FayoumUniversity
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Abstract

In this study, a novel polyurethane/organobentonite/iron oxide (PUF/OB/IO) magnetic nanocomposite adsorbent was prepared *via* in situ polymerization of toluene diisocyanate (TDI) and polyol in presence of 5 wt% OB/IO. OB was derived from natural bentonitic clay mined from Qalamshah depression-Fayoum government-Egypt.

Different characterization means were employed to investigate the physicochemical characteristics of the natural bentonite, sodium exchanged bentonite, organobentonite and PUF/OB/IO nanocomposite such as XRD, IR, SEM and TEM techniques.

The efficiency of the raw bentonite and the prepared nanocomposite toward removal of cadmium and zinc ions from aqueous solutions and natural water samples was evaluated during this study. The applicability of the obtained nanocomposite for removal of methylene blue (MB) and methyl orange (MO) dyes – as organic pollutant models from aqueous solutions was also investigated in detail.

Moreover; this study has divided into four chapters as follow:

1) **Chapter 1**: includes an introduction to the thesis that shows a brief statement about the importance of water for living beings. It also highlighted the importance of surface water treatment and the most used techniques for this purpose especially the adsorption process as a promising technique with unique advantages. Many adsorbents frequently studied as alternatives for wastewater treatment purpose were introduced in this chapter particularly clays and clay minerals. Concise description for the methods used to prepare clay/polymer

nanocomposites as highly efficient adsorbents for pollutants removal from natural waters was also given.

2) **Chapter 2**: this chapter presents a survey about the most hazardous pollutants i.e. heavy metals and organic dyes, together with the conventional and advanced methods employed to treat water streams laden with them with a short mention for advantages and/or disadvantages of each technique. The aim of the work is also stated in this chapter.

3) **Chapter 3:** all chemicals, solutions and the followed procedures to prepare the nanocomposite were listed in this chapter. The characterization techniques used to investigate the physicochemical aspects of raw bentonite clay,organobentonite and the prepared nanocomposite were presented in this chapter. Also, experiments, used to test the adsorption efficiency of raw clay and the synthesized nanocomposite, were presented.

4) **Chapter 4:** include results and discussions as it comprises several parts:

A) **Part one:** presents the results for the characterization of raw clay, organobentonite and PUF/OB/IO nanocomposite. The results revealed that a nano-structure has been formed.

B) **Part two:** the results of application of raw clay and the obtained nanocomposite for removal of cadmium and zinc ions from aqueous solutions were depicted in this part. A higher removal efficiency of both metal ions onto the nanocomposite was observed compared to raw clay. It was found that the removal process greatly affected by initial solution pH, contact time, adsorbent dose and initial metal ion concentration.

Kinetic studies showed that only intraparticle diffusion step controls the adsorption rate onto raw clay, but film diffusion and intraparticle diffusion steps largely affected the adsorption rate onto the nanocomposite.Also**,** the results of reusability of the nanocomposite and analytical application of the obtained adsorbent for removal of cadmium and zinc ions from natural samples collected from Fayoum government (Qaroun Lake water and Bahr Youssef water) were depicted in this part. It was confirmed from the results of this part that the obtained nanocomposite can be used for five successive adsorption-desorption cycles without significant loss in the adsorption efficiency and the prepared nanocomposite could be efficiently used to extract Cd^{2+} and Zn^{2+} ions from natural samples with higher recoveries ranging 96.6% and 110% for both metal ions.

C) **Part three:** this part includes the results of application of PUF/OB/IO nanocomposite for MB and MO dyes removal from aqueous solution. The prepared nanocomposite afforded lower affinity toward MB dye in comparison with that for MO dye and heavy metal cations. This may be attributed to the restricted diffusion of such bulky size dye hydrolyzed molecules onto the interior mesoporous structure of the prepared nanocomposite. However, the isotherm study confirmed that the prepared nanocomposite has adequate adsorption capacity for MB and MO dyes compared to other studied adsorbents. Additionally, the results of reusability of the obtained nanocomposite for removal of organic and analytical application of PUF/OB/IO nanocomposite for removal of methylene blue and methyl orange dyes from natural samples collected from Fayoum government (Qaroun Lake water and Bahr Youssef water) were presented in this part. It was confirmed from the results of this part that the obtained nanocomposite can be used for five successive

adsorption-desorption cycles without significant loss in the adsorption efficiency and the prepared nanocomposite could be efficiently used to remove organic dyes from natural samples with high recovery potential.