after purchase from store.

3. Fading affect is produced in the garment in regular or irregular pattern.
4. Fading affect could be produced in the specific area of the garment as per specific design.
5. Different outlook of garment could be produced in the garment by different washing techniques.
6. Similar outlook can be produced in the garments by different washing techniques.
7. Initial investment cost to set up a garment washing plant is comparatively lower.
8. Dirt and spots if present in the garment are removed.
9. Shrinkage occurs in the garment washing, hence no possibility of further shrinkage.[6]

2.7 Requirements of Garments Washing

With the change of time, human choice, demand, garments design and fashion is changing very quickly .to meet the demand of users, garments manufacturers are adapting new technology and processes. Garments washing is a new technology, which is capable to meet the present requirements. This new technology needs new machines and various types of chemicals. Requirements of garments washing are summarized below:-

1. Starch materials present in the new fabrics of the new garments are removed, hence feels soft during use.
2. Softness feeling of garments could be further increased.
3. Dirt and spots if present in the garments are removed.
4. Shrinkage occurs in the garments during washing, hence no possibility of further shrinkage.
5. Washed garments could be wearing directly after purchase from store.
6. Fading effect is produced in the garments in regular or irregular pattern.
7. Fading effect could be produced in the specific area of the garment as per specific design.
8. Different outlook of garments could be produced in the garments by different washing techniques.

9. Similar outlook can be produced in the garments by different washing techniques.[7]

2.8 Effects of Garments Washing

The major effects of garments washing are given below-

1. Change the appearance of the garments.
2. Change in size.
3. Change in color.
4. Change outlook of the garments.
5. Change in comfort.
6. Change in design, etc.

2.9 Types of Garment Washing

Primarily garment washing are two types-

1. Wet process/ Chemical process
2. Dry process/Mechanical process

2.9.1 Wet Process/Chemical Process

Different types of wet process or chemical process are mentioned below:

- Normal wash/ garment wash
- Pigment wash
- Enzyme wash
- Stone wash
- Tinting (Tie) & Over Dyeing(Dip Dyeing)
- Bleach wash
- Acid wash

2.9.2 Dry Process/Mechanical Process

Different types of dry process or mechanical process are mentioned below:

- Sand blasting
- Hands scraping
- Permanent wrinkle
- Over all wrinkles
- PP spray
- PP sponging
- Grinding and destroy
- Tagging
- Ripping and Pilling etc.[8]

2.10 Description of Wet Process & Dry Process

2.10.1 Normal Wash:

It is the Process in which heavy or slight soiling is removed and transferred to the water in the form of a solution or dispersion. Washing has the effect of cleaning surfaces. The resulting effect is several physical/ chemical processes (Washing process). Washing and cleaning constitute a complex process, during which soiling is removed by means of physical separation, with or without substance conversion, from a substrate. Industrial washing processes can be categorized as solution washing, dispersion washing and reaction washing.

2.10.2 Stone Wash

Stone wash means washing garments with special stones so that garments achieve a very strong washed effect. Volcanic stones are used in such wash abrade exposed parts of the garments, this idea of washing with porous volcanic stones is to give the garment a strong and rough wash to achieve the pronounced washed effect through abrasion on the exposed areas, such as the seams and pocket corners. Sometimes, bleach is added to the wash so that the color fades in a more pronounced manner. This is done to make navy blue jeans into a more faded light blue. Such wash requires a lot of skill, experience; workmanship and expertise so that desired results are achieved. In stone wash

the following points should be carefully checked.

a) Size of the stones: Stone size is very important in stone wash. They have varied affect on the garment being washed. Larger stones give tough abrasion while smaller ones lend less abrasion. Stone should be selected based on the required abrasion affect as well as type of fabric of the garments. Larger stones may, however, damage comparatively light-weight fabric. Smaller stones give softer abrasion.

b) Garment-Stone ratio: (Weight of stones relative to the weight of garment) Wash with more stones may lead to more apparent blue/white contrast on the fabric.

c) Washing time: Washing time also much important in stone wash.

d) Quantity of bleach: Use of more bleach can shorten wash time and leads to more productivity. Bleach, however, cannot be used indiscriminately. Disproportionate amount of bleach may lead to loss of the desired blue/white contrast on the fabric. In order to achieve better result, one should cut a balance between quantity of bleach, stone size and amount of stone. Sometimes one needs to use the normal quantity of stone and longer washing time to achieve the color standard requirements.[9]

Figure 2.1: Stone washed garment

2.10.3 Bleach Wash

Bleach wash means that bleach chemical is used in water while washing in a tumble washer. Strict washing time is a requirement with such wash because otherwise the garment may be over bleached and the color cannot be reversed. [9]

Figure 2.2: Bleach washed garment

2.10.4 Enzyme Wash:

The wash in which enzyme is used called enzyme wash. This enzyme may be neutral or acid depends on the requirement of shed. In this wash, enzyme is used for producing different types of abrasion for the garments. As a result, the garments are looking very nice to see. The main target of enzyme wash is to change the outlook of any knit garments.[10]

Figure 2.3: Enzyme washed on denim

2.10.5 Hot Wash:

Normally in fabrics, hot wash is used to prevent the shrinkage problem after completing different treatment of that garments. Hot wash should be done before making any garments. It's should be noted that, When a garment have any treatment such as- Garment dye, Cold dye, P.P spray etc. then it's a mandatory process to complete fabrics hot wash before making of that garment. Otherwise, it will create problems during measurement.[10]

2.10.6 Acid Wash:

The main target of this wash is to produce uneven look on garments. Acid wash is done by potash and stone. At first, we have to dip the stone in potash solution then slight dry the stone and wash in a washing machine. After all we will get an uneven look on garments.[10]

Figure 2.4: Acid washed on denim

2.10.7 P.P Spray:

P.P Spray means potassium permanganate spray on the specific area of a garment. This chemical is used to reduce the color from the garments. At first, garments have to take by two person in two sides, then this chemical will be applied with the help of P.P gun by air pressure. This spray is done on the scrapping area and after neutralize by sodium meta- bi-sulphite chemical in washing machine, a white look on the spray area will be achieved.[10]

Figure 2.5: P.P Spray

2.10.8 Garment Dye:

Garment dye process is done all time after making the garments. Traditional garments are made from fabric that is pre dyed. Garment dye can be pigment dye or cold dye which is totally depends on the buyer's instruction. The main advantage of this process is the cost effectiveness of much producing identical garments of particular colors. Also it has another advantage, due to garments dyeing; it becomes softer and feels more vintage which is one of the important factors to satisfy the buyer. [10]

