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Effects of O_3 Treatment on Different Composition % (Cotton, Polyester, Elastane) of Denim Fabrication (GSM 295, 327, 340, 343, 357, 360, 413) after Random O_3 Wash

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Abstract

In the present day, all the buyers are encouraging the sustainable wash in the industry to conform to their orders. The washing industry is facing some difficulties after receiving the order from the buyers. That's why, in this study, the authors have selected different percentages of cotton, polyester, and elastane fabric containing the GSM 295, 327, 340, 343, 357, 360, and 413 to conduct these experiments to reduce the difficulties of the washing industry. For all different types of denim fabrics, the physical properties test (tensile, tear, and GSM) and the chemical properties test (color fastness to crocking, color fastness to ozone, pH) have been done here to collect the row data. The main aim of this study was to find out about shade variation, weight loss, physical property changes, etc. before and after the third wash. This study will help the washing industry choose fabric types for sustainable washing in the future.

Keywords

Ozone, GSM, Shade, Fabric

1. Introduction

"Denim" comes from the French word "serge de Nimes", as it is a hardcore texture that started in Nimes, France. It is customarily woven with 100% cotton yarn, however, to control contracting and wrinkles; it is generally mixed with polyester or spandex [1]. Denim is a long-lasting cotton-twist-confronted cloth in which the weft passes below the loom or twist strings. These will weave a

slanting ribbing that acknowledges it as Cotton Duck [2]. The most extensively identified denim is indigo denim, in which the strings are colored while the weft string is left white. Just like the twist-confronted twill weaving, one facet of the fabric is overwhelmed with the aid of the blue twist strings and every other facet is overwhelmed by the White weft strings. This makes the pants white inside. The indigo coloring measure, in which the center of twist strings stays white, makes denim's characteristics. Twill is a kind of material that weaves, with an example of slanting equal ribs [3]. It tends to be recognized by taking a gander at the presence of articulated inclining lines that run along the width of the texture. It has higher protection from tearing than a plain weave since it has fewer yarns interweaving per territory, resulting in a more prominent level of inward portability. Also, two yarns will bear the heap when the texture is torn. There have been numerous endeavors to utilize synthetic compounds in denim pieces of clothing washing. The most utilized denim washing techniques are catalyst wash, blanch wash, corrosive wash, stone wash, and so forth, Albeit the enzymatic technique is an eco-accommodating compound treatment on the cellulose article of clothing corrupts cellulose chains, yielding more limited chain cellulose polymers and diminishes its mechanical strength seriously. Ozone wash is another innovation and used to change the tone in the wake of washing [4]. Typical washing needs water, synthetic compounds, time, and mechanical activity. However, ozone wash replaces every one of those things in wet washing and saves energy and assets. An ozone machine is utilized for ozone washing. It utilizes oxygen gas and makes ozone gas for the interaction. Numerous specialists are occupied with the examination to research the impact of different washing on physical, mechanical, and colorfastness properties of unbending and stretching denim textures. Be that as it may, there is an absence of exploration on the assurances of climate cordial climate and manageable wash measure for four-way stretch denim texture to grow new plans as design with life span as higher wear execution by an enzymatic strategy as far as physic-mechanical properties, substance properties, contamination heap of washing gushing, morphological changes of the textured surface [5]. In this view, the current examination is intended to improve a climate-friendly and maintainable cycle for washing the denim texture. The advancement of the denim market has prompted improvements.

Research Aims

1) To know about the Random wash on different common composition denim fabric.

2) To know the effect of ozone treatment.

3) To understand the variation of different denim fabric after ozone wash.

4) To compare the physical and chemical properties between before ozone treatment and after ozone treatment.

2. Materials and Methods

2.1. Materials

Denim Fabric with blended compositions (Contents: Cotton, Polyester, Elastane, GSM used from 295 to 413. Shrinkage was 2 × 14% to 5 × 18%)

Chemicals (Desizing Agent, Enzyme, Stone, Patash, Meta, Detergent, Orange ARLE, Salt, Cationic softener)

Machineries Used in the Experiment [6]

