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Short Communication

Polyaniline-Titanium Dioxide-Bentonite Nanocomposite for Removing Heavy Metal and Dyes from Wastewater: A Short Review

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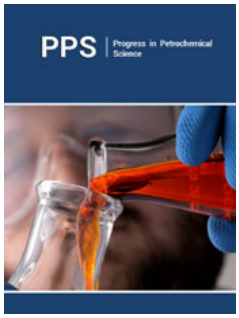

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Abstract

The ever-increase in water pollution by industrial and anthropogenic activities is a well-established risk to the well-being of the human populace. Several remediation systems and processes have been and are currently used to tackle the challenge. Scientists have risen to the challenge and are thus synthesizing various compounds/composites to serve as water remediators from pollutants, especially via sorption processes. In this short review, the potential of some composites; (Polyaniline (PANI), Titanium Dioxide (TiO_2), and Bentonite) in wastewater treatment is briefly discussed. The combination of the three composites is anticipated to be an excellent nanocomposite in wastewater remediation due to their excellent adsorptive properties, ease of preparation, and environmental benignity.

Keywords: Polyaniline; Titanium dioxide; Bentonite; Synthesis; Removal of metal ions

Introduction

Water is a basic necessity for all living forms on the earth, and it is vital to preserving the cleanliness of the water for sustainability. However, rapid progress in industrial, agricultural, and domestic activities have brought a negative impact on the environment, where large amounts of toxic and hazardous wastes generated by these activities have been discharged into the aquatic system. Contamination of water with these potentially toxic wastes such as heavy metal ions, organic dyes as well as emerging micropollutants which have high toxicity and carcinogenic effect, pose a threat to the aquatic lives as well as bring harmful effects to the ecosystem and human health such as causing severe headaches, diarrhea, skin irritation, cancer, and even death if ingested in sufficient amounts. Hence, industries must handle wastewater with special treatment until it meets the standard before discharge into the river, lakes, or oceans. Several techniques and methods have been applied to remove such pollutants from wastewater, including biological treatment, precipitation, adsorption, membrane filtration, and photocatalytic degradation [1-5].

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Nanomaterials with unique properties have been more useful recently, especially in water treatment. Titanium dioxide nanoparticle is a semiconductor with excellent photocatalytic performance and antibacterial properties which has been widely studied and used in the remediation of wastewater. Apart from its photocatalytic and antibacterial properties, it is also non-toxic, environmentally friendly, has low cost, high chemical stability, and readily available which allows it to be the most popular photocatalyst in modifying its composite with other materials to enhance its efficiency and overcome its shortcomings such as the high tendency of agglomeration and low absorption capacity [6]. Clay and clay minerals are also one of the popular classes of materials used in environmental applications due

to their high surface area, significant adsorption capacities, environmentally friendly and abundant availability [7]. It has been used in supporting nanoparticles where Titanium dioxide (TiO_2) nanoparticles can be loaded on it in order to address and solve the drawbacks of the TiO_2 nanoparticles such as poor adsorption capacity, tendency of aggregation, recovery and separation issues [7]. Bentonite is one of the naturally occurring clay minerals, composed of montmorillonite clay which has been gaining high attention and known as the novel bio-sorbent for remediation of contaminated water through adsorption process. It has superior chemical stability, non-toxicity, abundant availability, low cost, high adsorption capacity as compared to other clays, and variety of surface and structural properties [8]. In the recent decades, it has been modified by incorporating different kinds of polymer and nanoparticles to enhance its adsorption capacity for dye removal. Recently, [2] have constructed a novel alginate/bentonite impregnated TiO_2 beads which has shown promising result for removing and degrading the organic dye methylene blue through adsorption and photocatalytic activity simultaneously.

The adsorption and photocatalytic performance of this novel beads are proved to be very efficient where the discoloration of methylene blue is achieved at the rates of 98% during a reduced time of 60min. Moreover, Polyaniline (PANI) based nanocomposite has attracted considerable attention for the removal of aqueous pollutants due to their unique properties such as high surface area, good dispersibility, diverse morphological structures, high environmental stability, low costs of monomer, simple synthesis procedure and unique functional groups that can be easily protonated and deprotonated which is known as the highly reactive adsorption sites that play an important role in its adsorptive properties [9,10]. Various PANI-absorbent for removing various pollutants have been reported such as heavy metal ions, organic dye and emerging pollutants where its morphology, surface area, diverse functional groups as well as the chemical nature of PANI-adsorbent often play a role in the adsorption capacities [10]. Currently, we wish to develop a novel innovative approach inn wastewater treatment by synthesizing a novel PANI-TiO_2-bentonite nanocomposite for water treatment purposes to remove dye and heavy metal ions from wastewater through double phenomenon of adsorption and photocatalytic processes. Polyaniline and bentonite will function as the support and enhance the adsorption capacities while at the same time increase the photocatalytic process of TiO_2 while PANI will reduce the band gap of TiO_2 from UV to visible light region.

Conclusion

The excellent established chemical and physical properties of the discussed composites; PANI, TiO_2 and Bentonite. The ease of preparations, low market costs, environmental friendliness and high potentiality of applications in different systems is indeed promising in the field of wastewater treatment for the removal of contaminants. Developing a Polyaniline-Titanium Dioxide-Bentonite nanocomposite for removing heavy metal and dyes from wastewater is thus promising and refreshing to researchers in the context of this menace.

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