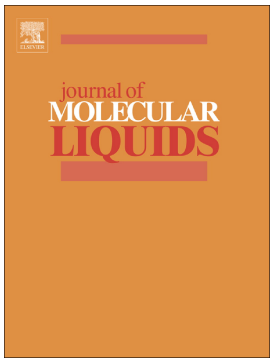

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Sonochemical preparation and photocatalytic application of Ag-ZnS-MWCNTs composite for the degradation of Rhodamine B under visible light: Experimental design and kinetics modeling

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ABSTRACT

Composite of silver, zinc sulfide and multi-walled carbon nanotubes (Ag-ZnS-MWCNTs) was synthesized sonochemically using a direct immersion ultrasonic probe and characterization results (XRF, XRD, FE-SEM, EDX, and DRS) showed the success of composite synthesis. The photocatalytic activity of the Ag-ZnS-MWCNTs composite was tested using Rhodamine B (Rh-B) degradation under visible light irradiation. The effects of four key operational variables (Rh-B and Ag-ZnS-MWCNTs concentration, pH, and visible light exposure time) on treatment process were analyzed and optimized using Response Surface Methodology (RSM). The maximum removal efficiency of 87.53% was obtained at optimum condition (4 mg L^{-1} of Rh-B, 1.25 g L^{-1} of Ag-ZnS-MWCNTs, at pH=9, and an irradiation time of 116 min). In continuation of our investigations, a novel kinetics model was developed based on the proposed mechanism for the photocatalytic process. Eventually, byproducts produced within the photocatalytic degradation of Rh-B dye were identified by gas chromatography–mass spectrometry (GC-MS) technique.

Keywords: Sonochemical; Visible light photocatalysis; Ag-ZnS-MWCNTs; Rhodamine B; RSM; Kinetics modeling.

1. Introduction

Today, the storage and preservation of natural resources are important priorities. It is necessary to access healthy drinkable water for the protection of human health and sustainable development of societies. The importance of water has been discussed and confirmed in different scientific conferences and literature on health and development [1,2]. Environmental concerns are raised when much of the water is converted to detrimental wastewaters with low degradability. It is well documented that wastewaters containing organic dyes cause serious problems to flora and fauna [3-5]. One of the extensively used colorants in the industries is xanthine Rhodamine B (Rh-B) dye, which carcinogenic and mutagenic properties of this compound has been medically proven due to its poisonous, high stability, and aromatic structure [6,7]. Therefore, it is mandatory to reduce these compounds before entering the environment. Diverse biological and physicochemical strategies have long been employed to remove color contaminants. These methods have some drawbacks such as the bio-refractory of most dyes or producing sludge and transferring the dye from the liquid to the solid phase [8-11]. Bearing this in mind, a method known as advanced oxidation processes (AOPs) which is based on the production of highly active species such as hydroxyl radicals, was proposed, which rapidly and selectively oxidizes a wide range of organic pollutants [12]. Photocatalysis, which is a pioneering method in AOPs, is an extensively studied field in recent years. The controversial issue in this method is the use of efficient catalysts and affordable energy