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Photocatalytic Decolorization of Red Dye in Aqueous ZnO-TiO_2 Suspensions

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Abstract. The photocatalytic decolorization of aqueous solutions of Direct Red 27 in the presence of various amounts of semiconductor powder suspensions has been investigated in a batch reactor with the use of artificial light sources. ZnO and TiO2 have been found the most active photocatalysts; the effect of catalyst loading and type on the reaction rate was optimized for maximum degradation. The results imply that 1:1 ratio is proper for the photocatalytic removal of Direct Red 27. In addition, the effects of particle size and surface area were examined in this photocatalytic process. The results showed that the decolorization efficiency increases with increase in surface area, and decrease in powder size. The efficiency is related to mechanism of reactions on the active sites of the catalyst surface and broad adsorption of compounds with different band gaps.

Introduction

In recent years, problem of wastewater became very important both for the sake of increasing amount and its variety [1]. Removing colour from waters is often more important than other colourless organic substances, because the presence of small amounts of dyes is clearly visible and influence the water environment considerably [2]. Advanced oxidation process (AOPs) generates a powerful oxidizing agent hydroxyl radical, which completely destroy the pollutions in wastewater quickly and nonselectively [3]. Among AOPs, semiconductor photocatalysis has emerged an important destructive technology leading to pollution treatment. Combination of semiconductors such as metal oxides (TiO2, ZnO and Fe2O3) and metal sulphides (CdS and ZnS) as photocatalysts with UV light can be used for degradation of a wide range of dye contaminations [4]. Rutile and anatase (TiO2) have been used in most photocatalytic investigation. Both the phases are semiconductors with a bandgap of 3.23 eV for anatase and 3.00 eV for rutile [5]. Under UV light illumination, they create an electron hole pairs. The pairs migrate at the surface, if trapped by titanium and OH surface groups, form free radicals. These radicals cause AOP [6]. The other semiconductor is ZnO, The biggest advantage of ZnO in compare with TiO2 is that, it absorbs over a larger fraction of UV spectrum and corresponding threshold of ZnO is 425 nm [7]. To obtain a good property, many structural parameters are important such as particle size, crystalline quality, morphology, specific surface area, surface state, etc [6]. Another way to enhance the photocatalytic activity is the coupling of two semiconductors [8]. This way is suitable to achieve amore efficient charge separation, an increased lifetime of the charge carriers, and an enhanced interfacial charge transfer to adsorbed substrate [9].

In the present work, we describe results of our recent experiments on ZnO/TiO2 systems and their photocatalytic decolorization behaviour.