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Original Research Article

Investigating the Photocatalytic Activity of TiO_2@WO_3/ZnO Catalyst in the Waste Water Treatment Containing Alkanolamine Contaminants

Paymaneh Taghizadeh-Lendeh[1], Amir Hossein Mohsen Sarrafi[1], Afshar Alihosseini[2,*], Naeimeh Bahri-Laleh[3]

[1]Department of Chemistry, Central Tehran Branch, Islamic Azad University, P.O. Box. 1496969191, Tehran, Iran

[2]Department of Chemical Engineering, Central Tehran Branch, Islamic Azad University, P.O. Box.1496969191, Tehran, Iran

[*]Corresponding Author Email: Afs.alihosseini@iauctb.ac.ir

[3]Polymerization Engineering Department, Iran Polymer and Petrochemical Institute (IPPI), P.O. Box 14965/115, Tehran, Iran.

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ABSTRACT

Natural gas has wide range of acid gas concentrations such as CO_2 and H_2S. Alkanolamines dissolved in aqueous solutions are commonly employed to scrub CO_2 and H_2S from natural gas. As a result, the high level of this polutant is emitted through the waste water during cleaningIn this study a novel photocatalyst, TiO_2@WO_3/ZnO, has been designed and fabricated. To prepare the catalyst with the highest performance, the optimized weight fraction of WO_3+Zno (with 1:4 weight ratio) has been alloyed with TiO_2. The results from BET and BJH indicated that the synthesized catalyst had relatively high specific surface area (10.3 m^2 g^{-1}) and meso-

pore structure with cavities diameter of 10.9 nm. The as-synthesized photocatalyst has been employed in the alkanolamine contaminant degradation of wastewater obtained from an industrial gas refinery plant in the presence of LED light. In this regard, the degradation of alkanolamine during time was monitored using UV-Vis and fluorescence spectroscopies. The obtained results confirmed high performance of the designed catalyst in the rapid treatment of the wastewater of gas refinery effluent at very low catalyst loading of only 0.5 wt.%, thereby making it a good candidate for the catalytic purposes. Finally, a possible mechanism for catalytic degradation of alkanolamine over TiO_2@WO_3/ZnO was suggested.

Keywords: synthesis; degradation; gas refinery effluent; TiO_2@WO_3/ZnO photocatalyst; alkanolamine.

Introduction

Natural gas is one of the major energy resources in the world and its production is exceeding. It has a wide range of acid gas concentrations such as CO_2 and H_2S. Due to the corrosiveness of these polutants in the presence of water, the toxicity of H_2S and the ineffectiveness of CO_2 in heating process, natural gas needs to be sweetened [1]. Alkanolamines dissolved in aqueous solutions are commonly employed to scrub CO_2 from natural gas. As a result of aforementioned mechanism, the high level of this polutant is emitted through the waste water during cleaning, maintenance and even shutdown of the absorption and desorption columns. This polutant is toxic and dengorous to the environment and the poluted wastewater cannot be refined in the typical wastewater refineries [2, 3]. In fact, the release of alkanolamines in the industrial waste water from gas refinery effluents has raised many concerns and motivated many researchers to find the proper solutions for the efficient removal of these hazardous pollutants [4].In this regard, many approaches such as the use of adsorbents, photodegradation, oxidative and membrane processes have been suggested [5-8]. Briefly, extensive research has been conducted on Photocatalysis: Fundamental Processes and Applications [9]: in the fields of Electronic structure: From basic principles to photocatalysis [10], Photodegradation processes [11], Using dyes to evaluate the photocatalytic activity [12], Advanced oxidation [13], The kinetic models in electron transfer processes [14], Fundamental developments in the zeolite process [15], Design of active