HOMOGENEOUS CATALYSIS THROUGH FENTON PROCESS FOR DEGRADATION OF REMAZOL BLUE DYE IN MODEL WASTEWATERS FROM TEXTILE INDUSTRY

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ABSTRACT

Effluents of textile industry have strong environmental impact on waterways, because of its toxicity, high load of organic compounds, turbidity and coloring capacity. The latter is responsible for the decrease in oxygenation capacity of water bodies because color hinders the occurrence of photosynthesis by aquatic plants.

Azo dyes are one of the most frequently used dyes in textile industry. This work aims to contribute to define a process that is simple, cheap, fast and effective for the degradation of Azo dyes present in the wastewater of textile industry [1].

Ramazol Blue RGB was selected as model Azo dye. The degradation of the same colorant was already studied in the group using another advanced oxidation process (AOP) methodology by heterogeneous photocatalysis, using as catalyst to obtain the OH radicals, the semiconductor titanium dioxide. [2] Now for degradation method was used an AOP in homogeneous media: Fenton methodology. According to this method the degradation of the chromophore group of the colorant is accomplished by the action of strongly oxidizing hydroxyl radicals OH, produced from the reaction of iron II salt with hydrogen peroxide (Fenton reagent) [3]. Despite being a method known for a long time, Fenton reagent is still little used at industrial level. The achieved results present good perspective for a wider use in the future.

Keywords: Advanced Oxidation Processes; Fenton Reagent; iron II Catalyst; Hydroxyl radical; Textile Dyes; Azo Dyes; Ramazol Blue; Textile Effluents

1 - INTRODUCTION

This work aims to optimize a degradation process for water containing Remazol Blue dye by Advanced Oxidation Processes based on Fenton methodology [1,3,4,5,6]. To this dye is intended to define a process of elimination or breakdown into simpler and environmentally harmless components that is fast, effective and easy to implement on an industrial scale, with the ultimate goal of degrading the dye present in industrial effluents, using small quantities of reagents in a simple, quick and very effective process [1,5,6]. For the optimization of the degradation process several tests were performed namely the balance between the volume of Hydrogen Peroxide and the mass of the iron salt II, the use of different iron salts, the pH of the medium analysis, the dye Concentration and the use of distillated and lake water were investigated [6].

2 - EXPERIMENTAL
The tests were performed with a solution of Remazol Blue RGB in water (20mgL\(^{-1}\)), 30% hydrogen peroxide (Panreac) and with FeSO\(_4\)-H\(_2\)O (José Manuel Gomes dos Santos) as the source of Iron (II) salts. Assays were performed using samples of 100 mL of a solution 20mgL\(^{-1}\) of Blue Remazol RGB dye (See Figure 1) in distilled water, irradiate and in the dark and samples collected at 0, 1, 5, 10, 15 and 20 minutes after the addition of reagents. Then the degradation of the samples (irradiated by an 150 watt halogen lamp) was followed by its UV-VIS absorption spectrum (Cary 100).

![Figure 1 – Addition of reagents](image)

### 3 - RESULTS AND DISCUSSION

For the optimization of the degradation process several tests were performed namely the balance between the volume of Hydrogen Peroxide and the mass of the iron salt II, the use of different iron salts, the pH of the medium analysis, the dye Concentration and the use of distilled and lake water were investigated [6]. Figure 2 presents the absorption spectra of the dye prior degradation.

![Figure 2 - UV-visible absorption spectrum of Blue Remazol RGB in water (20 mgL\(^{-1}\)), pH = 3.](image)

It was observed that the degradation process for Remazol Blue RGB with 7.5 mg FeSO\(_4\)-H\(_2\)O is not complete regardless of the amount of added H\(_2\)O\(_2\). Then the degradation was tested varying the amount of Fe (II) ions and varying the amount of H\(_2\)O\(_2\), in order to obtain the best ratio between the two components of Fenton’s Reagent. The best degradation was obtained for 20 mg of FeSO\(_4\)-H\(_2\)O and 30µL of H\(_2\)O\(_2\) in only 20 minutes.

Acid pH Tests were conducted (pH = 3 and pH = 6) and to validate the use of acidic pH, were performed tests even at alkaline pH (pH = 11) (See Figure 3).
Figure 3 - UV-visible spectrum of molecular absorption of Blue Remazol RGB (20 mg/L) in water, before (blank) and after treatment with Fenton reagent, using iron II salt (20 mg) and 30 µL of H$_2$O$_2$ (30 µL) at pH = 3, pH = 6 and pH = 11.

To assess the strength of the method, also solutions with higher dye concentrations (40mg/L and 80mg/L) were tested, maintaining the ratio between the components of Fenton’s Reagent. We observed that the degradation process is always very effective, with degradation rates higher than 90%. (see Figure 4).

Figure 4 – Degradation rates at different dye concentrations in Remazol Blue RGB (20mg/L, 40mg/L, 80mg/L).

After all the test, the best results found for Ramazol Blue RGB in distillated water were a 98% degradation rate, using 20 mg of Iron II Sulphate Heptahydrate and 30 µL of hydrogen peroxide added to 100 ml of the reaction medium at pH=3 after only 20 minutes of degradation.

The latter degradation conditions were also tested for the dye dissolved in lake water and we observed a strong decrease in the efficiency of the process, mainly at pH=6. (See figure 5)

Figure 5 - UV-visible spectrum of molecular absorption of Blue Remazol RGB (20 mg/L) in lake water at pH=3 and pH=6.

4 - CONCLUSION

The degradation of Remazol Blue RGB in water by the Fenton process proved to be a very fast process compared to the photodegradation of the same dye using heterogeneous catalysis with TiO$_2$, were degradation rates of this order of magnitude usually needed much longer treatment times. For several conditions, with Fenton, were observed degradation rates always exceeding 90% in laboratory conditions (distillated water), which is a good prospect for defining a method to be tested in pilot scale. The best degradation results were recorded with a mass of iron II sulphate heptahydrate salt 20 mg, 30 µL Hydrogen Peroxide added to 100 mL of the reaction medium and the pH near 3 (degradation rate of 98%). However for natural water the efficiency of the process was much lower probably due to the presence of ions that contribute to hydroxyl radical trapping and deactivation. It was also confirmed the method consistency for
more concentrated solutions maintaining the relationship between the iron II salt mass and volume of hydrogen peroxide.

The question of decrease of efficiency in natural waters can be addressed adjusting the ratios of degradation for these waters (in a similar way to the previously done for distilled water) and conjugating the use of irradiation together with Fenton methodology, in a process known as photoFenton. We intend in a near future to conduct tests using a CPC reactor, in order to check the consistency of the method for natural water on a pilot scale when co-added together with solar irradiation.

5 - BIBLIOGRAPHY


