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DEVELOPMENT OF OZONE EFFECTING SYSTEM WITHOUT USING HARMFUL CHEMICALS

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ABSTRACT

Recently, new bleaching methods are developed and presented as an eco-friendly alternative for the traditional bleaching processes. Traditional bleaching chemicals such as sodium hypochlorite, potassium persulfate, potassium permanganate, hydrogen peroxide, sodium perborate, sodium percarbonate, and benzoyl peroxide is harmful to human health and the environment. In this study, new eco-friendly and sustainable denim bleaching processes are developed. Textile washing and giving effect process is provided by using only ozone with different techniques without using any harmful chemicals. In terms of both technical and visual aspects, successful results have been obtained in comparison with the traditional method in ozone technology. With this new method, the processing time has been shortened and the water consumption has been reduced by about 53%.

KEYWORDS

Denim Bleaching, Ozone, Giving Effect.

INTRODUCTION

Denim fabric is a kind of woven fabric, which is mainly made of cotton fiber, and it is also produced from fibers such as polyester, elastane, linen, viscose. Denim, which has a wide variety of patterns that can be woven with various construction in recent years, is a type of fabric whose warp is usually dyed indigo dyestuff [1–2]. Formerly denim products were only desizing and sold with no washing process. Denim products had a stiff hand feeling. The effects and coloration on garment occurred by the wear of indigo dyestuffs, in which the warp yarn was dyed, over time during the use of the denim product. That is why denim products have acquired a special appearance after a long period of using and washing. Over time the demand for used appearance denim products has increased. Garment denim products began to undergo bleaching processes at washing plants. Denim washing processes are aimed at giving the products effects and color. Processes are made on washing plants for making the garment denim products more comfortable. The bleaching process is applied to achieve lighter color on garment denim product. This process is applied to achieve lighter color that cannot be achieved using pumice stones or enzymes. At this step, by various methods and chemicals, the indigo fabric acquires the requested color. In addition to the traditional methods; ozone bleaching, which is a sustainable method, is very important for denim garment products. Ozone as for that, is a compound consisting of three oxygen atoms and has a higher energy than atmospheric oxygen. Ozone is an oxidative substance and its redox potential is higher than that of hydrogen peroxide [3]. Thanks to this oxidation property of ozone gas indigo molecules of denim fabric are degraded quickly. Achieved effects in traditional denim bleaching can be achieved with ozone gas and without any harmful chemicals. While there is excess water consumption



for traditional denim washing, ozone bleaching system needs far fewer water and reuse of ozone bleaching wastewater is possible. With this study, it is aimed to save water and energy by ozone bleaching method compared to traditional bleaching method in denim products.

MATERIALS AND METHODS

1. The Reaction of the Formation of Ozone

Ozone is formed in the atmosphere when ultraviolet (UV) radiation dissociates molecules of oxygen, O_2 , into separate oxygen atoms. Free oxygen atoms can recombine to form oxygen molecules, but if the free oxygen atom collides with an oxygen molecule, it will combine to form ozone. Ozone molecules can also be decomposed by ultraviolet radiation into a free atom and an oxygen molecule [4]. Formation and disintegration of ozone are showed below in Figure 1.

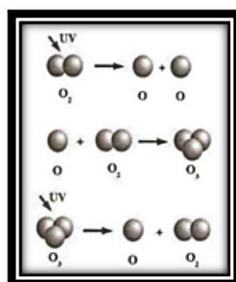


Figure 1. The scheme of formation of ozone [4].

2. The Use of The Ozone Device and The Reaction of Ozone with The Indigo Molecule

Firstly the conditions of the ozone generator are adjusted to give effect to the fabric with ozone. Then fabrics which will applied put into the washing machine. Indigo carmine molecule disintegration of ozone are showed below in Figure 2.

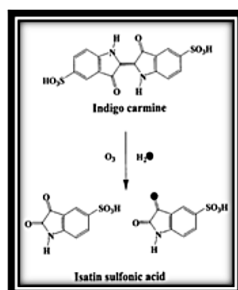


Figure 2. Indigo carmine molecule disintegration of ozone [5].

Three different methods for ozone bleaching are showed below in Figure 3.

