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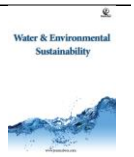

Research paper

Levafix blue color's visible light degradation utilizing Fenton and photo-Fenton procedures

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A R T I C l E I N F O

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A B S T R A C T

Synthetic colors are generally utilized in the industrial section for the chemical consistency and ease of synthesis. Micropollutants in water sources propose an actual hazard to the natural ecosystem and the health of humans (Kim and Zoh, 2016). The traditional procedures have been limited approaches for dealing by sewage pollutants. Furthermore, Advanced Oxidation Processes, according to the hydroxyls radicals' generation, have been discovered and indicated to be influential procedures for removing the poisonous chemical mixes. In this study, we have investigated Fenton and Photo-Fenton procedures' performance on the Blue levafix color degradation, as a substitution technique for the textile industry swage treatment. The irradiation intensity impact, initial color concentration, initial PH, iron concentration, nitrate, and organic material have been investigated. The whole irradiation investigations have been gained at 365 nm utilizing high-pressure mercury lamp (Philips HPW, 15 W). Levafix Blue color discoloration kinetics has been monitored by UV-Vis spectrophotometer analysis in the highest adsorbion wavelength (613 nm). So, under an acidic medium, it has been regarded that both procedures, Fenton and Photo-Fenton, could remove around 99 percent of contaminants. Nevertheless, the iron concentration growth causes the response prohibition.

Introduction

Blue Levafix is an artificial Azo color considerably utilized in material industriousness. Today, the colorful lifestyle forces huge color construction destined for various section (tissue, food, cosmetics, etc.). Newly, water deficiency sources are one of the essential highlighted issues near the world (Almazán-sánchez et al., 2017). The human daily needs implement the competitive industrial section growth, which make sewage loaded by highly concentration of micropollutants (Cotto-maldonado et al., 2017). About 100.000 tons of co;or every year are used and around a half of this amount is released in the environment (Fan et al., 2009; Layazi et al., 2014). The traditional treatment approaches has been tried and verified useless versus the micropollutants endurance (Saharan et al., 2014), (Cetinkaya et al., 2018). Therefore, the material industriousness are between the sections reliable of the steady organic contaminants production (Cotillas et al., 2018).

Advanced Oxidation Processes illustrate a new challenging approach for dealing with the refractory organic combinations (Bensalah et al., 2011), (Trovó et al., 2013). These techniques comprehended with their capability for generating hydroxyl radical which delivers high oxidation potential ($E^{\cdot} = 2.8\,V$) (Babu et al., 2019). The mixture of various Advanced Oxidation Processes improves the performance (Mazivila et al., 2019; Li et al., 2019). Many investigators have been fucosed photocatalysis procedure as a green

Approach for dealing with micropollutants reduction (EL Azzouzi et al., 2020). Furthermore, It has been confirmed that the Fenton procedure is one of the most uncomplicated and available technique (Possetto et al., 2018). Combining Fe^{2+} and hydrogen peroxide is comprehended for be an influential approach for the hydroxyl radical's generation in the dark Equation. 1 (Guzman et al., 2017).

The reaction of ferric ions is occure in the turning by H_2O_2 to reproduct Fe^{2+} Equation. 2, 3 (Verma and Haritash, 2019).

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + HO^\circ \quad (1)$$

$$Fe^{3+} + H_2O_2 \rightarrow Fe^{2+} + HOO^\cdot + H^+ \quad (2)$$

$$Fe^{3+} + H_2O_2 \rightarrow Fe^{2+} + O_2 + H^+ \quad (3)$$

$$Fe(OH)^{2+} + h\gamma \rightarrow Fe^{2+} + HO^\circ \quad (4)$$

$$H_2O_2 + h\gamma \rightarrow 2\,HO^\circ \quad (5)$$

Homogeneous Fenton-based reaction has demonstrated a high performance on organic pollutants reduction (Hassan et al., 2016). Photo-Fenton reaction utilizing UV light (Reddy and Devaraju, 2019) or observable radiation (Giannakis et al., 2018) have been accomplished in earlier study. However, the UV radiance have been reported to be a high effective irradiation source, the visible light remain to be a more suitable choice as endurable source (Zhou et al., 2017), (Tekin et al., 2018), (Zhu et al., 2018). The light radiance accelerates the hydroxyl radicals production by the ferrous and ferric ions photo-reduction Equation. 4, 5 (Pouran et al., 2015). Both procedures have been considered on various pollutants colors (Rashad et al., 2017) antibiotic (Giri and Golder, 2018), pesticide (Alalm et al., 2015) and bacteria (Giannakis et al., 2017).

