SYNTHESIS OF MAGNETIC GRAPHENE OXIDE/β-CYCLODEXTRIN NANOHYBRIDS FOR THE REMOVAL OF CONGO RED FROM AQUEOUS SOLUTIONS

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ABSTRACT

Nowadays, the widespread industrial activity is responsible for the generation of serious environmental issues, such as water pollution. Dyes release into waste water from various industrial outlets, such as textile, dyeing, printing, paper, food colouring, cosmetics, leather, rubber, plastics manufacturing, etc. These dyes are highly toxic and even carcinogenic to both humans and animals. Therefore, it is essential to be removed from aqueous solutions. It is a fact that various technologies have been developed for dyes removal, such as adsorption, photo-chemical degradation, coagulation-flocculation, oxidation, etc. Among these techniques, adsorption is the most popular due to its simplicity and low cost. Environmental researchers are actively exploring carbon-based nanomaterials as adsorbents for dyes removal. As a new form of carbon-based nanomaterials, graphene is considered to be an ideal adsorbent because of its high specific surface area and superior chemical stability. However, the application of graphene in dyes removal is limited by its poor aqueous dispersibility. On the other hand, graphene oxide (GO), which is derived from graphene by introducing several oxygen-containing functional groups (-OH, -COOH, -C=O, −C−O−C) onto its basal planes and edges is well dispersed in water. Nevertheless, it is difficult to separate GO sheets from aqueous solutions. In order to overcome these drawbacks, the combination of GO with magnetic nanoparticles is considered as an ideal option, which could retrieve the adsorbents which adsorb the target compounds by applying an external magnetic field. Aim of this work is to synthesize magnetic GO-based nanohybrid materials and evaluate their performance in the removal of Congo Red (CR) dye from aqueous solution. In particular, the adsorbents were prepared via a three-step method. Firstly, GO was produced via a modified Hummer's method, using graphite powder as starting material. Following this, GO was successfully functionalized with magnetic copper ferrite ($CuFe_2O_4$) nanoparticles via a solvothermal method, using $FeCl_3{\cdot}6H_2O$ and $CuCl_2{\cdot}2H_2O$ as starting materials. The process took place in a Teflon-lined autoclave at 200°C for 12 h in the presence of ethylene glycol (EG). Subsequently, magnetic GO was further decorated with β-cyclodextrin (β-CD), through either a hydrothermal or a solvothermal method. Both procedures took place in a Teflon-lined autoclave at 90°C for 12 h in the presence of deionized water and EG, respectively. The obtained magnetic GO/β-CD nanohybrid materials were characterized using X-ray powder Diffraction (XRD), Fourier Transformed Infrared Spectroscopy (FT-IR), Thermogravimetric Analysis (TGA), as well as, N_2 porosimetry. Adsorption experiments were performed to evaluate the adsorption capacity and efficient removal of Congo Red dye of the magnetic GO/β-CD nanohybrids using a UV-Vis spectrophotometer.