1) Garments Washing Machine
2) Ozone machine
3) Garments dryer machine
4) Color Fastness to Ozone m/c (Grey Scale)
5) Tensile Strength tester (Model 601538 & HTE-5000N, Brand-Tinius Oisen)
6) Tearing Strength tester (Model Patents No 1,423,841, Brand-Thwing-Albert)
7) pH tester (Model PH-208, Brand-Lutron)
8) Color Fastness to Crocking (Model 718C0026 & M238BB, Brand-SDL Atlas)
9) GSM cutter (Model Die cutter, Brand-Rotacutex)

2.2. Methods

Research methodology framework is given below:

Sourcing (Common composition denim fabric)
↓
GSM cutting
↓
Sent to Washing
↓
Desizing
↓
Stone Enzyme
↓
Acid Wash
↓
Neutralization of By-Product (Mno_2)
↓
Neutralization
↓
Cleaning
↓
Tint
↓
Finishing/Softening
↓

Drying
↓
Ozone Implementation
↓
5% Ozone (O_3) – 10 Min
↓
Neutral
↓
Cleaning
↓
Tint
↓
Softener
↓
Comparison between before and after Ozone treatment

3. Results and Discussions

Observation: In Figure 1, we can see that different GSM fabrics have been selected for the test. A randomly selected fabric was selected. After that lab test, the GSM found out. Here are 8 types of GSM that have been found: 295, 327, 340, 343, 357, 360, and 417. After that, fabrics are treated in the random wash. The same recipe was followed for all the fabrics. Washing is also done in the same bath. In the random wash, a blanket effect is created for the experiment. Found shade variation from fabric to fabric. One fabric shade is not matching another

DIFFERENT COMPOSITION DENIM

SL NO	GSM	SAMPLE	SAVPLE (BEFORE OZONE)	SAVPLE (AFTER OZONE)	REMARK
SPECLMIEN-1	357				95% cotton 2% Elastane 3% Polyester
SPECLMIEN-2	295				86.5% Cotton 4.5% Elastane 9% Polvester
SPECIMIEN-3	340				91% Cotton 6% Polyester 3% Elastane
SPECLMIEN-4	357				98% Cotton 2% Elastane
SPECIMIEN-5	343				94.5% Cotton 5.5% Elastane
SPECIMIEN-6	413				85% Cotton 12% Polvester 3% Elastane
SPECIMIEN-7	327				93% Cotton 5% polvester 2% Elastane
SPECLMIEN-8	360				88% Cotton 11% polyesyer 1% Elastane

Figure 1. Denim type fabric analysis based on GSM.

fabric shade. The reason behind this shade variation is GSM. After completing the random wash, all fabrics were put into the ozone dryer for ozone treatment. 5% ozone was applied for 10 minutes. Finally, after ozone treatment, the color fading occurred. Specimen 7 has more color fading compared with other specimens. Because it has 93% cotton, 5% polyester, and 2% elastane. Hence, after analyzing, we found that the reason behind this color fading is fabric content. Ozone is mostly affected by cotton, followed by polyester, and finally elastane. When the fabric has the maximum cotton content and a higher polyester content than elastane, ozone is the most effective finishing element.

3.1. Physical Properties Test (Denim Type)

In physical properties there are three tests has been done such as Tearing Strength test, Tensile Strength test and GSM.

1) Tearing Strength Test

ASTM D1423-96 is followed in the process. Minimum three tests are taken for single specimen [7].

Discussion: From Figure 2 and Table 1, we can see that the tearing strength test reading, it is apparent that changes are visible in specimens 1, 2, 4, 5, 7, and 8. Specimen 1 indicates that the tearing strength is reduced in the warp direction after ozone treatment, but the strength is greater in the weft direction compared with before and after ozone treatment. The same status is also reflected in specimen 8. Specimens 2, 4, 5, and 7 reflected that in the weft direction, the strength is higher after ozone treatment. On the other hand, in specimens 3 and 6, there are no changes in the tearing test.

