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Fe^{2+}/Persülfat ve Isı/Persülfat Yöntemleri ile Alcain Mavisi 8GX Giderimi

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Anahtar Kelimeler
Alcain Mavisi 8GX; İleri oksidasyon; Teksil atıksu arıtımı; Fe^{2+}/Persulfate; Heat/Persulfate.

Öz

Bu çalışma, Alcain Mavisi 8GX boya çözeltilerinin demir (II) iyonu ve ısı aktivasyonuna dayalı persülfat oksidasyonu ile sulardan arıtımını içermektedir. Giderim çalışmaları üç farklı sıcaklık (40 °C, 60 °C ve 80 °C) ve farklı boya:Fe^{2+}:persülfat molar dozlarında (1:1:1, 1:2:1, 1:1:0.5, 1:4:1) gerçekleştirilmiştir. Buna ilaveten, pH'ın giderime etkisi iki farklı pH koşullarında (3 ve 5.7) test edilmiştir. Sonuçlar, artan sıcaklığın ve persülfat dozunun Alcain Mavisi 8GX giderimini artırdığını göstermiş ve pH 3 koşullarında 90 dakika sonunda 80 °C sıcaklıkta % 91 giderilmiştir. Fe^{2+}/Persülfat yöntemi ise 1:1:1 boya:Fe^{2+}:persülfat molar dozunda pH 3 koşullarında 90 dakika sonunda % 73 boya giderimi sağlamıştır; 1:2:1 koşullarında pH 5.7'de ise % 72 giderim gözlenmiştir.

Alcıan Blue 8GX Remediation by Fe^{2+}/Persulfate And Heat/Persulfate

Keywords
Alcain Blue 8GX; Advanced oxidation; Textile wastewater treatment; Fe^{2+}/Persülfat; Heat/Persülfat.

Abstract

In this work, decolorization of reactive Alcain Blue 8GX dye solution were investigated by persulfate oxidation activated by ferrous ion and heat. Three different temperature (40 °C, 60 °C and 80 °C) were tested during heat activated persulfate and ferrous ion activated persulfate were tested under various molar ratios of dye:Fe^{2+}:persulfate ratio (1:1:1, 1:2:1, 1:1:0.5, 1:4:1). In addition, pH effect has been tested at ambient conditions (5.23) and pH of 3. The results showed that increasing the temperature and persulfate concentration was favorable to the degradation of the dye with decolorization efficiency as high as 91 % observed at 80 °C after 90 minutes of reaction at pH 3. The ratio 1:1:1 decolorized AB 8GX 73 % at pH of 3 and 72 % at pH 5.7 after 90 minutes.

1. Introduction

Since the beginning of 21 century, human being is responsible of Water pollution which is the most serious environmental issues and which causes odor problems and affects health. Among various kinds of water pollutants, residual dyes discharged from textile, paper industries and biomedical laboratories are universal and harmful to life due to their high chemical oxygen demand, heavy color and high toxicity, carcinogenicity and mutagenicity. (Hayat,2015). Activated persulfate provides a unique technology that can provide both oxidative and reductive processes to treat a wide range of contaminants that can be applied to soils and groundwater. As a result, persulfate is effective in destroying a wide range of organic contaminants and can address mixed contaminant plumes of petroleum products and chlorinated solvents. Alcian Blue 8GX is a cationic dye used to quantitatively determine glycosaminoglycans by forming insoluble complexes in solution. Alcian Blue 8GX can be used to determine proteins based on their Resonance Light Scattering by strongly enhancing the signals. It is useful as a bacterial stain, and as a dye for histiocytes and fibroblasts. Alcian Blue 8GX is used as a heteroglycan stain for neutral, sulfated and phosphated mucopolysaccharides and glycosaminoglycans in tissues such as cartilage and extracellular matrices. Once it becomes a wastewater, it is a recalcitrant water pollutant (Figure 1).

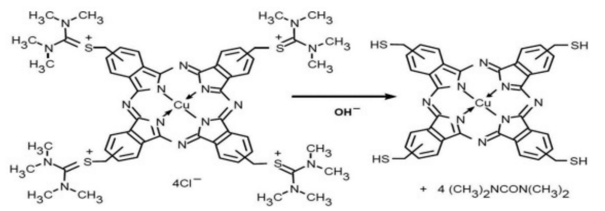

Figure 1. Structure of alcian blue 8G and its reaction with alkali to form an insoluble pigment (Scott,1972).