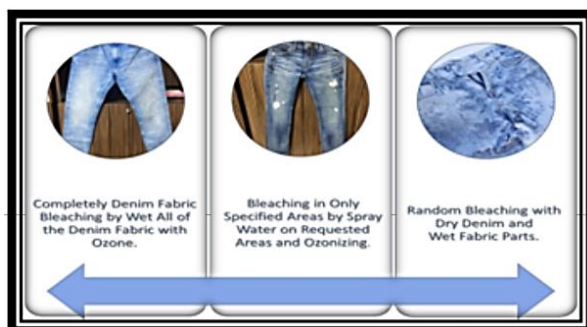


Figure 3. Three different methods for ozone bleaching.

RESULTS AND DISCUSSION

In this study, traditional wash and Wiser Wash (ozone) systems are compared is showed in Table 1. Comparison is made by only one denim garment product between traditional wash and Wiser Wash. One piece of denim product weights approximately 650 grams.

Table 1. The comparison of traditional wash and Wiser Wash (ozone) technology.

TRADITIONAL WASH		WISHER WASH
350 g	SODIUM HYPOCHORITE	No
1.4 g	POTASSIUM PERMANGANATE	No
492.42 g	AVG CHEMICALS	12.50 g(ZDHC Approved)
60 L	WATER	28 L
2 kg	PUMICE STONE	No
1.11 kW	ELECTRICITY	0.8 kW
355 min.	PROCESS	198 min.

When the table 1 is examined, 350 grams sodium hypochlorite, 1.4 grams potassium permanganate and 2 kilograms pumice stone is used in the traditional method but no sodium hypochlorite, potassium permanganate and pumice stone is used in Wiser Wash. Thanks to the Wiser wash, the use of bleaching chemicals that are harmful to nature and human health has been eliminated. The use of AVG Chemicals has also been reduced from 492.2 grams to 12.50 grams (ZDHC Approved) thanks to the Wiser Wash. Significant savings are revealed by comparing the energy consumption of Wiser Wash and Traditional Washing. The traditional washing electricity energy consumption is 1.11 kW, while the Wiser Wash electricity energy consumption is 0.8 kW. On the other hand, the traditional washing method has processing time of 355 minutes, while the Wiser Wash method has processing time of 198 minutes. The Wiser Wash method provides many energy savings due to its short duration. The highest consumption in denim washing plants is water consumption. For this reason, the most important point of the Wiser Wash method is that it reduces water consumption from 60 liters used in classic washing to 28 liters.

The Amount of Potassium Permanganate in the Denim Washing Water

Two different water samples were taken from denim washing baths belonging to the traditional and Wiser Wash method. Spectrophotometric method was used to determine the amount of potassium permanganate contained in denim washing baths. Light was passed in certain spectra through the solution (bath sample) with the spectrophotometer device. How much of this beam is absorbed by the solution is found. The greater amount of potassium permanganate contained in the bath sample, the more rays were absorbed by the bath sample. The spectrophotometer device thus detected the intensity of light that can pass through (not be absorbed) the water sample and gave quantitative information about the amount of potassium permanganate in the bath sample. When the test results of determination of potassium permanganate in denim washing baths are examined according to the spectrophotometric method, the amount of potassium permanganate is significantly less in the Wiser Wash method compared to the traditional method. Potassium permanganate was thought to be present in less amounts in the Wiser Wash method because of the manganese present in the water but there is no use of Potassium Permanganate in the Wiser Wash method. The test results are showed in Table 2 and Table 3.

Table 2. Amount of potassium permanganate in Wiser Wash (ozone) technology.

PARAMETER	UNIT	RESULT
KMnO ₄	mg/l	0.1
KMnO ₄	mg/l	0.3
KMnO ₄	mg/l	0.2

Table 3. Amount of potassium permanganate in traditional technology.

PARAMETER	UNIT	RESULT
KMnO ₄	mg/l	159.4
KMnO ₄	mg/l	175.91
KMnO ₄	mg/l	210.37

Amount of Colored Waste Water in Denim Washing

Traditional wash effluents have very dark colors while Wiser Wash effluents are light colored. A comparison of the wastewater of the two methods is showed in Figure 4.



Figure 4. The comparison of traditional wash and Wiser Wash.

CONCLUSION

The technical characteristics and visual designs of the products were compared between traditional wash and Wiser Wash. Both technically and visually, successful results have been achieved in Wiser Wash technology compared to the traditional method. When comparing denim fabrics per unit product (approximately 650 grams), it was observed that water consumption decreased by 53%, energy consumption by 27% and process time by 41%. The number of baths in the traditional wash has decreased from 15 to 7 in the Wiser Wash. The processing steps decreased from 32 to 11.

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