2) Tensile Strength Test

ASTM D5034 is followed in the process. Minimum three tests are taken for

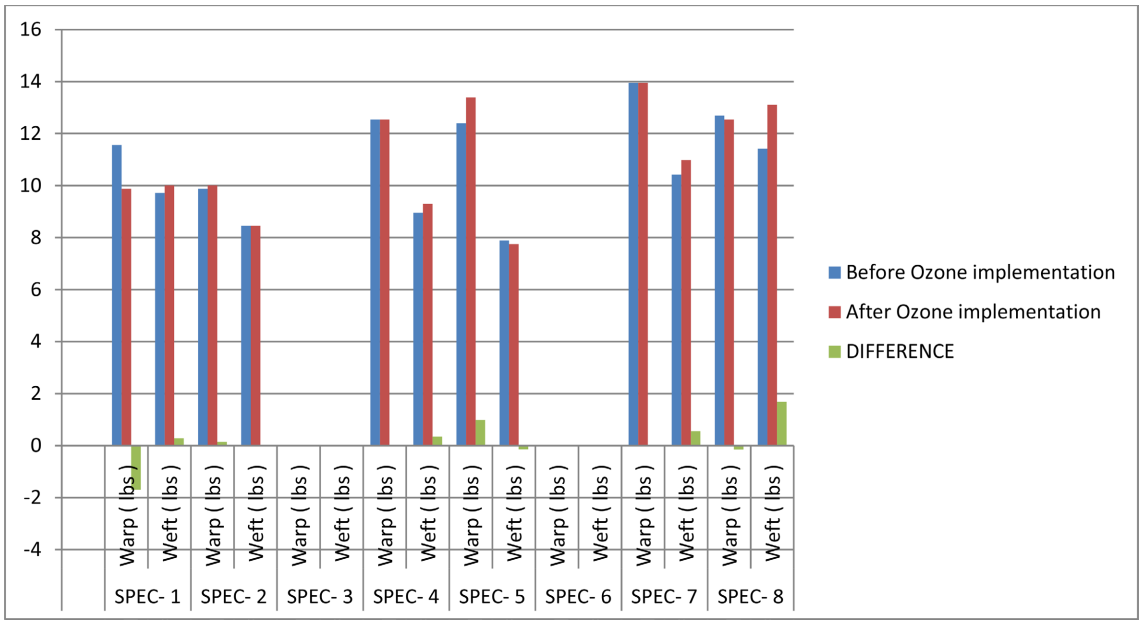

Figure 2. Tearing strength comparison.

Table 1. Tearing strength test comparison.

SL.NO	DIRECTION	Before Ozone implementation Test Value	After Ozone implementation Test Value	DIFFERENCE
SPEC-1	Warp (lbs)	11.56	9.87	−1.69
	Weft (lbs)	9.72	10.01	0.29
SPEC-2	Warp (lbs)	9.87	10.01	0.14
	Weft (lbs)	8.46	8.46	0
SPEC-3	Warp (lbs)	>14	>14	0
	Weft (lbs)	>14	>14	0
SPEC-4	Warp (lbs)	12.54	12.54	0
	Weft (lbs)	8.95	9.3	0.35
SPEC-5	Warp (lbs)	12.4	13.39	0.99
	Weft (lbs)	7.89	7.75	−0.14
SPEC-6	Warp (lbs)	>14	>14	0
	Weft (lbs)	>14	>14	0
SPEC-7	Warp (lbs)	13.95	13.95	0
	Weft (lbs)	10.43	10.99	0.56
SPEC-8	Warp (lbs)	12.69	12.54	−0.15
	Weft (lbs)	11.42	13.11	1.69

single specimen [8].

Discussion: From Table 2 and Figure 3, we can see the tensile strength test reading; it is evident that tensile strength also varies from fabric to fabric. As the contents are not the same, they give different values. In some cases, it is reducing; in other cases, it is increasing. Hence, tensile strength has significant changes in fabric. All specimens' tensile strengths have been changed. Specimen 4 shows that strength is increasing after ozone treatment, and specimen 6 remains the same strength before and after ozone treatment.

3) Fabric Weight Test (GSM)

ASTM D3776 is followed in the process [9].

Discussion: From Table 3 and Figure 4, the results shows that the fabric weight loss has been found in specimens 1, 5, and 6 compared to before and after ozone treatment. Specimen 4 is reflecting that fabric weight has increased after ozone treatment. Hence, it can be said that ozone implementation influences fabric weight.

3.2. Chemical Properties Test (Denim Type)

In physical properties there are three tests has been done. Such as Color fastness to crocking, Color fastness to Ozone and pH test.

Table 2. Tensile strength test comparison.

