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Synthesis of cetyltrimethylammonium bromide modified montmorillonite nanomaterial for adsorption of an herbicide from contaminated water

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Introduction

Diffused groundwater contamination by herbicides has generated environmental and toxicological problems, which have resulted in a large number of studies to recognize the factors that influence the fate of agrochemicals in soils **[1]**. The discharge of wastewater containing herbicides to receiving streams affects the aesthetic value of environment. Bentazon is widely used herbicide usually applied for the control of broad-leaf weeds and sedges in many crops such as, beans, corn, rice, peanuts and peas **[2]**. The maximum permissible concentration of bentazon in drinking water is 30 g/L **[3]**.

Recently organo-nano clays have been characterized for their immense ability to remove herbicide **[4]** and it showed that they were a powerful sorbent. The application of pure MMT clay is not efficient for removing anionic herbicide such as bentazon from aqueous media. Thus, chemical modification of pure MMT with an appropriate chemical agent would be favorable to reach suitable surface charge in order to increase adsorption capacity of the clay **[5]**. The modification of MMT surface by using cationic surface active substances such as cetyltrimethylammonium bromide (CTAB) can change its surface properties such as surface charge, hydrophobicity and cation exchange capacity.

Experimental

The MMT nano-clay was K-10 grade purchased from Sigma–Aldrich Co. (USA) with a surface area of 279.28 ±0.846 m2/g. Bentazon as a model insecticide was obtained from Chem-service (USA). The chemical structure of bentazon are given in Fig.1. The hypothetical simulating of the modification of MMT with CTAB is depicted in Fig. 2.

The cation-exchange capacity (CEC) of the MMT-K10 (120 meq/100 g) was determined by the dye adsorption method as described in the literature **[6]**.

In order to determine the effects of various parameters, the experiments were conducted by different adsorbent amounts of 0.05 to 0.5 g/L, initial bentazon concentrations of 10 to 100 mg/L and initial pH of 3 to 11. The amount of bentazon adsorbed by the CTAB/MMT and the bentazon removal efficiency were calculated through Eqs. (1) and (2), respectively.

$$q=\frac{(C_0-C_e)V}{M}\times 100 \qquad (1)$$

$$\text{Removal efficiency }\%=\frac{(C_i-C_0)}{C_i}\times 100 \qquad (2)$$

where, q is the adsorption capacity (mg/g), C_i, C_0 and C_e are the initial, outlet and equilibrium concentrations of bentazon (mg/L), V is the volume of bentazon solution (L) and M is the total amount of CTAB/MMT (g).

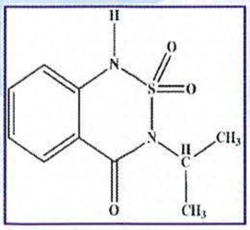


Fig.1. Chemical structure of Bentazon

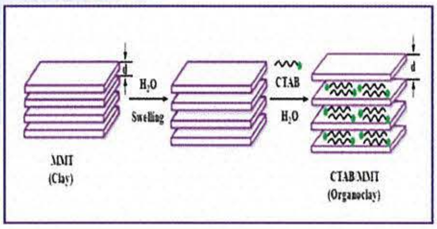
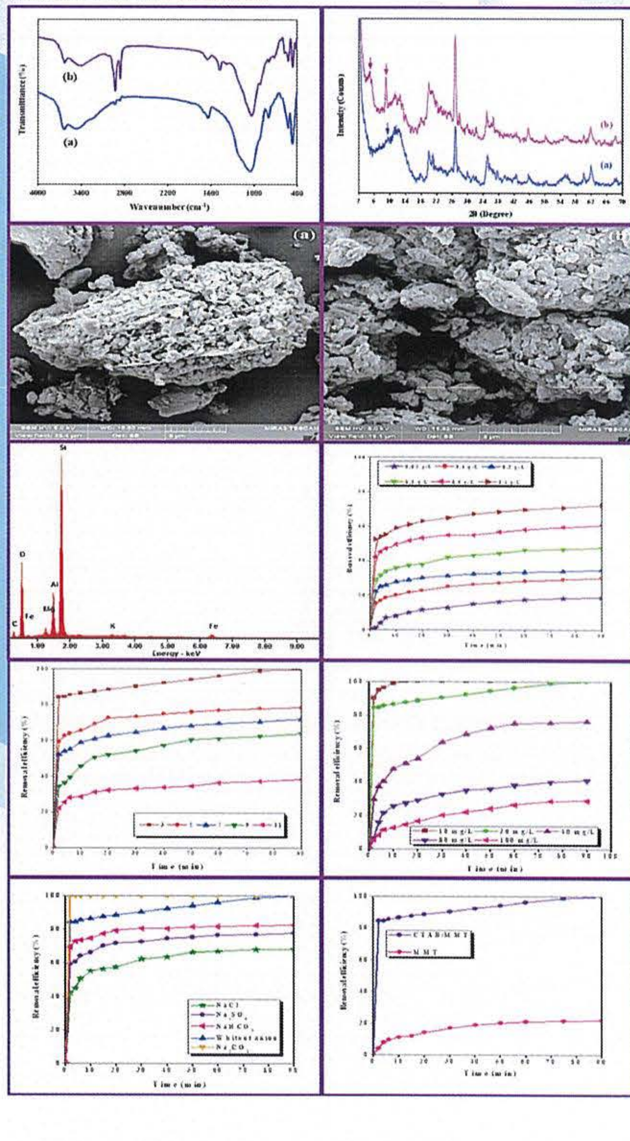


Fig.2. The modification procedure of MMT with CTAB.

Results and Discussion



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Conclusions

In the present research, the application of MMT modified with CTAB for adsorption of the bentazon in aqueous solutions was studied. The prepared sample was characterized by of FT-IR, XRD, SEM and EDX. The results indicated more adsorption activity of the MMT modified with CTAB in comparison with unmodified MMT. Analysis of CTAB/MMT by FT-IR, XRD, SEM and EDX revealed functional groups, porous surface and abundant cation elements that contribute to the bentazon adsorption.