Influence of NaCl on the photocatalytic activity of CaTiO3 in the degradation of red dye

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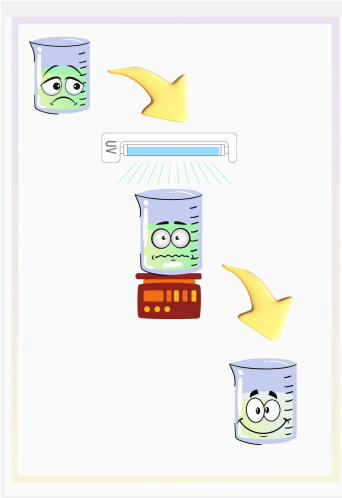
G.A. Kokubun[1], *A.C. Prodocimo*[1], *A.M.C. Ferrari*[1], *V.A.S. Ribeiro*[1], *C.D. Moura-Nickel*[1], *R.G. Marques*[1] *(1) Federal Technological University - Paraná, Rua Marcílio Dias, 635, Apucarana, Brasil, gabriellakokubun@alunos.utfpr.edu.br.*



Photocatalysis is a growing technique for treating effluents, especially in the textile industry, which is known for generating effluents rich in dyes. Due to the molecular complexity and chemical stability of these dyes, conventional treatment methods often fail to remove them effectively. In this context, this study aimed to explore photocatalysis using CaTiO3, both in the presence and absence of NaCl. The aim of including NaCl was to investigate its impact on photocatalytic activity during the degradation of a red dye. Spectrophotometric analysis, which allows the identification and quantification of chemical compounds by measuring the light absorbed by the sample, was used to assess the effectiveness of the dye removal. The degradation photocatalytic have approximately 55% degradation of the red dye was obtained with the CaTiO3 catalyst in the presence of NaCl, while CaTiO3 alone degraded around 59%. The results show that the presence of NaCl did not have a positive impact on the photocatalytic activity of CaTiO3

Introduction

The textile industry generates major environmental impacts, either because of the high consumption of fresh water in its processes or because of the incorrect disposal of its effluents, which can contain high concentrations of polluting substances that end up in contact with water, reaching reservoirs and even groundwater, which directly harms the living beings that inhabit these environments. Textile effluents are mainly wastewater discharged during the dyeing and textile treatment stages [1].

According to Araújo [2], ecological concern about waste from this type of industry has been growing, which has resulted in the need to develop new sustainable and low-cost treatment processes for these effluents. Advanced Oxidative Processes (AOPs) use advanced chemical reactions, such as the generation of hydroxyl free radicals, which have the ability to oxidize and decompose a wide range of persistent organic pollutants.

Heterogeneous photocatalysis is a POA that has stood out as an innovative and effective technology for the treatment of textile effluents, not only in reducing coloration, but also in reducing toxicity, contributing to the protection of the environment and public health [3].

CaTiO3 stands out as an effective photocatalytic agent due to its perovskite structure and its ability to generate electrons and gaps under illumination, which can participate in redox reactions that can lead to the degradation of dyes and other organic pollutants into less harmful components such as water and carbon dioxide. In addition, CaTiO3 has a wide light absorption range, which makes it effective under a variety of lighting conditions [4].

In this study, we will focus on the application of CaTiO3 as a catalyst in photocatalysis and the influence of NaCl on photocatalytic activity for the degradation of a red dye in textile effluents. We hope that our results can contribute to the development of more effective and sustainable water treatment technologies and open up new avenues for research into photocatalysis.

Material and Methods

Initially, the standard curve for the Quimacryl GTL-PO red dye was constructed in order to find the concentration that best matched the desired absorbance, 1. After this, a mother solution of the red dye was prepared with a concentration of 0.0625g/L, and a sample of this was sent for spectrophotometric analysis. Next, 1g of NaCl and 0.1g of CaTiO3 synthesized by the research group were added to 0.1L of this dye solution. This new solution was then stirred for 30min in a reactor, followed by another spectrophotometric analysis. In the same reactor, UV light was activated and spectrophotometric analyses were carried out every 30min, these samples being filtered through 45µm millipore membranes before each analysis. The experiment was completed after 120min.

The photocatalytic experiments were carried out using a photocatalytic reactor consisting of a multiple magnetic stirrer (Model SP-10015/S - Splabor) and four OSRAM Germicidal PURITEC HNS 15W G13 ultraviolet lamps. The samples were analyzed using UV-Vis spectrophotometry (UV-M51 BEL-Photonics).