Various biological, chemical and physical methods are adopted for the treatment of dyes which is discharged as effluent from industries (Ayed,2021; Montañez-Barragán,2020; Agrawal,2020; Kristianto, 2020; Garvasis, 2020). Different methods are reviewed for the removal of dyes and it is noticed that adsorption (Zhang,2021; Radwan,2020) is found to be most economical among all methods. However, the treatment ends up with accumulation of the pollutants which required further treatment. Therefore, advanced oxidation methods regarded to be the best alternative for ultimate removal of recalcitrant pollutants (Wang,2020; Abdi,2020; Muneer,2020; Shi,2021). In this study, the efficiency of Fe^{2+}/Persulfate and Heat/Persulfate techniques were tested for Alcain Blue 8GX removal from water.

2. Materials and Methods

2.1 Materials

Alcian Blue 8GX (AB 8GX) purchased from Sigma (a blue powder soluble in water). Iron (II) sulfate heptahydrate ($FeSO_4$), Hydrochloric acid (HCl) purchased from Merck used for pH adjustment. Potassium peroxydisulfate ($K_2S_2O_8$) purchased from Merck (Germany) serve as source of persulfate anion. Deionized water produced by Sartorius Arium 61316.

2.2 Experimental and Analytical Methods

2.2.1 Experimental methodology

AB 8GX was prepared by measuring 0.05 g of AB 8GX with a weighing balance, pouring into a 1000 ml graduated flask and filled with deionized water. 250 ml of 50 mg/L AB 8GX was placed in an erlenmeyer flask and placed on a magnetic stirrer for continuously mixing. Required amount of persulfate (PS) was added and stirred for around 10min for dissolution. Final step of Fe^{2+}/Persulfate process was to add the required amount of Fe^{2+} and after the reaction started samples were collected for absorbance measurement at different time intervals. The final step of Heat/Persulfate process was placing the Erlenmeyer in pre-adjusted water bath with desired temperature. Similarly, samples were collected at specific time intervals to reveal the decolorization efficiency. In this study, acidic and ambient pH was used to test process efficiency. pH was adjusted by 0.1 M HCl and measured by WTW inoLab 720 type pH meter. pH was not controlled throughout the experiments and it was observed that acidic pH remained constant and ambient pH dropped to 2.9-3.0.

2.2.2 Analytical methodology

AB 8GX concentration was measured by UV-visible spectrophotometer (UV-2450 Shimadzu) at 616 nm.

3. Results

3.1 Efficiency of Fe^{2+}/Persulfate Process for AB 8GX Removal

Fe^{2+}/Persulfate process efficiency was tested under various Dye:Fe^{2+}:persulfate molar ratio and the experimental design in given in Table 1.

The experiments conducted under ambient pH 5.23 is given in Figure 2. It was observed that PS alone was able to decolorize AB 8GX at 46 % after 90 minutes. Addition of Fe^{2+} at 1:1:1 dose slightly increased the decolorization but there was high removal under 1:2:1 molar ratio which was 72 % after 90 minutes. The standard deviation average reported during (0 to 90 minutes) was ±2.91 %.

Table 1. Dye:Fe^{2+}:persulfate molar ratio for Fe^{2+}/Persulfate oxidation

Dye:Fe^{2+}:Persulfate Molar Ratio	AB 8GX (mg/L)	Fe^{2+} (mg/L)	Persulfate (mg/L)
1:1:1	50	200	2000
1:2:1	50	400	2000
1:1:0.5	50	200	1000
1:4:1	50	800	2000

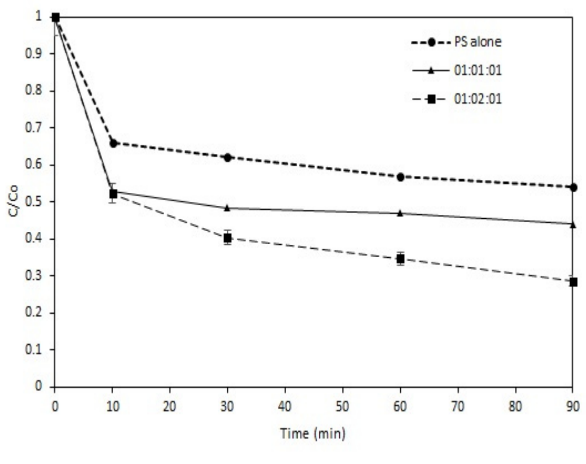

Figure 2. Decolorization of AB 8GX at 1:1:1 molar ratio

Persulfate alone and 1:2:1 molar ratio during Fe^{2+}/Persulfate process at pH 3 resulted with almost similar removal which were 63 % and 61 %, respectively. Under 1:1:1 molar ratio 73 % absorbance removal was recorded (Figure 3). In addition, other molar ratios namely 1:1:0.5 and 1:4:1 resulted with 65 % and 64 % removal at pH 3, respectively.