In this investigation, the photolysis, Fenton and Photo-Fenton techniques efficacy has been studied. A kinetic investigation of factors affecting the response has been performed. A reaction situation optimization in low hydrogen peroxide concentration and ferrous ions has been considered.

Methodology

Chemical

Levafix Blue has been gained from Dystar when Sulfuric acid (98 percent), hydrogen peroxide, Iron sulphate (II) and humic acid have been bought from Sigma Aldrich. whole chemicals have been utilized as gained by not considering any more sanitization. Deionized water has been utilized for the preparation of whole solutions.

Photolysis system

The photolysis has been performed in a cylindrical stain steel container by a Pyrex reactor and 4 polychromatic (365 nm) low-pressure mercury lamps of 15 W /every installed in a symmetric situation.

Fenton and Photo-Fenton processes

The Fenton reaction investigation has been worked in a 100 ml jacket batch reactor at room temperature. In 100 ml of color solution 10 $mg.L^{-1}$, the pH has been firstly modified to 3 by sulfuric acid. Hydrogen peroxide and FeSO4 have been counted together. The reaction has been conducted in the dark and under a visible radiance system. The samples have been accumulated consecutively at various radiance times.

The kinetic investigation has been pursued using a UV-Vis spectrophotometer (model Selecta 3100) at Levafix Blue color highest wavelength λ_{max}= 613 nm with a 1cm quartz cell. The reduction rate has been estimated from the absorbance measure.

Discussion and results

The Levafix Blue degradation has been conducted utilizing photolysis, Fenton, and Photo-Fenton procedures. According to Figure.1, no considerable decay of the layer under photolysis therapy, after sixty minutes just sixteen percent of the reduction rate has been gained. Nevertheless, the Fenton in the dark procedure gained a sixty-four percent of reduction rate, and the photo-Fenton procedures has been approved to be the most useful therapy, which gained eighty-nine percent of color degradation in the first 5 minutes of therapy for attaining the complete decay with twenty minutes. Therefore, we essayed investigations through different empirical situations for optimizing the decay of Levafix Blue.

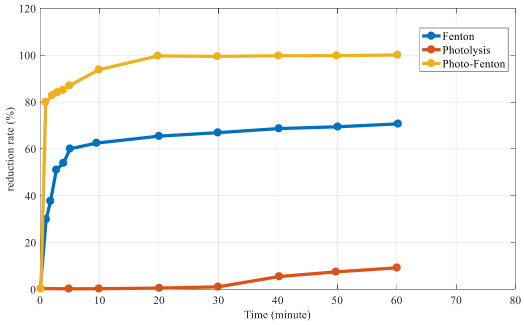

Figure. 1. Blue Levafix decay under various systems

The light intensity impact

Photolysis experimentations have been performed through various observable radiance severity: 0.98, 1.97, 2.96, and 3.94 μW/cm^2 by the purpose of investigating its influence on Levafix Blue color decay. As demonstrated in Figure. 2, the reduction rate advanced by the addition of visual light severity. After 2 days, the decay rate gained 22, 47, 51, and 70 percent for the different utilized severities orderly. Therefore, all upcoming photo-Fenton investigations have been recognized through the maximum light severity.

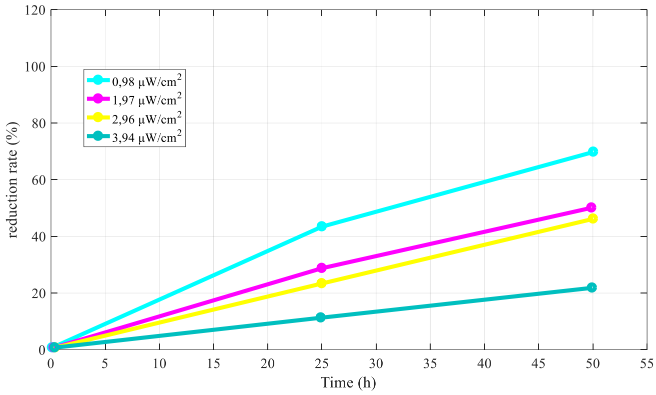

Figure. 2. Radiance severity impact on Blue Levafix decay

Primary PH impact

For investigating the primary PH impact on Fenton and Photo-Fenton procedures efficiency, and investigations have been identified in various PH situations: 3, 7, and 9. Figure. 3 indicated that for both procedures, the optimal situations have been in an acidic medium, i.e. PH 3. The Levafix Blue reduction rate attained 70 percent and 98 percent for Fenton and Photo-Fenton orderly. Nevertheless, neutral and alkaline PH medium have negatively influenced the reaction. The inconsistancy of ferrous ions and hydrogen peroxide at alkaline PH reduces the fixed concentration of hydroxyl radicals and therefore stimulates the construction of ferric ions complexes which form a block of particles and light interaction.