Results and Discussion

The standard curve for the dye is shown in Figure 1.

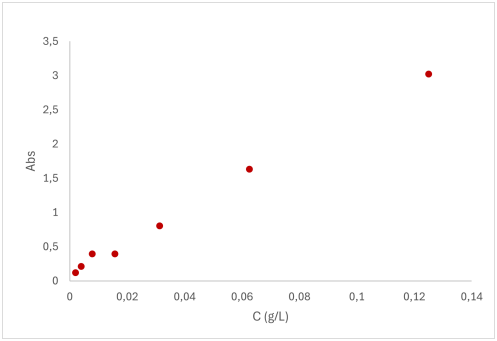


Figure 1. Standard curve of the red dye Quimacryl GTL-PO.

From the Lambert-Beer Law, it is possible to find the relationship between concentration and absorbance, shown in Equation 1.

$$Abs = 23.405 * C + 0.1125 \quad (1)$$

After 30min of stirring, the absorbance of the dye solution containing CaTiO3 and NaCl dropped to 1.4833, while that of the second dye solution containing only CaTiO3 dropped to 1.4129. Similarly, the concentration went from 0.0625g/L (mother solution), to 0.0586g/L and 0.0556g/L, following the order previously mentioned.

A comparison of the Abs/Abs0 curve as a function of time for each catalyst is shown in Figure 2.

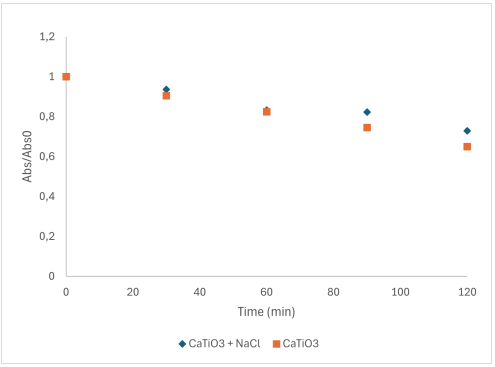


Figure 2. Comparison of catalyst performance.

At the end of 120min of photocatalysis with and without NaCl, the concentration was 0.0263g/L and 0.0229g/L, respectively. Comparing these final concentrations with those measured at the start of photocatalysis, approximately 55% degradation of the red dye was obtained with the CaTiO3 catalyst in the presence of NaCl, while CaTiO3 alone degraded around 59%.

Generally, photocatalytic degradation processes they follow the Langmuir-Hinshelwood kinetic expression, obeying pseudo first order kinetics. In this case, the same behavior was observed. A specific reaction rate of 0.0034min^{-1} was found for CaTiO3 and 0.0025min^{-1} for CaTiO3 with saline solution.

Conclusions

Although photocatalysis was not as efficient in both situations, the results show that the presence of NaCl had no positive impact on the photocatalytic activity of CaTiO3, since the degradation efficiency was higher when only calcium titanate was used, with just over 40% of the dye degraded.

Acknowledgments

For UTFPR.

References

[1] KUNZ, A. et al. New trends in textile effluent treatment. Química Nova, v. 25, n. 1, p. 78-82, feb. 2002.

[2] ARAÚJO, K. S. et al. Advanced oxidative processes: a review on the fundamentals and applications in the treatment of effluents and industrial wastewater. Ambiente e Água - Uma Revista Interdisciplinar de Ciência Aplicada, v. 11, n. 2, p. 387, 15 abr. 2016.

[3] MEDEIROS, M. et al. APPLICATION OF HETEROGENEOUS SOLAR PHOTOCATALYSIS TO EFFLUENT FROM TEXTILE INDUSTRIES. [s.l: s.n.]. Available at: <https://www.ibeas.org.br/congresso/Trabalhos2016/II-032.pdf>. Accessed on: 27 Mar. 2024.

[4] PEREIRA DE ALMEIDA, F.; LIMA, A.; LIMA, M. Use of CaTiO 3 in the photocatalysis of methylene blue Use of CaTiO 3 heterogeneous photocatalysis of methylene blue RESUMO. [s.l: s.n.]. Available at: <https://eventos.utfpr.edu.br/sicite/sicite2020/paper/viewFile/7041/3179>. Accessed on: 27 Mar. 2024.