Figure 2.6: Dyed Garments

2.10.9 Pigment Dye:

Pigment dye is also one kinds of garment dye. After completing this process, knit garments will achieve the even shade. The main difference between cold dye and pigment dye is, in cold dye, knit garments will achieve uneven shade and in pigment dye, will achieve the even shade.[10]

Figure 2.7: Pigment Dyed Garments

2.10.10 Tie Dye:

This is the dyeing process which is applied on the knit garments by using tie. At first, the knit garments have to tie with string or rubber bands then its send to the dyeing. In this

process, dyes percentage should be set previously. By this dyeing process, the knit garments achieved an uneven dyeing shade. Where some area of the garments absorbed dyes and some of the area did not absorb. The main target of this process is to produce an uneven dyeing shade in all parts of knit garments.[10]

Figure 2.8: Tie dyed on denim

2.11 OZONE FADING

Ozone is a gas that is generally present in our atmosphere and is formed naturally by photochemical reaction with solar UV radiation. It can be generated artificially by several ways such as corona discharge. Ozone is a triatomic molecule consisting of three oxygen atoms. Ozone has a strong tendency to react with almost any organic substance. The use of ozone in water and wastewater treatment currently remains the most prevalent industrial application. Ozone is a powerful oxidant and disinfectant capable of destroying the cellular structure of viruses, parasites and bacteria. It has some advantages over other oxidants commonly used in the textile industry, particularly in chlorine. The main advantage is the lack of persistence: ozone is chemically unstable; leaves no secondary derivative products on treated products. Among the most common oxidizing agents used in a denim laundry, ozone remains the most efficient. In fact, this gas fades dyed textile materials by the rupture of the chromophores in dyes of synthetic or natural fibers. Because of its high oxidation potential (E = 2.07 eV), ozone can effectively break down complex aromatic rings of the dyes, resulting in decolorization. Color is removed when certain bonds are broken by the ozone, such as the bond -C = C- and heterocyclic and aromatic rings. Indeed, indigo ozonolysis leads to the formation of isatin.[11]

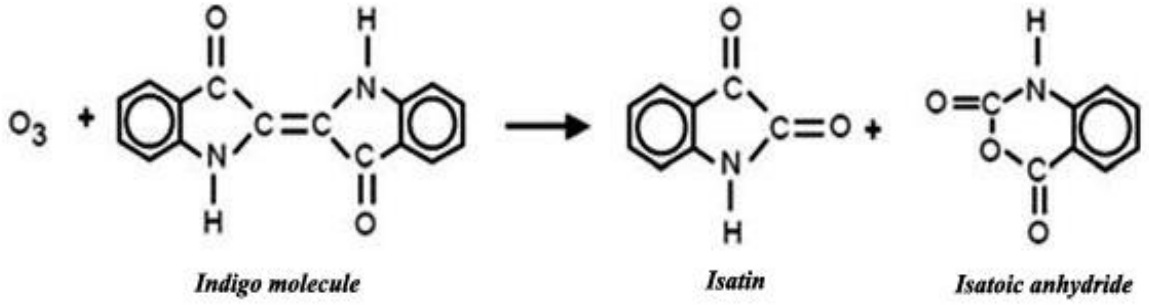


Figure 2.9: Reaction of indigo oxidation by dry ozone.

The isatin molecule presents a yellowish color. Thus, the material passes from blue (indigo) to the yellow (isatin) during the reaction. The process allows replacing carbon-carbon double bonds by carbon-oxygen double bonds. Indeed, in an anhydrous medium, ozonolysis of indigo results in two reaction products: isatin and isatoic anhydride. We chose to study various parameters influencing denim ozonation, which are moisture content of the fabric, power of the ozone gas, and the treatment time. The ozonation treatment does not require vapor or hot water, because temperature has an important effect on the half-life of ozone. As the temperature increases, the half-life of ozone decreases due to its rapid decomposition and low stability.[12]

2.12 The ozone machine

The bleach testing of denim was performed by means of an ozone machine G2 Plus from Jeanologia. This finishing machine is equipped with an ozone generator using electric power to charge the oxygen molecules in the incoming air and generate ozone for denim. The oxygen is compressed and gathered in a tank that will supply the ozone generator. Oxygen should be dry and not moistened so it does not interfere with the dielectric generator. Because ozone is an unstable molecule, it must be generated at the moment of use. Oxygen (O2) is purified and enriched, then an O2 molecule is converted into O3 by the corona discharge generator. The resulting ozone is injected into the drum containing the fabrics. Ozone naturally ages the denim, similar to the effect of sunlight on the textile. At the end of the fading cycle, the ozone is sucked from the drum to a burner and then destroyed with a temperature of 300 °C to become oxygen before being discharged to the atmosphere. This operation takes several cycles to reach a sufficient concentration of ozone in the machine. The ozone generator is equipped with a cooler to prevent the increase of

temperature in the discharge space. The temperature of the cooler should not exceed 25 °C.[12]

Figure 2.10: Ozone machine Jeanologia G2 Plus

2.13 Previous Works

Cheung et al. (2013) investigated the effect of Plasma induced ozone treatment on the color yield of the ozone fabric. In this study, a textile fabric with red color was subjected to plasma-induced ozone treatment under different treatment conditions. According to this study the color yield of untreated sample is better than the plasma-induced ozone treated samples. Moreover, with comparing of different water content used in the plasma-induced ozone treatment among different groups of results. It is found that the colour strength decease much in water content of 35% when compared with water content of 45% in the air concentration of 10%, 30% and 50%. However, when the air concentration was increased to 70%, the water content of 45% gave the better color fading effect. Also, it is found that the decreasing rate of K/S SUM is larger between air concentration of 10%, 30% and 50% but lesser after air concentration of 70%. The decreasing rate of K/S SUM values is larger between treatment time of 10 minutes and 20 minutes while the decreasing rate is smaller between treatment time of 20 minutes and 30 minutes. It concludes that the colour yield is more affected before air concentration of 50% and treatment time of 20 minutes while

colour yield is less affected after air concentration of 70% and treatment time of 30 minutes in the plasma-induced ozone colour fading treatment. [13]

C.W. Kan et al. (2013) studied the color fading of 100% cotton single jersey knitted fabric by plasma treatment and enzymatic process. Experimental results revealed that APP treatment could achieve similar color-fading effect when compared with conventional enzymatic colour-fading process without much loss in fabric weight and with shorter treatment time. [14]