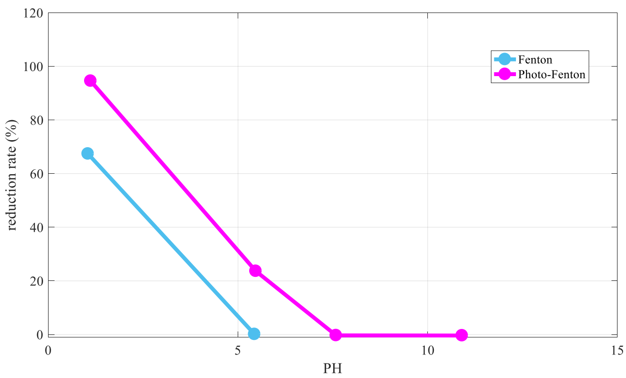

Figure. 3. Primary PH of solution impact

Primary color concentration impact

The primary contaminant concentration has been performed as demonstrated in Figure. 4. The concentration differed from ten to a hundred $mg.L^{-1}$. Both procedures have confirmed a high decay rate from ten to fifty $mg.L^{-1}$. A little reduction has been seen for Fenton reaction beyond 50 $mg.L^{-1}$ concentration owing to the molar ratio of oxidant as shown in the alike investigation (Lucas and Peres, 2006). Thus, the essential color concentration underestimates the performance of the reaction and needs for increasing the oxidant dosage (Rache et al., 2014).

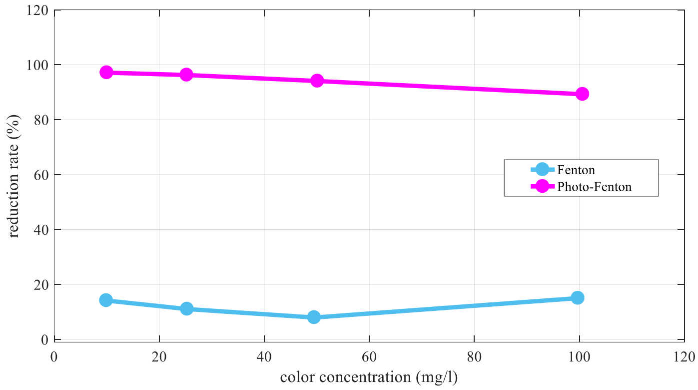

Figure. 4. Primary color concentration impact

H_2O_2 concentration impact

Hydrogen peroxide is comprehended for its high oxidant potential that has been mostly introduced in prior studies. In this study, the study of the effect of hydrogen peroxide has been experimented with in lower doses: 0.5 percent, 1 percent, 2 percent, and 3 percent. Figure. 5 verified that procedures performance and the growth of hydrogen peroxide doses have risen in similitude for both procedures after sixty minutes. The hydrogen peroxide has an essential role in hydroxyls radicals productions •OH. The light radiance thoroughly stimulates the reaction. For both procedures, the decay rate difference has been less considerable.

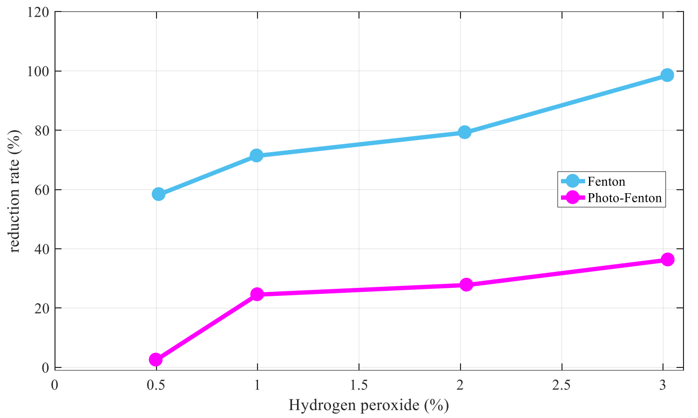

Figure. 5. Hydrogen peroxide impact

Ferrous ions concentration impact

Iron is the flagship component of the Fenton reaction. Hydrogen peroxide and PH have been investigated at 3 percent and PH 3 orderly. 6 concentrations of $FeSO_4$ has been experimented on Fenton and Photo-Fenton procedures 1mM, 10mM, 50mM, 100mM, 150mM and 200mM. As demonstrated in Figure 6, a high decay of Levafix Blue gained 70 percent from 10mM to 100mM ferrous ions concentration for Fenton procedures in the dark. However, the decay rate utilizing Photo-Fenton procedure regarded 98 percent at low iron sulfate (II) concentrations from 10mM to 100mM. The visible light radiance improved the efficiency of the Fenton reaction.

