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COLOR REMOVAL OF DISPERSE DYEING WASTE WATER BY OZONE IN AN EXAMPLE DYEHAUSE

ÖRNEK BİR BOYAHANEDE DİSPERS BOYAMA ATIK SULARININ OZON İLE RENK GİDERİLMESİ

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ABSTRACT: As a result of rapid population growth and industrialization, wastewater generated in various sectors poses a threat to the environment and living things.Textile industry wastewater comes first among these wastewater sources.These wastewaters contain dyestuffs and different chemicals. These waters, which contain many impurities, must be treated well, otherwise they may cause serious problems in the environments where they are discharged. Various physical, chemical and biological methods are used for color removal in wastewater. However, due to the cost and low efficiency of these methods, researches are carried out on innovative and more economical methods. Among the new technologies, advanced oxidation processes (AOPs) are highly efficient new methods being studied for the purification of certain impurities that cannot be removed by general techniques. AOP methods include photocatalytic reaction with UV, ultrasound, Fenton/Peroxide, ultrasound sound waves and similar reactions. One of these methods is ozonation method. In this study, ozone decolorization of wastewater after disperse dyeing taken from textile dyehouse was investigated. In the determined procedure, the removal of color by ozonation method, which is one of the advanced oxidation methods for wastewater recipes after dyeing, was investigated and the color absorbance and COD values of the samples were examined and the results were evaluated.

Keyword*:* ozone, disperse dyeing wastewater, decolorization

ÖRNEK BİR BOYAHANEDE DİSPERS BOYAMA ATIK SULARININ OZON İLE RENK GİDERİLMESİ

ÖZ: Hızlı nüfus artışı ve sanayileşme sonucu çeşitli sektörlerde oluşan atıksular çevre ve canlılar için tehdit oluşturmaktadır. Tekstil endüstrisi atıksuları bu atık su kaynaklarının başında gelmektedir. Bu atıksular boyarmaddeler ve farklı kimyasallar içermektedir. Pek çok kirlilik içeren bu suların iyi bir şekilde arıtılması gerekmektedir aksi halde deşarj edildikleri ortamlarda ciddi problemlere yol açabilirler. Atık sularda renk giderimi için çeşitli fiziksel, kimyasal ve biyolojik yöntemler kullanılmaktadır. Ancak bu yöntemlerin maliyeti ve verimlerinin düşük olması nedeniyle yenilikçi ve daha ekonomik yöntemler üzerinde araştırmalar yapılmaktadır. Yeni teknolojiler arasında, ileri oksidasyon prosesleri (AOP'ler), genel tekniklerle giderilemeyen belirli safsızlıkların saflaştırılması için üzerinde çalışılan oldukça verimli yeni yöntemlerdir. AOP yöntemleri UV ile fotokatalitik reaksiyon, ultrason, Fenton/Peroksit, ultrason ses dalgaları ve benzeri reaksiyonları içerir. Bu yöntemlerden biri de ozonlama yöntemidir. Bu çalışmada, örnek bir işletme tekstil boyahanesinden alınan dispers boyama sonrası atıksuyun ozonla renk giderimi incelenmiştir. Belirlenen prosedürde, boyama sonrası atık su reçeteleri için ileri oksidasyon yöntemlerinden biri olan ozonlama yöntemi ile rengin giderimi araştırılmış ve numunelerin renk absorbansları ve KOİ (Kimyasal Oksijen İhtiyacı) değerleri incelenmiş ve sonuçlar değerlendirilmiştir.

Anahtar Kelimeler: Ozon, Dispers boyama atıksuyu, dekolorizasyon

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1. INTRODUCTION

The clean water resources in the world are decreasing day by day. Because; It is essential for sustainability to use waterless and make it reusable. Therefore, many studies are carried out on the purification and reuse of water in sectors that consume high amounts of water. One of the areas where water is used a lot is the textile industry. By 2050, the world population is expected to increase by about 35%. It is thought that this increasing population and economic growth will increase textile consumption. The increase in textile consumption is likely to increase water and energy use in the textile industry, as well as chemicals and total discharged waste. A lot of clean water is consumed, especially in finishing processes such as dyeing and printing, where dyestuffs and pigments are used. At the end of these processes, these waters are thrown into the environment. Both the clean water used in the processes and the water discharged after the processes pose a significant environmental risk [1-6]. Today, wastewater treatment methods include solvent extraction, ion exchange, precipitation, evaporation, reverse osmosis, membrane bioreactor, and membrane separation. However, these existing methods are very costly and low-efficiency methods in wastewater treatment [7,8].

