

Adsorption of cationic and anionic organic dyes on SiO₂/CuO composite

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ABSTRACT

Silica (SiO₂) is one of the most abundant minerals in soils and sediments. Copper oxide (CuO) is a low-cost material with an excellent antimicrobial property. In the present work, a composite comprising silica and copper oxide (SiO₂/CuO) was synthesized by dissolution of SiO₂ (cristobalite) in 6.0 M NaOH followed by deposition of dissolved SiO₂ on CuO. The composite was characterized using XRF, XRD, SEM and FTIR techniques. The XRF analysis indicated that SiO₂/CuO contains 79.42 wt% CuO and 14.36 wt% SiO₂. Both XRD and SEM analysis revealed that silica exists in SiO₂/CuO as amorphous agglomerates. The Si–O–Si stretching at 1,076 cm⁻¹ in the FTIR spectrum of SiO₂ was shifted to 1,033 cm⁻¹ in the case of SiO₂/CuO due to dissolution of SiO₂ and interaction with CuO. Two types of organic dyes, namely, cationic (methylene blue [MB], crystal violet [CV]) and anionic dyes (acid blue 29 [AB], Congo red [CR]) were tested for their adsorption on SiO₂/CuO which was found to have much more dye adsorption capacity than the precursors (SiO₂ and CuO). Furthermore, SiO₂/CuO had an exceptional fast rate of adsorption for the MB and CV where 77% and 66% of the initial amounts were removed within 1 min, respectively. On the other hand, the anionic dyes were found to be poorly adsorbed on SiO₂/CuO. However, when ionic strength increased from 0.0 to 0.5 M NaCl, the adsorption of anionic dyes such as CR increased from 0.4% to 82.3%, while the adsorption of cationic dyes such as MB decreased from 91% to 28%. Thus, the selective removal of dyes can be achieved by controlling the ionic strength.

Keywords: Adsorption; Copper oxide; Silica; Cristobalite; Methylene blue; Crystal violet; Acid blue; Congo red

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