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Synthesis of $NiFe_2O_4$ and $FeTiO_2$ Photocatalysts for Rhodamine B Degradation via Photo-Fenton Catalysis.

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ABSTRACT

The main objective in this study is to investigate the catalytic activity and specific properties of $NiFe_2O_4$ and iron-doped titanium dioxide ($FeTiO_2$). To assess their effectiveness, we employed the photo-Fenton process to examine the decomposition Rhodamine B from water under irradiation. However, the results obtained under the selected experimental conditions did demonstrate a significant improvement in pollutant degradation. Intriguingly, when the catalysts were employed individually, the kinetics of photodegradation exhibited promising outcomes.

Keywords: Photo-Fenton process, spinel, rhodamine b, dye degradation, kinetics.

1 Introduction

The use of chemicals has increased over time, due to industrial activities, resulting in liquid and gaseous discharges that significantly impact the environment and public health. Various physical, chemical, and biological processes have been developed to eliminate these pollutants. However, certain pollutants exhibit high stability, making their degradation challenging. Various treatment techniques can be employed to purify effluents, the advanced oxidation processes (AOPs) have emerged as one of the practical ones. AOPs operate under ambient temperature and pressure, facilitating the generation of highly reactive HO• radicals in an aqueous medium using a primary oxidizing reagent. This technology is particularly effective in removing pollutants that are resistant to destruction through other treatment methods such as carbon adsorption, reverse osmosis, and coagulation-flocculation [1]. Unlike these techniques, which merely transfer pollutants from one phase to another without destroying them, AOPs offer the advantage of complete degradation. The efficiency of AOPs depends on several parameters, including oxidant concentration, UV light intensity, pH, and temperature [2]. Photo-Fenton, is an advanced oxidation process that extends the Fenton process, is favored over other alternatives due to its ability to achieve high reaction yields while maintaining low processing costs. This advantage is primarily attributed to the efficient utilization of sunlight as a photon source [3].

2 Experimental

2.1 Synthesis of $FeTiO_2$ and $NiFe_2O_4$

In our study, we employed two precipitation methods to prepare the iron-doped titanium dioxide. These methods were utilized to ensure the successful incorporation of iron into the titanium dioxide matrix, resulting in the desired composition and properties of the material [4]. The concentration of Rhodamine B during the photocatalytic process was measuring using a UV-vis spectrophotometer at a measuring wavelength of 554 nm [5].

2.2 Photodegradation experiments

The photodegradation of Rhodamine B was conducted in 500 mL of distilled water at room temperature, with each beaker containing 0.05 g of the respective catalyst. A specific quantity of H_2O_2 was added to each beaker, and the pH of the solution was adjusted using a few drops of 2N nitric acid. To ensure proper

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equilibration, the beakers were kept in a dark environment for 30 minutes. Subsequently, the photodegradation process was initiated by turning on the UV lamp.

3 Results and Discussion

Figure 1 depicts the photodegradation process of Rhodamine B using spinel nickel ferrite as a photocatalyst under UV light conditions and titanium dioxide prepared by the first method and titanium dioxide prepared by the second method, with a pH of 2.96 and a temperature of 24.2°C. The results show same effects of the catalysts on the degradation of Rhodamine B within the time interval of 0 to 40 minutes. Notably, when the catalyst is prepared using the first method (pH=3, T=25.1°C), the degradation of Rhodamine B exhibits a discontinuous pattern. Despite slight variations in the curves, all catalysts demonstrate high efficacy in degrading Rhodamine B which is performed in the following order : 74,18% ($FeTiO_2$-1) > 68.57% ($FeTiO_2$-2) > 67.21% ($NiFe_2O_4$).

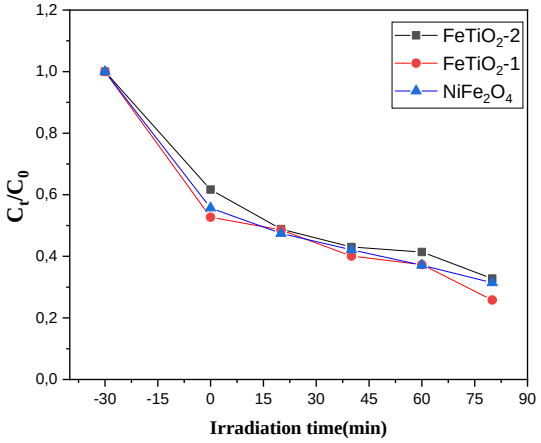

Figure 1: Photo-Fenton degradation curves of RhB over the photocatalysts.

4 Conclusions

The results presented in this study are consistent with those reported in the literature. Our findings demonstrate the highest yield using nickel-based spinel, $NiFe_2O_4$, and iron-doped titanium dioxide, $FeTiO_2$, with a significant degradation of Rhodamine B.

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