National Congress on
Chemistry and nano-chemistry,
from research to national development
کنگره ملی
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محل برگزاری
۳ نیروی ۱۳۹۶
حضور و مشارکت ۵۰ دانشگاه ،انجمن و رسانه فعال علمی در
بزرگترین رویداد داخلی حوزه شیمی و نانو شیمی کشور
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شماره مجوز ISC
۹۶۱۷۰-۶۰۳۰۱

Photocatalytic Degradation of Dye Using UV/ZrO_2

Zahra Faraji Chamzini[1,*], Sohrab Fathi[2], Mohsen Mansouri[3]
[1] Department of Chemical Engineering, Kermanshah Branch, Islamic Azad University, Kermanshah, Iran
*corresponding author : zfput@yahoo.com
[2] Department of Chemical Engineering, Kermanshah University of Technology, Kermanshah, Iran
[3] Department of Chemical Engineering, Ilam University, Ilam, Iran,

ABSTRACT

In this work, the zirconium dioxide nanocatalyst was primed by sol-gel method for degradation of Acid Red 40 (AR 40) solution in water. The effectiveness of the treatment method applied for the degradation of AR 40 based on an advanced photocatalytic oxidation process was investigated. The three various key parameters were optimized by using response surface modeling namely: pH, ZrO_2 concentration and the initial AR 40 concentrations. The optimized values were obtained at the PH (11), ZrO_2 concentration (0.04 g/L), and the initial AR 40 concentration (18.11 mg/L).

Keywords: *Photocatalytic degradation; ZrO_2 catalyst; response surface modeling.*

1. INTRODUCTION

Necessity for using of effective operations of remove and separation is necessary because of concerning for water environment contaminations (Shan et al., 2010). Most common method such as physical (like absorbance), biological, chemical methods and combination of these methods were used in refining of polluted wastewater, so for. Common processes are not appropriate for refining of these wastewaters because these kind of methods cause a defect destruction of contamination and just transfer from one phase to another phase as well as we have a second contamination. As a result, applying chemical processes based on Oxidation Process has been considered. Researchers in order to improvement the process of degradation of contamination try to use Advanced Oxidation Process (AOPs) (Rajeshwar, et al., 2008). In the last three decades, advanced oxidation processes have been an efficient method for degradation of organic contaminants. One of the AOPs is the photocatalysis process that mineralizes and degrades the organic contaminants (Arana, et al., 2008). Advanced Oxidation Process is widely used for photocatalytic degradation of organic contaminants in water and air because of its non-soluble, non-toxic, high photocatalytic activity, doable in low pressure and in low temperature and low production cost (Colon, et al., 2006). In the past two decades, many oxide and sulfide semiconductors such as TiO_2, ZnO, WO_3,$SrTiO_3$, ZnS, and CdS were applied as photocatalysts for environmental control technology and also a wide range of chemical reactions (Hoffmann, et al., 1995). Recently, Kuriakose et al. (2014), Cheng et al. (2014), and Ren et al. (2014) successfully employed ZnO- and TiO_2-based nanomaterials for photocatalytic degradation of organic dyes. ZrO_2 has been considered as a photocatalyst in different chemical reactions due to its relatively wide band gap value E_g and the high negative value of the conduction band potential (Navio, et al., 2001). The reported band gap energy of ZrO2 range was between 3.25 and 5.1 eV, depending on the preparation technique of the sample (Botta, et al., 1999). It is reported that a good manipulation of ZrO_2 morphological tuning, porous structure control, and crystallinity development is required in order to enhance the light harvesting capability, prolong the lifetime of photoinduced electron-hole pairs, and facilitate the reactant accessibility to surface active sites (Sreethawong, et al., 2013). As ZrO_2 is used in a wide variety of applications in addition to photocatalysis, the fabrication of identical ZrO_2 nanoscale structures has been recently attracted a great deal of interest.

In this study, ZrO_2 catalyst was synthesized by sol-gel method. After this procedure, the effects of parameters such as solution's initial pH, ZrO2 concentration and contaminant's concentration on photocatalytic degradation of AR 40 were examined.

2. MATERIALAND METHODS

2.1 Materials

Zirconium (IV) propoxide (Sigma-Aldrich), Acid Red 40 (Alvansabet Co. Iran), Acetic acid (Sigma-Aldrich), Isopropanol, Nitric acid (SD Fine) chemicals received and used as such without further purifications. Double distilled water is used for the preparation.