SL.NO	DIRECTION	Before Ozone implementation Test Value	After Ozone implementation Test Value	DIFFERENCE
SPEC-1	Warp (lbs)	225.9	221.4	−4.5
	Weft (lbs)	80.4	73.2	−7.2
SPEC-2	Warp (lbs)	130.2	126.8	−3.4
	Weft (lbs)	60.7	58.7	−2
SPEC-3	Warp (lbs)	195.6	181.6	−14
	Weft (lbs)	97.9	93.4	−4.5
SPEC-4	Warp (lbs)	145.3	173.9	28.6
	Weft (lbs)	90.8	82.5	−8.3
SPEC-5	Warp (lbs)	197.4	188.2	−9.2
	Weft (lbs)	73.3	67.5	−5.8
SPEC-6	Warp (lbs)	186.1	171.6	0
	Weft (lbs)	117.4	126.8	0
SPEC-7	Warp (lbs)	177.5	177.5	0
	Weft (lbs)	73.3	77.8	4.5
SPEC-8	Warp (lbs)	190.6	185.7	−4.9
	Weft (lbs)	101.8	103.7	1.9

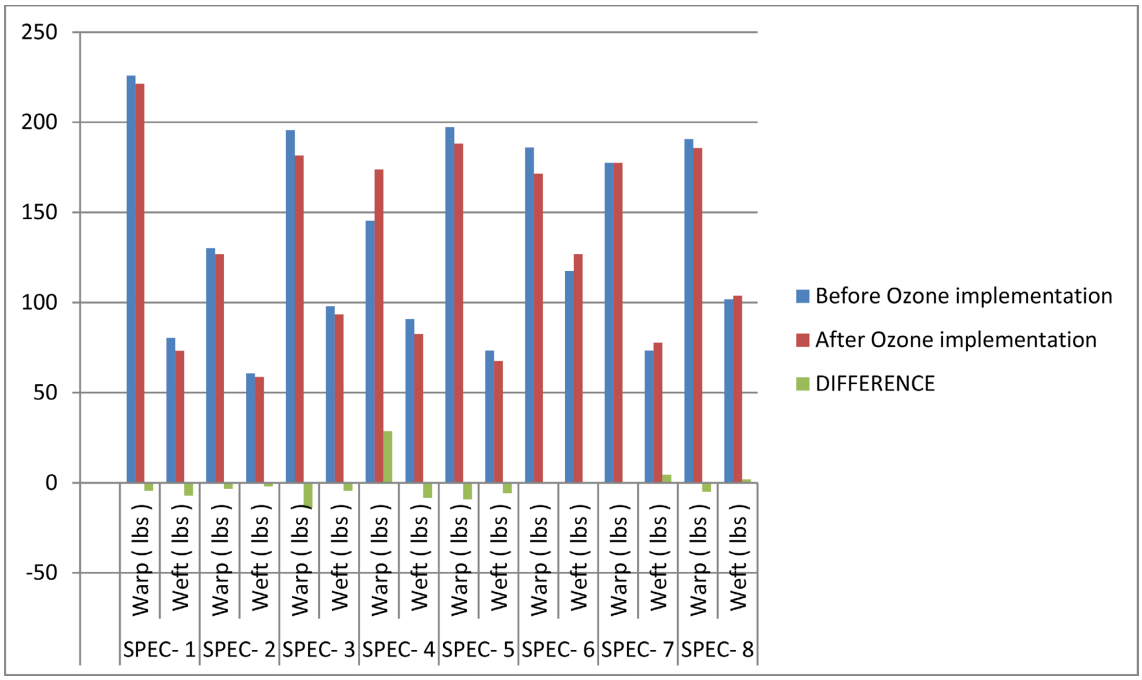

Figure 3. Tearing strength comparison.

Table 3. Fabric weight test comparison.

SL.NO	Before Ozone implementation Test Value	After Ozone implementation Test Value	DIFFERENCE
SPEC-1	426	420	−6
SPEC-2	385	387	2
SPEC-3	385	387	2
SPEC-4	383	390	7
SPEC-5	404	403	−1
SPEC-6	420	419	−1
SPEC-7	399	400	1
SPEC-8	416	418	2