C.W Kan et al. (2015) studied plasma induced ozone fading treatment on the color fading of dyed cotton. In that study the effect of plasma-induced ozone treatment on the colour fading behaviour of reactive dyed cotton knitted fabrics is investigated with the use of a commercial plasma machine. Three process parameters, namely: (i) air ratio, (ii) water content and (iii) treatment time, were used and it was found that the setting of plasma-induced ozone treatment process parameters is important to achieve the desired colour fading behaviour. Experimental results revealed that prolonged treatment time caused considerable increase in the colour fading effect. The colour fading effect was more influenced by increase of air ratio. However, the fabrics treated at water content of 45% would have less colour fading effect compared to fabrics treated at water content of 35%. Moreover, plasma-induced ozone treated fabrics achieved excellent colour levelness. [15]

Hmida et al. (2015) studied parameters affecting dry and wet ozone bleaching of denim fabric. It was found Wet ozone treatment is more profitable and gives a richer range of washed jeans than dry ozone; however, the moisture content of the fabric remains a difficult factor to control at the textile industry work conditions and depends on the spin and the time where the jeans remain in carriages between the different finishing treatments. The denim bleaching by the action of ozone dissolved in water may offer better results by maintaining the same wetting conditions and an even bleaching. [16]

CHAPTER – THREE
MATERIALS AND METHOD

3.1 Materials

3.1.1 Garments Samples

For ozone fading process we used denim fabric. Its GSM was 292, type was 3/1 twill and Z twill.

3.1.2 Chemicals

- Ozone Gas (60%/80%/100%)
- Air
- Bleaching Agent
  - Brand name: Clorox
  - Place of origin: Oakland, California
- Desizing Agent
  - Brand name: Saisize O7z
  - Place of origin: china
- Enzyme
  - Brand name: Tosowoong (Neutral)
  - Place of origin: China

3.1.3 Ozone Machine

Tonello

Model: G1LW1

Height: 2130mm

Width: 650mm

Depth: 2000mm

Cylinder Dia: 1323mm

3.2 Method

Desizing:

Add Desizing agent (10g/l) + Wetting agent (5g/l) + Antiback stain (3g/l) into the machine and

run at 60°c for 10 minutes

↓

Bath drain

↓

Rinse 2 times

Enzyme:

Add Neutral enzyme (2g/l) + Antiback stain (3g/l) into the machine and run at cold temperature

for 25 minutes

↓

Bath drain

↓

Rinse 2 times

Bleaching:

Add Bleaching agent (10g/l) + soda ash (5g/l) into the machine and run at 50°c temperature

↓

Bath drain

↓

Rinse 2 times

↓

Hydro extractor

↓

Air dryer

Ozone Machine Preparation:

At first ozone generator starts

↓

Cleaning the machine

↓

Drying the machine (Ozone should be dry condition)

↓

Ozone generated complete

↓

Open the door of machine

↓

Input the sample in the Machine

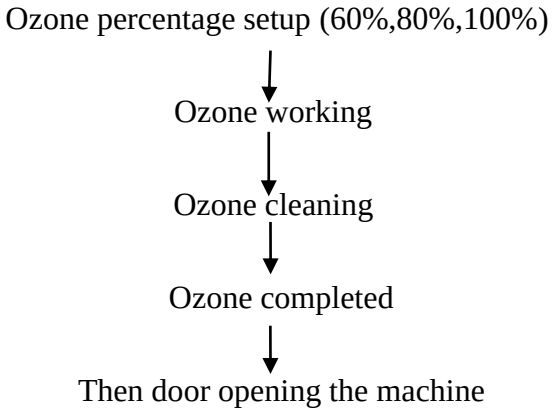
↓

Close the door of the machine

↓

Program setup in the monitor(For 2 minutes)

↓



3.2.1 Determination of Tensile Strength

Tensile strength was measured according to ASTM D 76. We cut the sample 100×1500mm. We clammed the sample between the jaw. Jaw width is 25mm. Speed is adjust so then the sample is broken 23 seconds.[17]

3.2.2 Determination of Fabric Weight

Fabric weight was measured according to ASTM D 3776 methods of standards. We cut seven pieces of the fabric with the GSM cutter and Weight the fabric with the electric balance. Then multiplied by 100 and took the average results.[18]

3.2.3 Determination of Ends per Inch (EPI)

EPI of the fabric is calculated by counting the number of the yarn (Ends) contents in 1 inch of the fabric. For this the fabric is marked by 1 inch in rectangular area. Then the yarn is open out and count the number Ends contains in 1 inch.[19]

3.2.4 Determination of Pick per Inch (PPI)

PPI of the fabric is calculated by counting the number of the yarn (Pick) contents in 1 inch of the fabric. For this the fabric is marked by 1 inch in rectangular area. Then the yarn is open out and count the number Picks contains in 1 inch. [19]

3.2.5 Determination of pH

We conducted this test according to the AATCC 81 methods. We used 10 g specimen,cut into small pieces. Then Boiled 250 ml distilled water for 10 minutes, immerse the specimen,

cover the beaker with a watch glass and boiled for an additional 10 minutes. Allow the covered beaker and contents to cool down to room temperature. Finally we determined the pH of the extract using a pH meter.[20]

3.2.5 Determination of Rub property

According to ISO 105 × 12: 2002 standards both the dry and wet rub tests were done as follows:-

Dry Rubbing Test

A test sample is clamped to the instrument base and a square of standard crocking cloth is fixed to a 16mm diameter, acrylic rubbing finger. The finger rests on the sample with a pressure of 900 grams force and traverses a straight path approximately 100mm long with each stroke of the arm. After testing textile materials, the crocking cloth is removed and compared against the color matching cabinet under standard lighting. Based on this comparison, we assigned a grade to the color change or amount of color transfer.