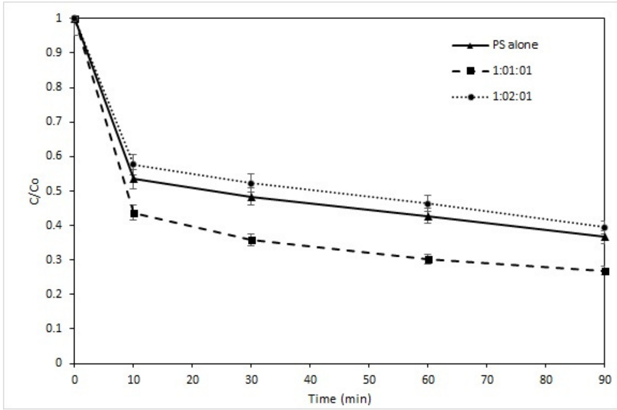

Figure 3. Decolorization of AB 8GX at pH 3 by Fe^{2+}/Persulfate

3.2 Efficiency of Heat/Persulfate Process for AB 8GX Removal

The experimental results under ambient pH conditions (5.7) are represented in Figure 4. It was observed that at 40 ^oC to 60 ^oC the percentage of degradation of AB 8GX was 72 % and 74 %, respectively. When the temperature raised to 80 ^oC, high decolorization 87 % was recorded. Under acidic pH conditions, the removal was increase to 91 % at 80 ^oC which can be attributed to higher generation of sulfate radicals.

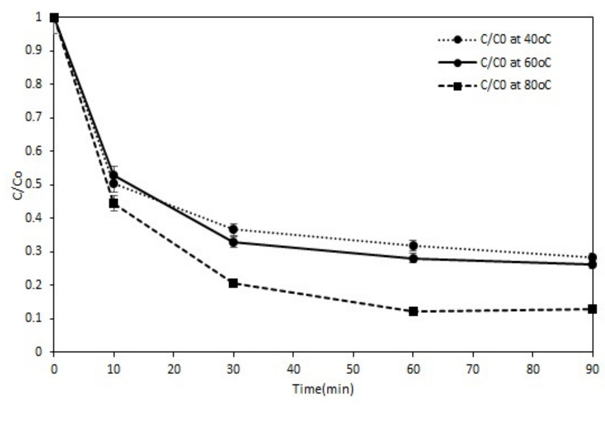

Figure 4. Decolorization of AB 8GX by Heat/Persulfate process at pH 5.7

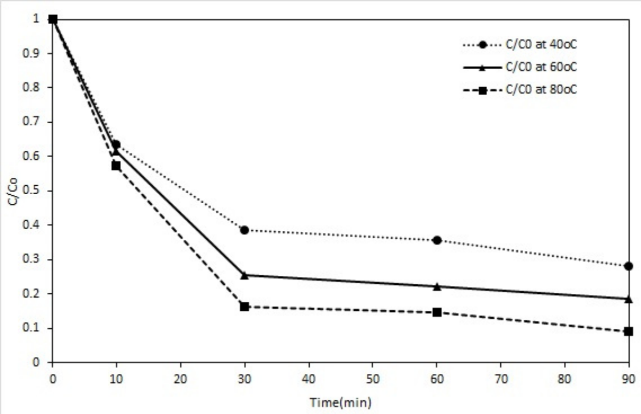

Figure 5. Decolorization of AB 8GX by Heat/Persulfate process at pH 3

4. Conclusion

Heat activated persulfate produced highly reactive and strong radical that was useful for decolorization of AB 8GX. It was observed that the combination of heat and persulfate was efficient for the degradation of AB 8GX at pH 3 than Fe^{2+}/Persulfate process. The highest removal was obtained at 80 °C and pH 3 which was 91 %. It is further recommended to measure mineralization and persulfate consumption to understand the persulfate oxidation mechanisms on particular topic.

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