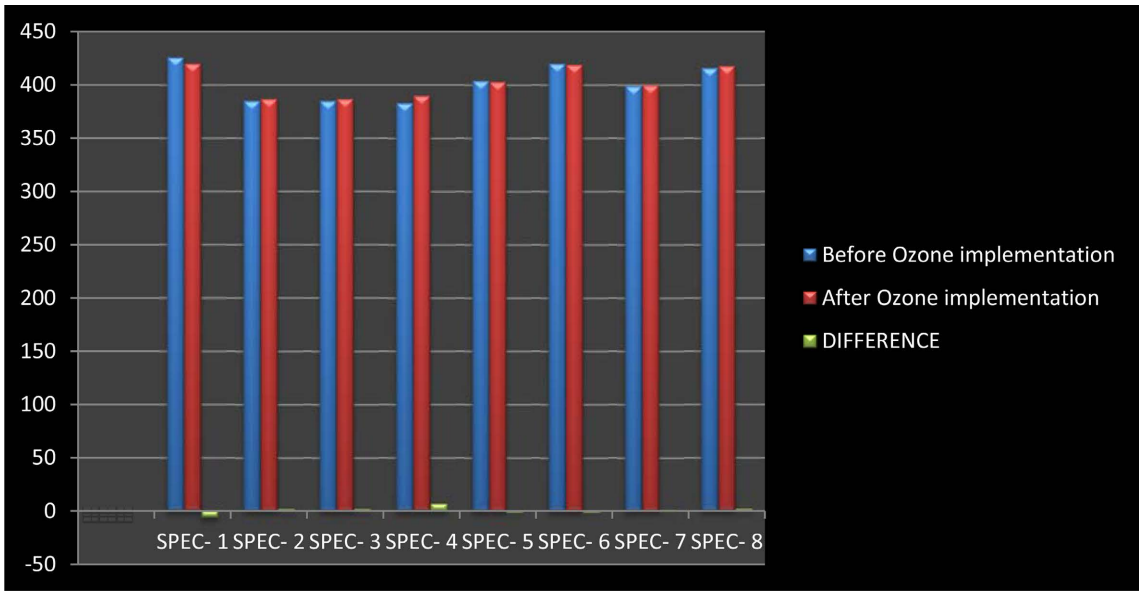

Figure 4. GSM comparison.

1) Color Fastness to Crocking: AATCC 8 is followed in the process [10].

Discussion: Table 4 and Figure 5 show the colorfastness to crocking is mostly reflected in Specimen 3. Because this is a grey denim fabric with 91% cotton, 6% polyester, and 3% elastane (base grey), we can say the grey fabric is not suitable for color fastness to crocking.

2) pH test: AATCC 81 is followed in the process [11] [12].

Discussion: In Table 5 and Figure 6, we can see the pH value for all specimens was found to be similar. Maximum pH value found for specimen 5 Specimen 5 showed that before ozone, the pH was 8.02, and after ozone, it had reduced to 7.9. In the meantime, it needs to be reminded that when the washing is done in the same bath, the pH value will not very much. There will be a small difference from fabric to fabric.

Table 4. Color fastness to crocking test comparison.

SL.NO	CONDITION	Before Ozone implementation Test Value	After Ozone implementation Test Value	DIFFERENCE
SPEC-1	DRY	4.5	4.5	0
	WET	1.5	1.5	0
SPEC-2	DRY	4.5	4.5	0
	WET	1.5	1.5	0
SPEC-3	DRY	4	4.5	0.5
	WET	1	1	0
SPEC-4	DRY	4.5	4.5	0
	WET	1.5	1.5	0
SPEC-5	DRY	4	4	0
	WET	1	1	0
SPEC-6	DRY	4.5	4.5	0
	WET	2	2	0
SPEC-7	DRY	4	4	0
	WET	1	1	0
SPEC-8	DRY	4	4	0
	WET	1	1	0