Wet Rubbing Test

Repeat the procedure from dry rubbing test on another sample with the white cotton test cloth wetted it in distilled water. Ensure that the rubbing test cloth will be wetted with water to 100% take up. Compare the contrast between the untreated and treated white rubbing cloth with the staining. Grey scale rates from 1-5 and changing in the tested specimen with changing grey scale. This visual assessment is done in a color matching cabinet under standard lighting D-65.[21]

3.2.6 Determination of Absorbency

For absorbency testing we followed AATCC 79 methods of standards. Samples were placed in an embroidery hoop with all creases out of it. A burette dispenses a drop of water onto the surface of the fabric from a distance of 9.5mm below the burette. Time was recorded until the water drop absorbs completely. [22]

3.2.7 Determination of Color fastness to washing Test

The samples were tested according to ISO 105 C06: 2010 and in the delivered condition; didn't wash and/or tumble it before testing. We used only multifibre from James Heal. The washing solution prepared freshly (one litre). The current liquor ratio (liquor/sample) is 20:1. We put the grey frame in same grey color as background. White papers were placed as background or according to the test method one or more original multifibre to assure no transparent affect coming out of the background. The edges of the specimen and original multifibre were cut straight. The edges of the specimen and original multifibre had cut straight under defined light D65 with defined angle of 45°. [23]

CHAPTER – FOUR
RESULT AND DISCUSSION

4.1 Effects on fabric tensile strength after Ozone fading

Table 4.1: Effects on Fabric tensile strength after ozone fading on denim pant

Tensile strength (N) Lengthwise				
Concentration of Ozone / Ozone gas Processing	Before	60%	80%	100%
Dry process	290	286	288	285
Wet process		292	294	295

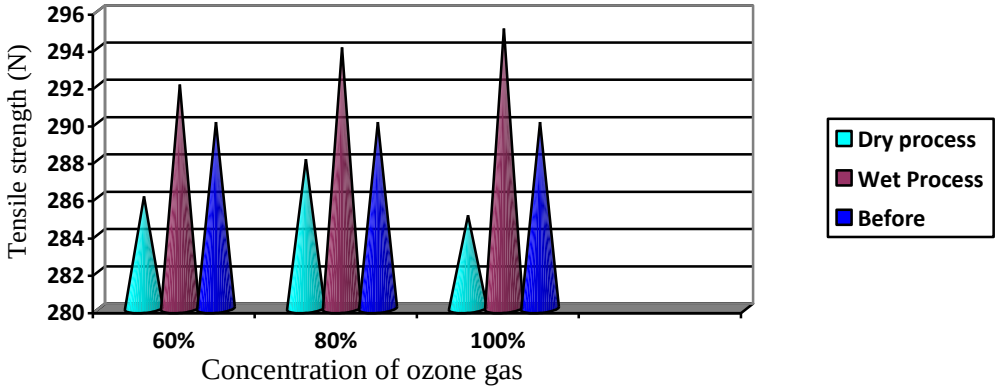


Fig. 4.1: Effects on fabric tensile strength after Ozone fading

From the above Figure 4.1 it is found that due to ozone fading the strength of the fabric decreases for both wet and dry process after increasesing the concentration of ozone gas. By increasesing the concentration of ozone gas, the fiber in the fabric is surrounded more with oxidative ozone gas that slightly damage the glycoside bands present in fibers.

4.2 Effects on fabric weight after Ozone fading (GSM)

Table 4.2: Effects on Fabric weight after ozone fading on denim pant

GSM				
Concentration of Ozone / Ozone gas Processing	Before	60%	80%	100%
Dry process	292	290	289	288
Wet process		294	294	295

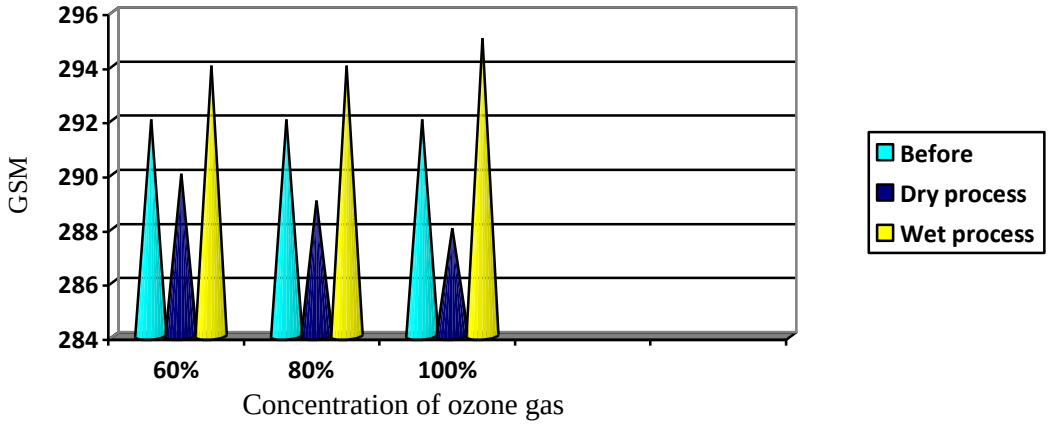


Fig. 4.2: Effects on fabric weight after Ozone fading (GSM)

From the above Figure. 4.2 it is found that due to ozone fading the weight of the fabric increases for wet process after increases the concentration of ozone gas but the weight of the fabric decreases for dry process after decreases the concentration of ozone gas. Actually when the denim fabric are faced with frictional action due to the Ozone gas in the ozone machine, ozone gas penetrated into the fiber structure causing change in internal tension in the constituted molecules. As a result the surface of the fabric is compacted and flappy due to increase and decrease GSM.

4.3 Effects on Ends Per Inch (EPI) after Ozone fading

Table 4.3.1: Effects on EPI changes after Ozone fading (For dry process)

EPI (For dry process)				
Concentration of Ozone gas / Ozone Processing	Before	60%	80%	100%
EPI After Washing	54	53	52	51
EPI Before Washing		54		

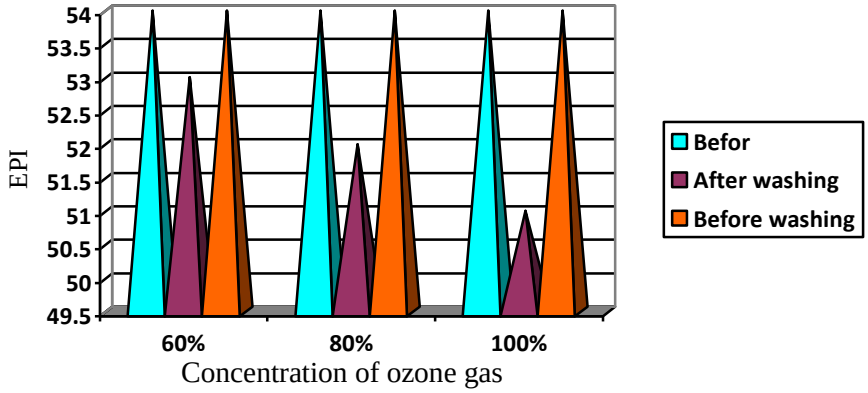


Fig. 4.3.1: Effects on Ends Per Inch (EPI) after Ozone fading (For dry process)

Table 4.3.2: Effects on EPI changes after Ozone fading (For wet process)

EPI (For wet process)				
Concentration of Ozone gas / Ozone Processing	Before	60%	80%	100%
EPI After Washing	60	61	62	62
EPI Before Washing		60		