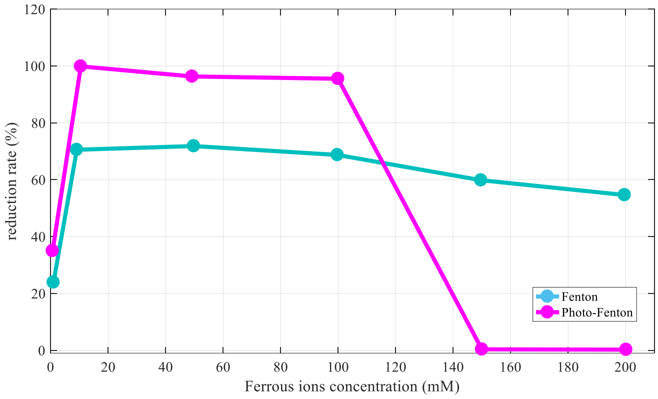

Figure. 6. Ferrous ions concentration impact

Above 100mM for both procedures, an evident reduction of the reduction rate has been regarded. Around 68percent at 150mM to 200mM for Fenton reaction. While no reduction has been regarded for the Photo-Fenton procedure above 150mM concentration. An extra ferrous ions concentration dose causes a prohibition impact on the procedures. The FeSO4 acts as hydroxyl radicals scavengers in a high concentration as noted in the literature earlier investigations (Verma and Haritash, 2019). The optimum concentration of ferrous ions as found in this investigation has been 50mM for Fenton reaction in the dark and 10mM for Photo- Fenton procedure.

Impact of Humic acid

Humic materials have been a debated issue for investigators for many years ago. Their chemical structure as macromolecules gives a challenge for scientific application investigations. With carboxylate, phenolic and carbonyl functional groups include, the Humic materials have the capability to form a new assembled with iron (F. Wang et al., 2016). Furthermore, humic acids have indicated a high catalytic action in the synthesis response of some matters (Kļaviņš et al., 2001; Wang et al., 2019; Wei et al., 2017). The impact of these combinations on Fenton and Photo-Fenton procedures has been profoundly investigated in the addition to 50mg.L-1 of humic acid. Figure. 7 showed that the utilization of these materials has increased the reduction rate of Levafix Blue that reaching 100 percent of decay in tem min for Photo-Fenton reaction.

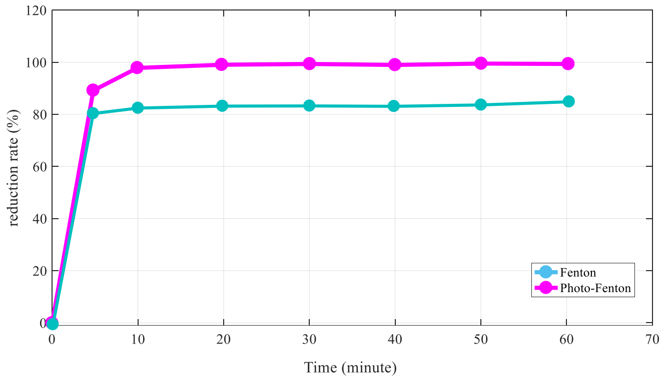

Figure. 7. Humic acid on Blue Levafix degradation effect

Nevertheless, for Fenton reaction in the dark, the decay rate attained 83percent in ten min and remained constant for sixty minutes of reaction. The humic acid materials assume photocatalytic behavior under light radiance.

The dark and Photo-Fenton procedure mixed with visible light has proved its high performance. Acidic medium, 3 percent of hydrogen peroxide, and a lower concentration of ferrous ions have been indicated as optimal situations for both procedures. An inhibition impact has been detected by overdoses of ferrous ions concentrations until a total obstacle of reaction, particularly in the Photo-Fenton reaction. According to these outcomes, both procedures demonstrate a remarkable capability for removing contaminants as azo colors.

Conflict of interest

The authors declare that they have no conflict of interest.

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