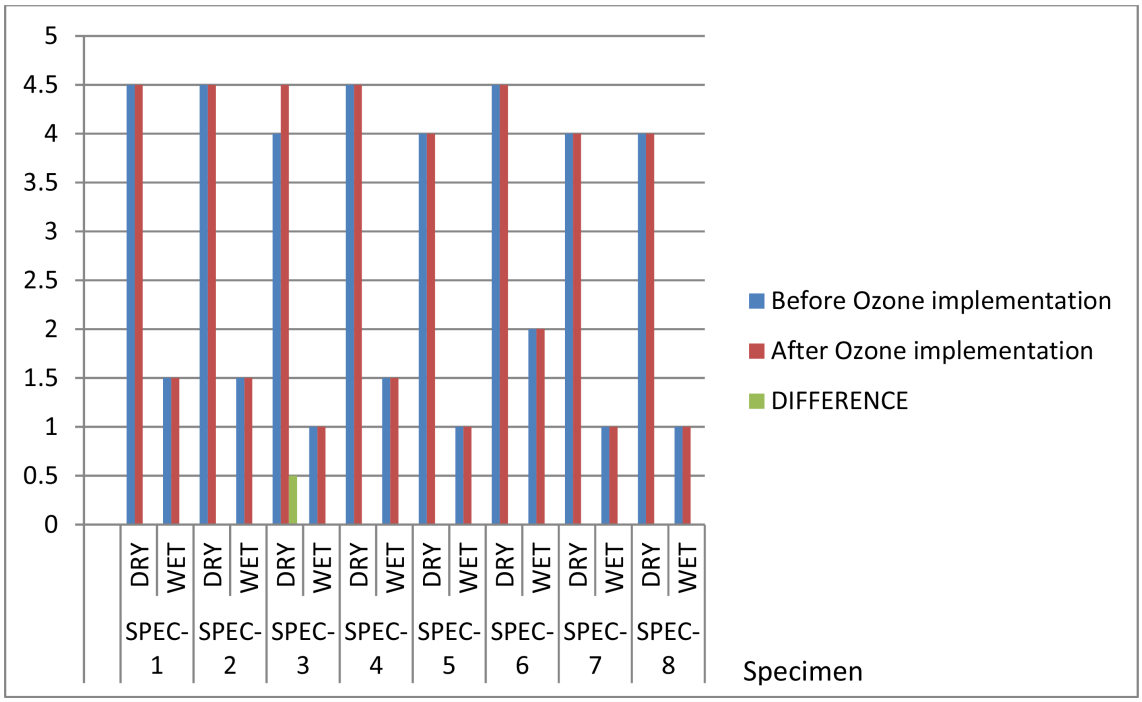

Figure 5. Color fastness to crocking.

Table 5. pH Test Comparison.

SL.NO	TEMP (Degree celsius)	Before Ozone implementation Test Value	TEMP (Degree celsius)	After Ozone implementation Test Value	DIFFERENCE
SPEC-1	25.1	8	24.8	7.95	−0.05
SPEC-2	25.1	7.88	24.5	7.9	0.02
SPEC-3	24.8	7.88	25.2	7.95	0.07
SPEC-4	25.2	7.89	25.2	7.8	−0.09
SPEC-5	25	8.02	24.7	7.9	−0.12
SPEC-6	25.2	7.95	24.9	8.1	0.15
SPEC-7	25	7.91	24.7	7.98	0.07
SPEC-8	24.8	7.8	24.7	8.2	0.4