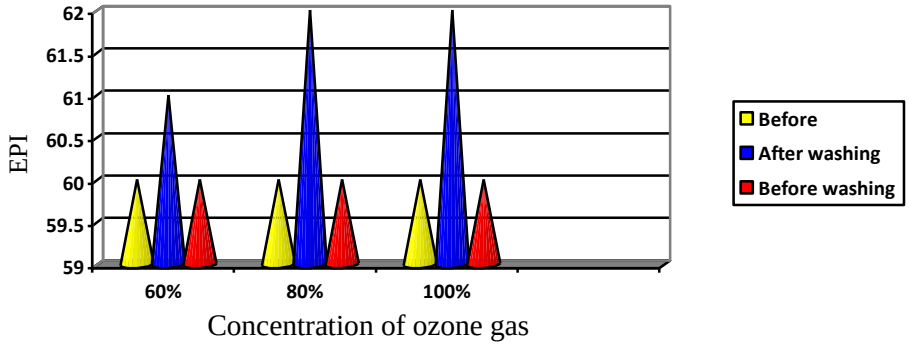


Fig. 4.3.2: Effects on Ends Per Inch (EPI) after Ozone fading (For wet process)

From the above Figure 4.3.1 and Figure 4.3.2 we show that EPI is increased for wet process after increases the concentration of ozone gas. But EPI is decrease for dry process after increases the concentration of ozone gas. Because when the denim fabric are faced with frictional action due to ozone gas of the ozone machine, ozone gas penetrated into the fiber structure causing change in internal tension in the constituted molecules. As a result the surface of the fabric is compacted and flappy due to increase EPI.

4.4 Effects on Pick per inch (PPI) after ozone fading

Table 4.4.1: Effects of pick per inch Changes (PPI) after ozone fading (For dry process)

PPI (For dry process)				
Concentration of Ozone / Ozone gas Processing	Before	60%	80%	100%
PPI After Washing	52	51	50	49
PPI Before Washing		52		

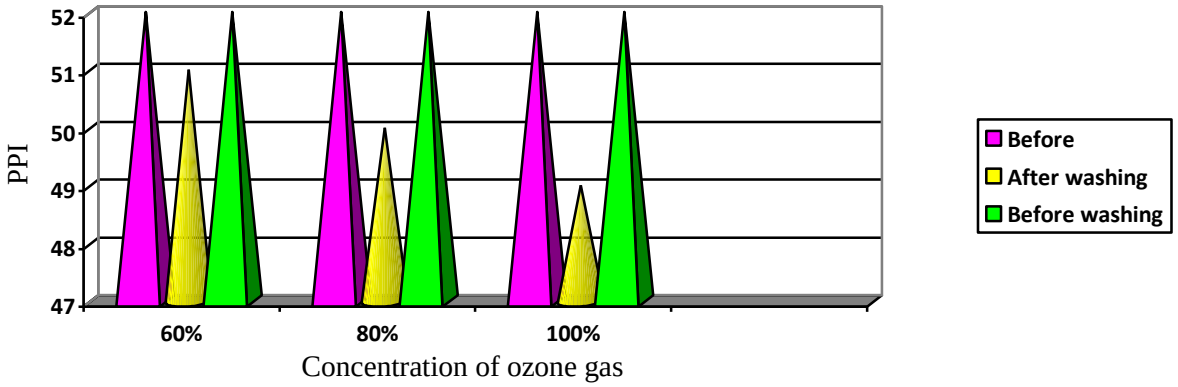


Fig. 4.4.1: Effects on PPI after ozone fading on denim (For dry process)

Table 4.4.2: Effects of pick per inch Changes (PPI) after ozone fading (For wet process)

PPI (For wet process)				
Concentration of Ozone / Ozone gas Processing	Before	60%	80%	100%
PPI After Washing	54	55	55	56
PPI Before Washing		54		

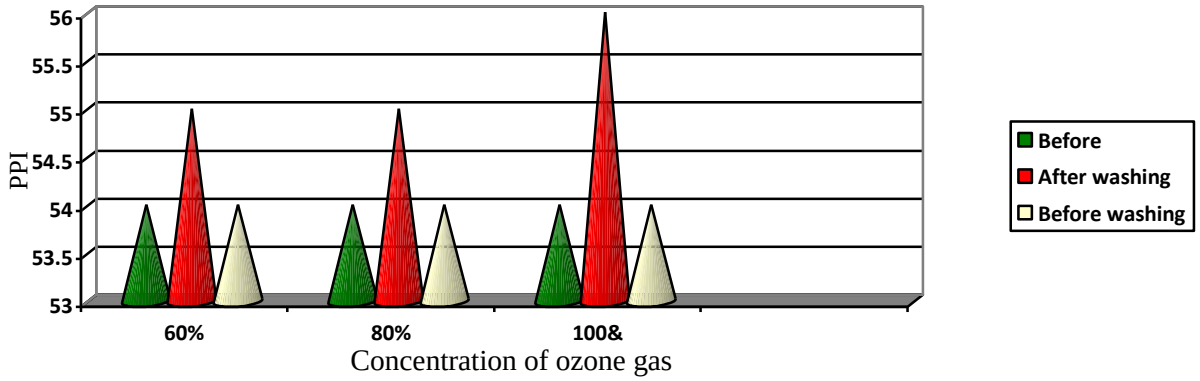


Fig. 4.4.2: Effects on PPI after ozone fading on denim (For wet process)

From the above Fig. 4.4.1 and Fig. 4.4.2 we show that PPI is increased for wet process after increase the concentration of ozone gas but PPI is decreases for dry process after increase the concentration of ozone. Because when the denim fabric are faced with frictional action due to ozone gas of the ozone machine, ozone gas penetrated into the fiber structure causing change in internal tension in the constituted molecules. As a result the surface of the fabric is compacted and flappy due to increase PPI.

