Chitosan/graphene oxide@montmorillonite composites for the adsorption of dyes from wastewaters

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Introduction

The dyeing industry produces over 800 thousand tons of synthetic dyes annually, with 18% ending up in water, posing a threat to the environment due to their high toxicity. Adsorption is a cost-effective method for removing these dyes, with chitosan being a bioactive polymer commonly used for its functional properties such as antibacterial activity and biodegradability. However, native chitosan has pH sensitivity and instability issues, making its derivatives more effective for adsorption. Graphene oxide (GO) can complement chitosan due to its stability and other properties. Combining chitosan (CS), graphene oxide, and montmorillonite (MT), a mineral clay with unique characteristics, offers a promising solution for greener and cost-effective dye removal from water Characterization of the materials through SEM and XRD has been conducted. Experimental studies have determined optimal conditions for pH, temperature, and contact time for removal reactive black 5 (RB5) from wastewater

Results & Discussion

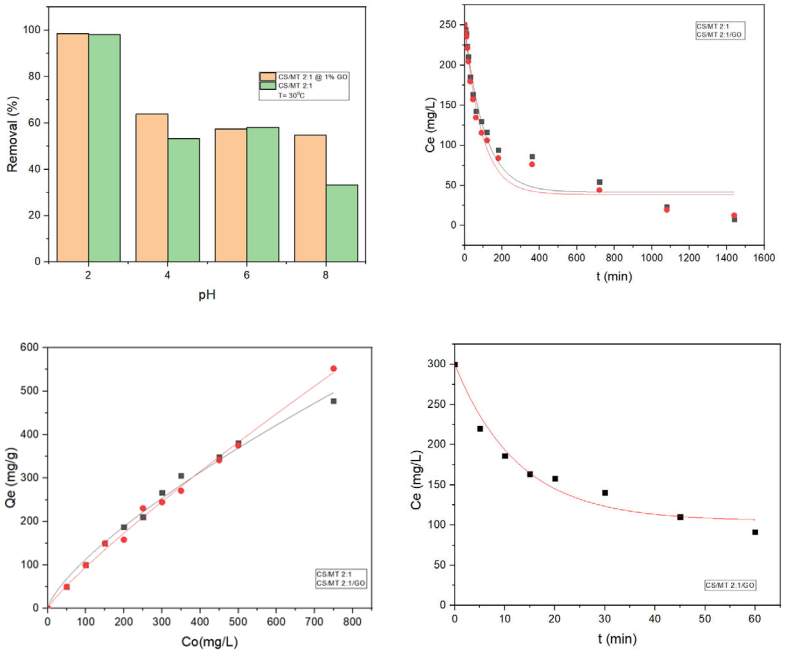


Figure 1. Figures (a), (b) and (c) depict the effect of pH, the effect of contact time, and the isotherm model at 30°C for CS/MT 2:1 and CS/MT 2:1/GO, respectively. Figure (d) describes the kinetic study of RB5 adsorption from CS/MT 2:1/GO material under continuous flow.

According to the experimental results of the kinetic study, the data align more closely with the PFO kinetic model. This implies that the adsorption of RB5 exhibits characteristics akin to physical adsorption. Furthermore, it was assumed that the Freundlich isotherm model, which depicts the multilayer adsorption on the surface of the adsorbent, more accurately described the adsorption. Lab-scale continuous flow adsorption experiments have been conducted. The results indicated that the same kinetic model, namely PFO, was applicable.

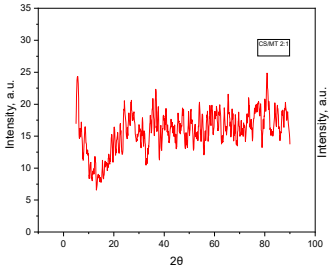


Figure 2: XRD diagram of CS/MT 2:1

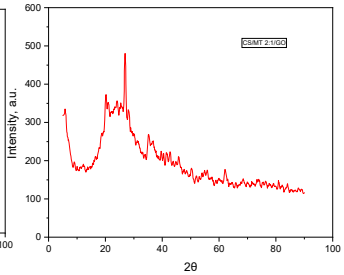
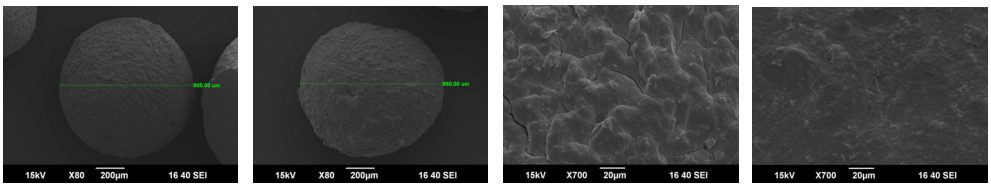


Figure 3: XRD diagram of CS/MT 2:1/GO

The XRD pattern shows in both materials peaks around 2θ = 20° indicating the presence of Chitosan. In addition, a broad peak around 2θ=5° and 2θ=7° indicating the presence of Montmorillonite with the high intensity of it corresponding to the big dose of the clay mineral to the material. Finally, an addition of 1% of GO in the bead can be confirmed by a low intensity broad peak at 2θ = 10°. Of course, the material is non crystal as it can easily be confirmed by the numerous peaks through the X axis of the figure.



(a) **(b)** **(c)** **(d)**

Figure 4. SEM images of (a) CS/MT 2:1 , (b) CS/MT 2:1/GO (c) CS/MT 2:1 (d) CS/MT 2:1/GO

The material is clearly spherical and stands around 900 µm length when is dried (Fig 4a and 4b). The small particles on the bead's surface is the well exfoliated GO (Fig 4c and 4d). Overall, the beads exhibited a smoother surface compared to other adsorption materials commonly found in literature

Conclusions

- Chitosan/graphene oxide@montmorillonite, has been synthesized, combining chitosan, montmorillonite and graphene oxide for enhanced adsorption capacity against RB5.
- It was found that at pH 2.0 ± 0.1, with the addition of 1.0 g/L the removal rate reached 90%.
- The Freundlich isotherm model and the pseudo-first order kinetic model were found to better fit the adsorption concluding that the adsorption of RB5 on CS/MT 2:1/GO was multilayer and closer to physisorption.
- Findings from XRD and SEM showed that the material has an amorphous and more compact structure

Acknowledgment

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