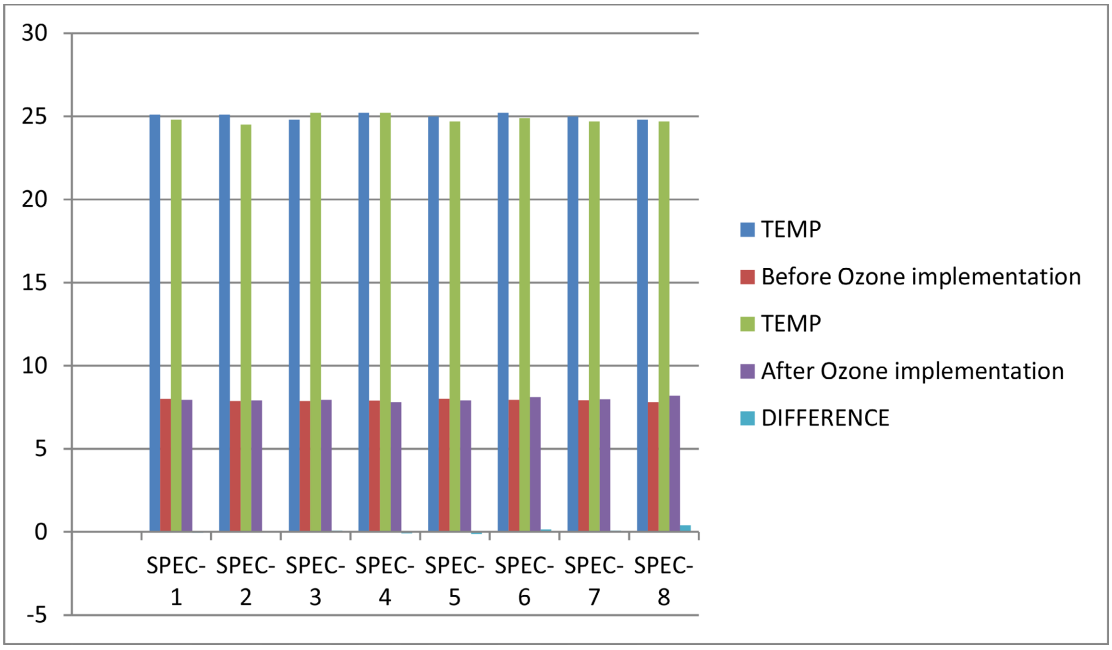

Figure 6. pH test comparison.

Color Fastness to Ozone: AATCC/109 is followed in the process. Non-Faded Area Color Change (1 cycle) [13].

4. Discussion

In Table 6 and Figure 7, the color fastness to ozone is mostly visible in specimens 1, 2, 6, and specimen 7. This specimen is faded compared with the balance specimen. Comparison is taking the form of grey scale. Ozone is mostly affected by the cotton part of a fabric.

1) LIMITATION: In this study, the author has used 10 different fabrics for the experiment. The limitation of this study is that the author has taken only 10 denim fabrics from different sources; if the author can take more than 50 different

Table 6. Color fastness to ozone comparison.

SL.NO	GRADE
SPEC-1	4
SPEC-2	4
SPEC-3	4.5
SPEC-4	4.5
SPEC-5	4.5
SPEC-6	4
SPEC-7	4
SPEC-8	4.5

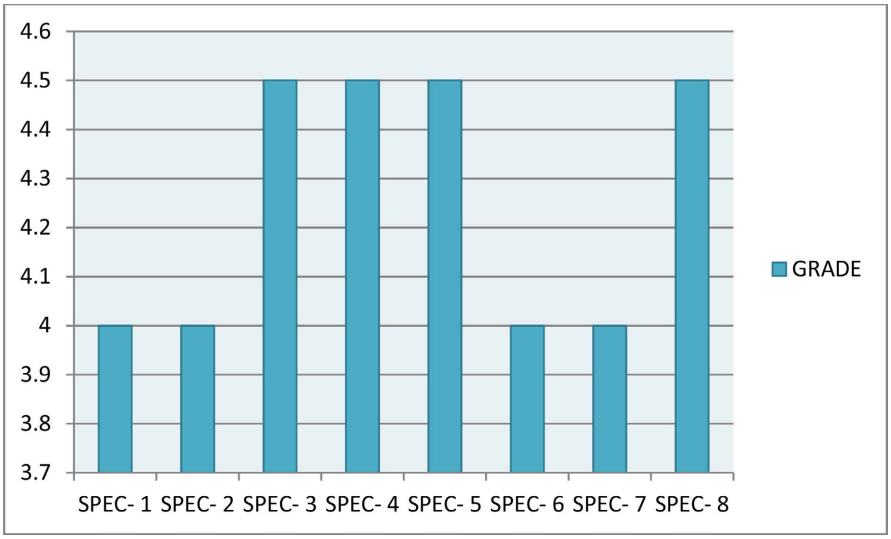

Figure 7. Color fastness to ozone comparison.

fabrics, shade variation and ozone treatment will be more visible in the wider range. But this is very difficult to find the different denim fabric around 50 different GSM and Contents. The author has done all washing and lab tests in the modern washing industry and modern labs. But they are not accepting more specimens for the washing and lab tests; they are too busy with their production, so it is quite difficult to do such washing and tests in the industry.

2) CONCLUSIONS: Random washing is also popular nowadays. If we want to create the effect of ozone treatment, we need to use the maximum cotton base fabric with a higher polyester part compared to the elastane part. It will create more luster and shade variation in garments. The ozone treatment is suitable for medium and dark washes. Lighter-wash denim is not suitable for this treatment. Because after a random wash, if we put the garments in an ozone dryer, the original shade will be cut off and the garments will look more yellowish. It is not suitable, and it has also lost this look and image. Nowadays, the popularity of Random Wash is increasing. To create some shade variation, one needs to apply

ozone as the finishing material. If any industry wants to make more ranges of shades and images for their clients, they should have applied ozone treatment, which helps to make more options for them.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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