4.5 Effects on pH after Ozone fading

Table 4.5.1: pH checking (dry process)

ph (Dry process)				
Concentration of Ozone / Ozone gas Processing	Before	60%	80%	100%
Dry process	5	6	6	6.5
Wet process		5	5	5.5

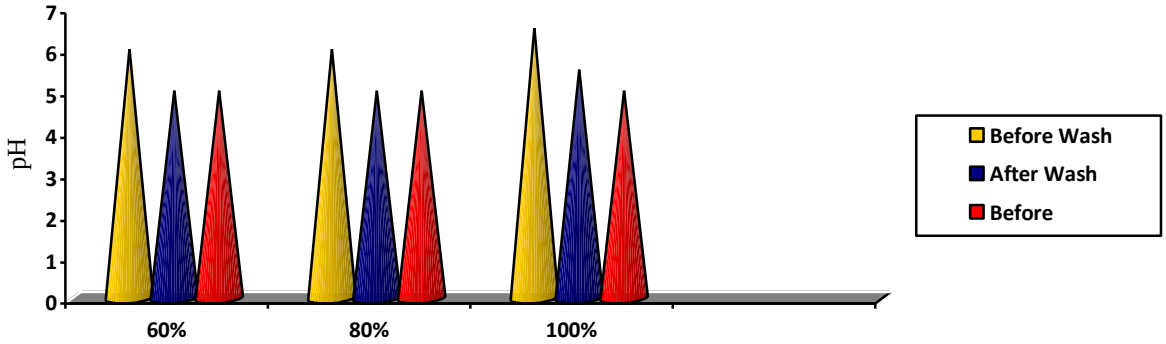


Fig. 4.5.1: Effects on pH after Ozone fading (Dry process)

From the above Figure 4.5.1 it is found that due to ozone fading pH is decreased for dry process on denim pant. We used some detergent before ozone fading so that pH decreased for dry process.

Table 4.5.2: pH checking (wet process)

ph (Dry process)				
Concentration of Ozone gas / Ozone Processing	Before	60%	80%	100%
Dry process	6	6	6	6.5
Wet process		6.5	6.5	7

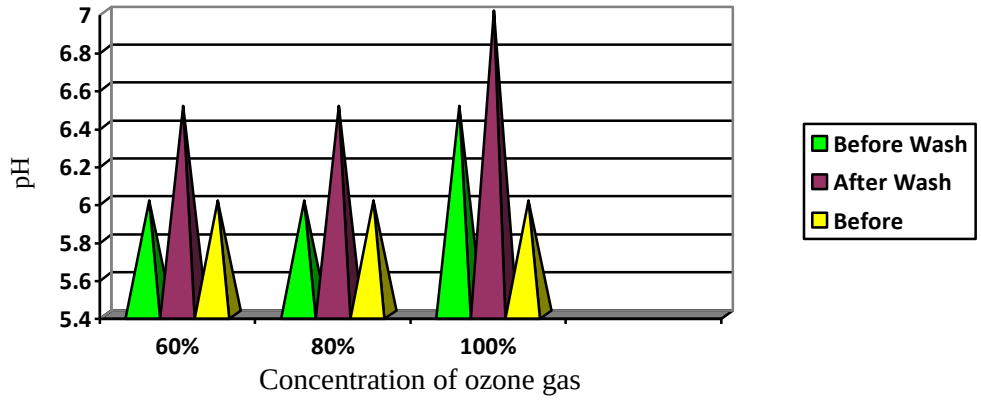


Fig. 4.5.2: Effects on pH after Ozone fading (wet process)

From the above Figure 4.5.1 it is found that due to ozone fading pH is increases for wet process on denim pant. We used some detergent before ozone fading so that pH increased for wet process.

4.6 Effects on rub fastness after washing

Table 4.6.1: Dry Rub fastness checking

Color fastness to rubbing (Dry)				
Concentration of Ozone / Ozone gas Processing	Before	60%	80%	100%
Dry process	3	5	5	5
Wet process		3	3	3

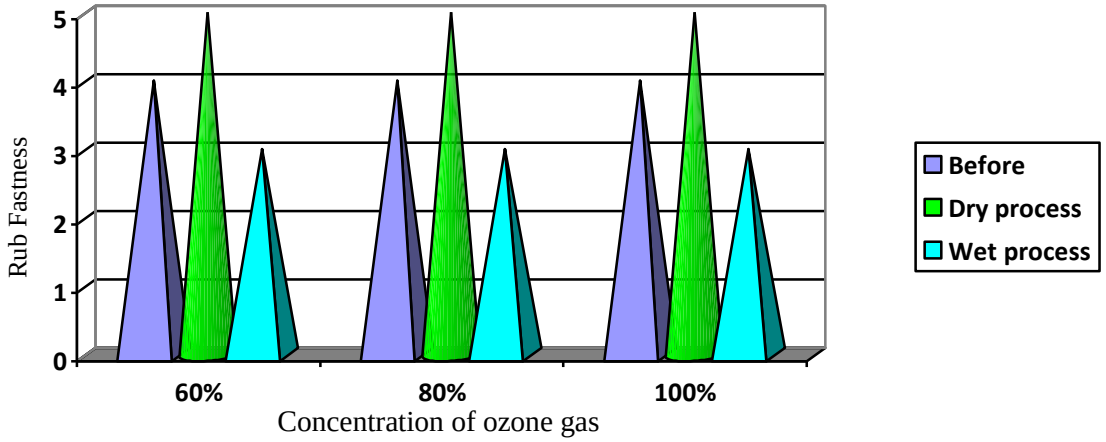


Fig. 4.6.1: Effects on rub fastness after washing (Dry)

From the above Fig. 4.6.1 it is found that due to ozone fading rubbing fastness is excellent for wet process but rubbing fastness is moderate for wet process by measuring the rub property through comparing with the measuring scale because this denim fabric color fastness property is very good.

Table 4.6.2: Wet Rub fastness checking

Color Fastness to rubbing (Wet)				
Concentration of Ozone / Ozone gas Processing	Before	60%	80%	100%
Dry process	4	5	5	4
Wet process		4	4	3

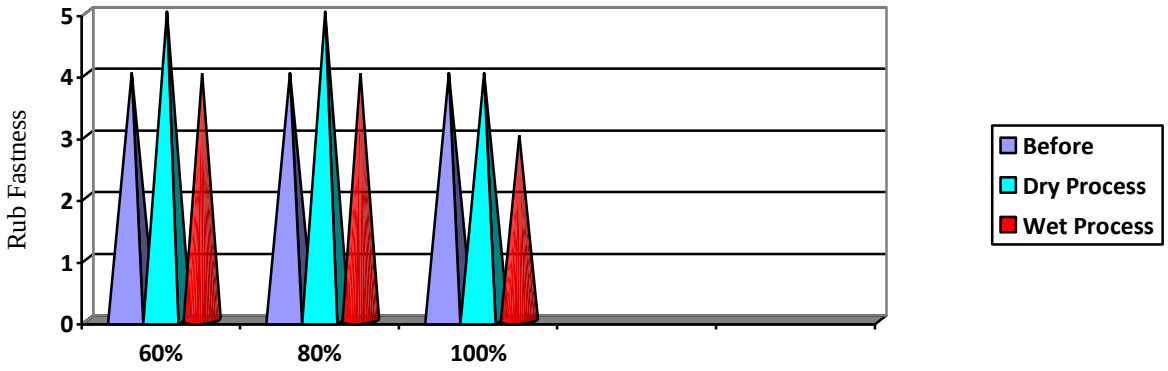


Fig. 4.6.2: Effects on rub fastness after washing (Wet)

From the above Fig. 4.6.2 it is found that due to ozone fading rubbing fastness is excellent for wet process but rubbing fastness is moderate to good for wet process by measuring the rub property through comparing with the measuring scale because this denim fabric color fastness property is very good.