Today, polyester fiber, a synthetic polymer widely used in home textiles, clothing industry and technical textiles, is used in many different forms such as yarn or fabric. Polyester is both economical and has superior performance properties in terms of mechanical, chemical, and thermal properties [9].

Ozone removes 99% of the color of polluted water. Ozone (0_3) has three oxygen-oxygen allotropes in its structure and has a high oxidation potential of 2.07 eV. (Figure 1). Ozone is used by various industries such as wood (pulp bleaching), textile, food, deodorization, water, and wastewater treatment due to its environmental, economic, and practical benefits. Ozone, which has a high oxidation potential, is also an effective disinfectant and plays a vital role in drinking water treatment. At the same time, ozonation does not require chemicals or uses less chemicals at low temperatures and does not produce waste. Ozone transforms into oxygen, its raw material, without leaving any residue. The irritant is a pale blue gas, reactive, heavier than air and cannot be stored or transported. Therefore, it should be produced and consumed in situ [10-29]

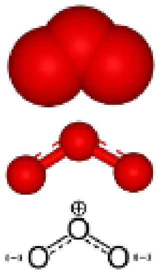


Figure 1. Ozone molecule structure[10]

The first of the two main methods for industrial ozone production is using Ultraviolet at 185 nm, and the second is the dielectric method known as Corona Discharge, and has different applications. The Corona Discharge method is widely used in laboratories and industrial studies [28]. A corona discharge creates ozone by applying a high voltage to a metallic grid sandwiched between two dielectrics. (Figure 2) The high voltage jumps through the dielectric to a grounded screen, creating ozone from the oxygen in the chamber. This occurs naturally during lightning storms [10, 28, 29].

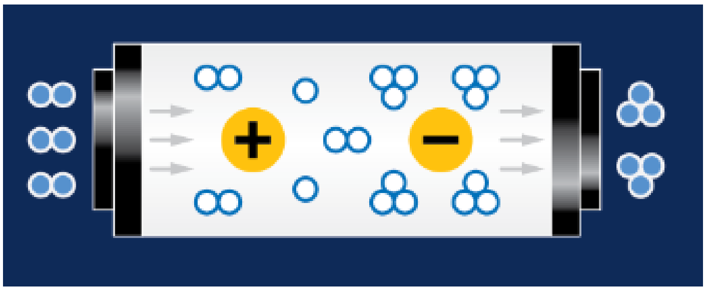


Figure 2. Ozone formation by Corona Discharge method [10]

In the ultraviolet method (UV), light, at a wavelength of about 185 nm (nanometers), creates ozone when it hits an oxygen atom. The O2 molecule splits into two oxygen (O to its atoms), and they combine with another oxygen molecule (O2) to form ozone (O3). (Figure 3)

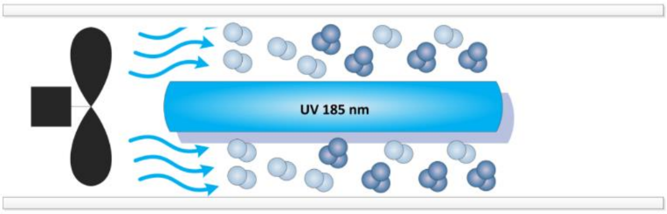


Figure 3. Ozone formation by Ultraviolet method [29]

This study investigated the ozone decolorization of wastewater from a sample textile dyehouse after disperse dyeing. For this purpose, the removal of color by the ozonation method, one of the advanced oxidation methods for wastewater recipes after dyeing, was investigated. The samples' color absorbance and COD (Chemical Oxygen Demand) values were examined, and the results were evaluated.

2. MATERIAL and METHOD

In this study, the effects of reference (untreated dyeing wastewater) and ozonated samples on color absorbance and COD values at different ozonation times were investigated. Ozone treatment was done in 10, 20, 30 minutes. In the experimental study, disperse dyeing wastewater samples taken from the plant were ozonated at 3 l/min ozone gas flow for color removal. Ozonation was done in 10, 20, 30 minutes and 3 times. The recipe used in disperse dyeing is given in Table 1, and the dyeing scheme is given in Figure 4.

