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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. This new method process time, and water consumption has been approximately reduced in 53% ratio.

Anahtar Kelimeler: 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 (Özdemir, 2006).

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 (Ozturk, 2010). Thanks to this oxidation property of ozone gas indigo molecules of denim fabric are degraded quickly. Given effects in traditional denim bleaching can be given 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.

MATERIAL AND METHOD

The Reaction of the Formation of Ozone

Ozone is formed in the atmosphere when ultraviolet (UV) radiation dissociates molecules of oxygen, O2, 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 (Ozturk and Eren, 2010; Morali et al., 2016; Eren and Çeven, 2018). Formation and disintegration of ozone are given below in Figure 1.

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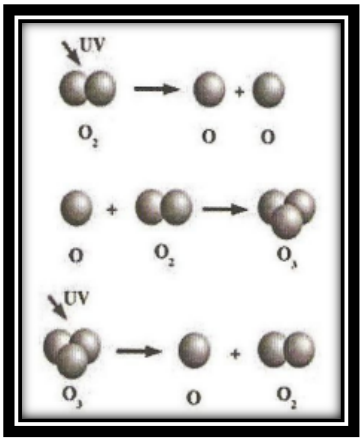

Figure 1. The Scheme of Formation of Ozone (Ozturk and Eren, 2010)

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 given below in Figure 2.

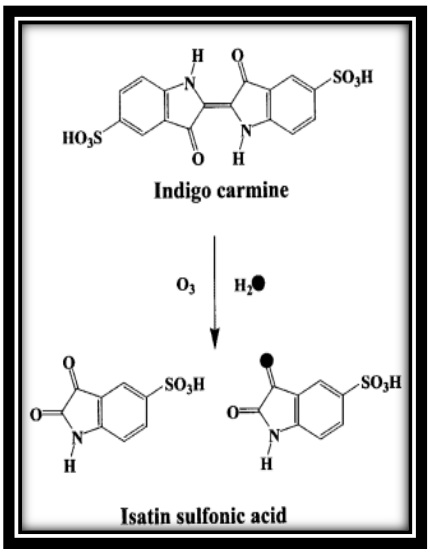

Figure 2. Indigo carmine molecule disintegration of ozone (Kettle et al., 2004)

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

Figure 3. Three different methods for ozone bleaching

RESULTS AND DISCUSSION

In this study, traditional bleaching and ozone bleaching systems are compared. In this scope;

The Amount of Potassium Permanganate in the Denim Washing Water

When the potassium permanganate test results on denim fabric samples were examined according to the spectrophotometric method; It has been proven that ozone bleaching application significantly destroys the amount of potassium permanganate compared to the traditional method. The test results are given in table 1 and table 2.

Table 1. Amount of Potassium Permanganate in Ozone Technology

PARAMETER	RESULT (mg/l)
KMnO4	0,1
KMnO4	0,3
KMnO4	0,2

Table 2. Amount of Potassium Permanganate in Conventional Bleach

PARAMETER	RESULT (mg/l)
KMnO4	159,4
KMnO4	175,91
KMnO4	210,37

Amount of Colored Waste Water in Denim Washing

Traditional bleaching effluents have very dark colors while ozone bleaching effluents are light colored. A comparison of the wastewater of the two methods is given in Figure 4 below.

Figure 4. The Comparison of Traditional Bleach and Ozone Technology

The Amount of Water Used in the Denim Process

The water consumption for a product in traditional bleaching is about 60 liters, while the water consumption in ozone bleaching is 28 liters.

The Amount of Electricity Energy Consumed in the Denim Process

The energy requirement for a product in traditional bleaching is about 1.11 kW, and the energy requirement for ozone bleaching is 0.8 kW. Thus, energy consumption is reduced by 27%.

Technical specifications and visual designs of products between traditional bleaching and ozone bleaching were compared. In terms of both technical and visual aspects, successful results have been

obtained according to the traditional method in ozone technology. It has also been observed water consumption has reduced the rate of 53%. The comparison of denim fabrics per unit product is given in table 3.

Table 3. The comparison of traditional bleach and ozone technology

CONVENTIONAL WASH		WISER WASH
350 GR	SODIUM HYPOCHLORITE	NO
1.4 GR	POTASSIUM PERMANGANATE	NO
492,42 GR	AVG CHEMICALS	12.50 GR (ZDHC APPROVED)
60 LT	WATER	28 LT
2 KG	PUMICE STONE	NO
1,11 KW	ELECTRICITY	0.8 KW
355 MIN.	PROCESS	198 MIN.

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