4.7 Effects on Absorbency after Washing

Table 4.7: Water Absorbency Checking

Water Absorbency (Time/sec)				
Concentration of Ozone / Ozone gas Processing	Before	60%	80%	100%
Dry process	20	20	19	18
Wet process		13	13	12

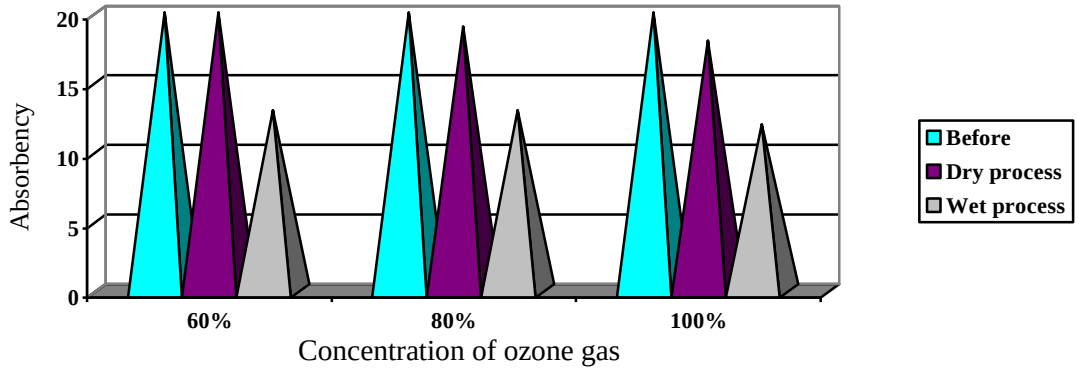


Fig. 4.7: Effects on Absorbency after Washing

From the above Fig. 4.7 it is found that due to ozone fading absorbance capacity is good for wet process than dry process. For ozone fading the surface of the fabric is inserted due to decrease absorbency for dry process.

4.8 Effect on Color Fastness to Washing

Table 4.8.: Color Fastness to Washing Checking

Color Fastness to Washing				
Concentration of Ozone gas / Ozone Processing	Before	60%	80%	100%
Dry process	4	4	4	4.5
Wet process		4	4.5	4.5

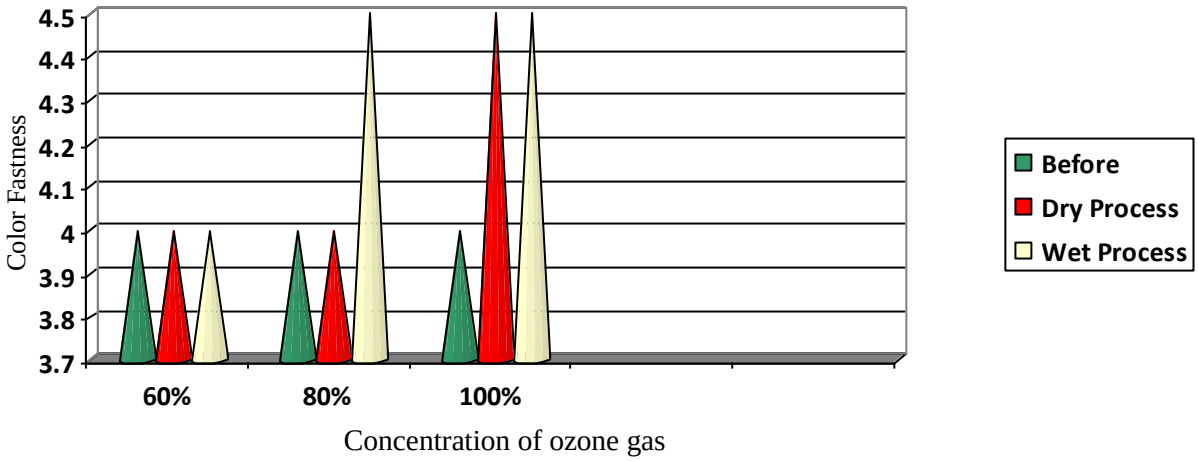


Fig. 4.8: Effect on Color Fastness to Washing

From the above Fig. 4.8 we found that due to ozone fading Color fastness to wash after ozone fading on denim pant is good to very good for both dry and wet process. Because the color fastness property of the fabric is good.

4.9 Effects on Shrinkage

Table 4.9: Shrinkage Checking (Lengthwise)

Shrinkage % Lengthwise				
Concentration of Ozone gas / Ozone Processing	Before	60%	80%	100%
Dry process	5%	5%	4.5%	4%
Wet process		5%	5.5%	6%

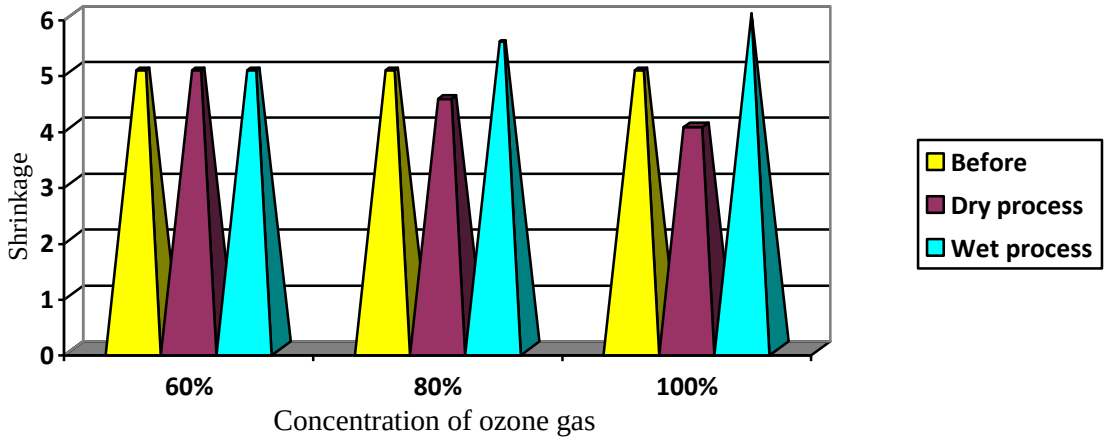


Fig. 4.9: Effects on shrinkage after ozone fading on denim

From the above Fig. 4.9 we found that due to ozone fading shrinkage is less in dry process compared with wet process because fabric is compact condition in dry process but fabric is flappy condition in wet process.