Table 1. Chemicals and dyestuffs used in dyeing recipe

Item No.	Material	Quantity (g/l)
1	Dispersing agent	1
2	Acetic acid	1
3	Dispersing agent	0,07
3	Syncron yellow br cern	0,42
3	Syncron red tt	0,06
3	Syncron navy blue cern	0,47

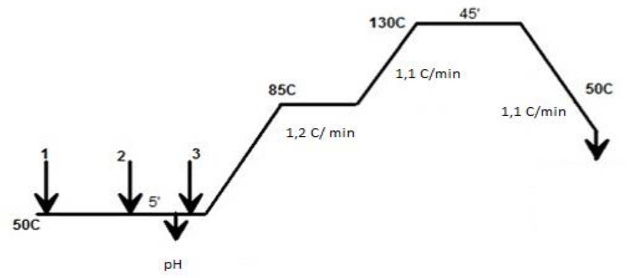
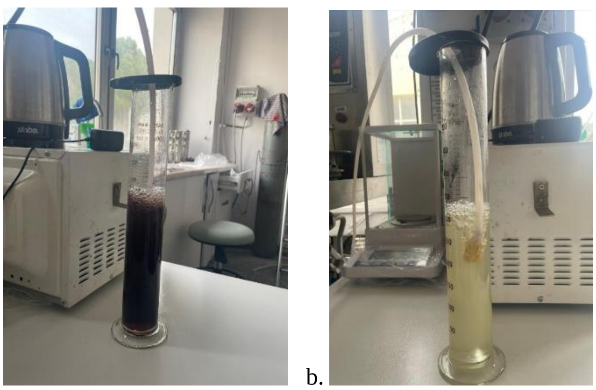


Figure 4. Dyeing diagram

The ozone generator shown in Figure 5 was used for wastewater treatment. For the ozonation process, 400 ml wastewater sample was ozonated in a beaker with the help of a diffuser. The visuals of the ozonation process of wastewater are given in Figure 6.

Figure 5. Ozone Generator



a. b.

Figure 6. Ozonation of sample wastewater: a. Colored wastewater b. Ozonation process

The standard titrimetric method measured the chemical oxygen demand values (COD) of bath solutions. Results are presented in mg. To test the color removal, the ADMI values of the samples were measured using the Spectroquant Pharo 300 brand spectrometer.

3. RESULTS AND DISCUSSION

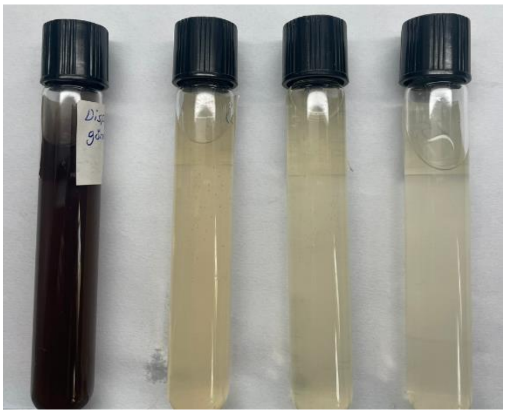
Within the scope of the study, the dyeing wastewater was ozonated for 10, 20, and 30 minutes. Absorbance measurement values and COD measurements of ozonated samples are given in Table 2 and Table 3, respectively. When Table 2 and Table 3 are examined, it is seen that both the color lightened and the COD value decreased as the ozonation time increased. The images of the samples before and after ozonation are given in Figure 7.

Table 2. Absorbance measurement values of ozonated samples

	Ozonation time (min)	Absorbance (based on 510nm)
Beginning	0	1,231
	10	0,672
Ozonation	20	0,642
	30	0,595

Table 3. COD measurement values of ozonated samples

	COD value (%)
Entrance	3520
After ozonation	3100



a. b. c. d.

Figure 7. Ozonated samples: a. initial wastewater b. 10 min ozonated wastewater c. 20 min ozonated wastewater d. 30 min ozonated wastewater

4. CONCLUSIONS

Finishing processes are very water-consuming, and the water discharged as waste at the end contains colored dyestuffs and many chemicals. Therefore, this polluted wastewater needs to be treated. This study investigated the color removal of disperse dyeing wastewater from a sample textile dyehouse with ozone after dyeing; it was subjected to an ozonation process at specific periods, and the results were interpreted. Color removal has been successfully achieved by ozonation in disperse dyeing wastewater.

The color became lighter as the ozonation time increased, and the COD value decreased. Ozone, one of the advanced oxidation methods, can be successfully used to separate aromatic hydrocarbons, pesticides, phenols, chlorinated hydrocarbons, dyeing water, and COD. The absence of sludge formation and toxic metabolites are among the essential advantages of ozonation. Reactive dyebath ozonation research is also planned in the future.

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