CHAPTER – FIVE

CONCLUSION AND RECOMMENDATIONS

Conclusion

At the end of the project it is found that when Ozone gas is applied on the denim pant it is increased GSM, EPI, PPI & Shrinkage with the increase of ozone concentration in wet ozone process while decreased these values in dry ozone processing. Color fastness properties and absorbency also increased with higher concentration of ozone gas. One the other hand, tensile strength reduced and pH of the sample increased a little bit with increasing ozone concentration. Overall the entire Denim pant hand feel is improved after ozone fading. Ozone fading garments popularity is increasing day by day because it is a new fashion and the garments is soft and comfortable to wear.

Recommendation

After completing this study following things can be recommended for further work or research -

1) In this project, we investigate the changes of physical and mechanical properties of ozone fading on denim.
2) In this study, we tested 9 types of properties of the sample garments such as; (1) tensile strength, (2) fabric weight (GSM), (3) EPI (4) PPI, (5) pH, (6) Rubbing, (7) Water Absorbency, (8) Color fastness, (9) Shrinkage. Others important physical properties can be tested. Such as color fastness to light, SEM analysis, FTIR analysis, Lightness or Darkness, Redness or Greenness and Yellowness or Blueness and perspiration test etc.
3) In this experiment, we also only treated garments samples with ozone fading techniques and observe the changes. Some other washing technique could be done for further investigation.

References

[1] Malcolm w. browne, Special to The New York Times. Published: June 28, 1990. Ozone-gas, Date 21-10-16. http://www.nytimes.com/1990/06/28/world/ozone-fading-fast-thatcher-tells-world- experts.html, https://www.ucar.edu/learn/1_5_1.htm

[2] Hegarty, Stephanie (2012-02-28). http://www.bbc.com/news/magazine-17101768

[3] March 4, 2012 By Textile Technologisthttp://textilefashionstudy.com/Denim-technologydefinition- and-types-of-denim-fabrics-produced-in-denim-mills/.Date 20-01-2016

[4] Sarkar, J & Khalil, E.(May-Jun. 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 (IOSR-JPTE) 1(3),PP. 46-49

[5] H. Shawon, S, "Industrial Garments Washing"Retrieved on 20 January 2016 from: http://apparelqc.blogspot.com/2015/02/industrial-garments-washing.html

[6] Kiron, M I, "Garment Washing | Objects of Garment Washing | Types of Garment Wash | Advantages of Garment Washing"Retrieved on 20 January 2016 from: http://textilelearner.blogspot.com/2012/04/garment-washing-objects-ofgarment.html#ixzz41UddaNxm

[7] Mayedul Islam, oct 18, 21016, Requirment-of-garments-washing http://www.garmentsmerchandising.com/requirements-of-garments-washing/

[8]Noor Ahmed Raaz | January 16, 2016| types-of-garments washing| http://textilemerchandising.com/different-types-of-garments-wash/

[9] Kiron, M I, "Normal Wash | Objects of Normal Wash | Garment Washing Process With Normal Wash" Retrieved on 20 January 2016 from: http://textilelearner.blogspot.com/2012/07/normal-wash-objects-of-normalwash.html#ixzz41WmyYaYD

[10]Different types of garments washing- https://textileapex.com/2015/04/different-types-of-garments-wash.html

[11] Khalil, M. M. H., and F. A. Al-Seif. 2008. "Molybdenum and Tungsten Tricarbonyl Complexes of Isatin with Triphenylphosphine." Research Letters in Inorganic Chemistry 2008 (4):1–4. Article ID 746058. doi:10.1155/2008/746058

[12] Ledakowicz, S., M. Solecka, and R. Zylla. 2001. "Biodegradation, Decolourisation and Detoxification of Textile Wastewater Enhanced by Advanced Oxidation Processes." Journal of Biotechnology 89:175–84. doi:10.1016/S0168-1656(01)00296-6.

[13] R. Morent, N. De Geyter, J. Verschuren, K. De Clerck, P. Kiekens, C. Leys: Surface and Coatings Technology Vol. 202 (2008), p. 3427.

[14] C. W. Kan, C. W. M. Yuen, and W. Y. Tsoi, "Using atmospheric pressure plasma for enhancing the deposition of printing paste on cotton fabric for digital ink-jet printing," Cellulose, vol. 18, no. 3, pp. 827–839, 2011.

[15] Kan, C.-w., et al., A study of plasma-induced ozone treatment on the colour fading of dyed cotton, Journal of Cleaner Production (2015), http://dx.doi.org/10.1016/j.jclepro.2015.10.100

[16] Perincek, S., K. Duran, A. Korlu, and I. Bahtiyari. 2007. "An Investigation in the Use of Ozone Gas in the Bleaching of Cotton Fabrics." Ozone: Science & Engineering 29 (5):325–33. doi:10.1080/01919510701509578.

[17] D.J. Shippy, P.P Gillis, and K.G. Hoge,Computer Simulation of a High Speed Tensile strength test. J. Appl. Polym.Sci. Applied. https://books.google.com.bd/books?id=5uRIb3emLY8C&pg=PA85&source=gbs_selected_pages&cad=2#v=onepage&q&f=false

[18] ASTM D3776 / (2013), Standard Test Methods for Mass per Unit Area (Weight) of Fabric, American Society for Testing and Materials, West Conshohocken, PA, USA.

[19] IS 1963 (1982) Methods for Determination of Threads per Unit Length in Knitted Fabrics. Bureau of Indian Standards, New Delhi.

[20] AATCC Test Method 81-2006, pH of the Water Wet Processed Textiles, American Association of Textile Chemists and Colorists, AATCC Technical, Research Triangle Park, North Carolina, U.S.A, 2006

[21] ISO 105-X12:2001; Textiles -- Tests for color fastness -- Part X12: Color fastness to Rubbing

[22] AATCC Test Method 79, Absorbency of Textiles, American Association of Textile Chemists and Colorists, AATCC Technical Manual, Research Tri U.S.A, 2009

[23] ISO 105-C04:1989; Textiles -- Tests for color fastness -- Part C04: Color fastness to washing: Test 4