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Degradation of ciprofloxacin in aqueous solution by activating the peroxymonosulfate using graphene based on $CoFe_2O_4$

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ABSTRACT

In this study, the graphene-cobalt ferrites (G-$CoFe_2O_4$) nanocatalyst was synthesized and used to activate peroxymonosulfate (PMS) for the degradation of ciprofloxacin (CIP). The scanning electron microscopy and powder X-ray diffraction analysis results showed the successful loading of $CoFe_2O_4$ on the graphene surface. The effect of operational parameters such as initial pH, G-$CoFe_2O_4$ dosage, PMS dosage and initial concentration of ciprofloxacin on CIP degradation efficiency and the kinetic constant rate was evaluated. The results showed that highest removal efficiency of CIP was achieved at pH 7, 200 mg/L G-$CoFe_2O_4$, 2 mM PMS, 25 mg/L CIP and 30 min reaction time. The results also showed that the PMS/G-$CoFe_2O_4$ system works in a wide range of pH (4–7) with a minimum reduction in degradation efficiency. The PMS/G-$CoFe_2O_4$ system has a higher efficiency in PMS activation and CIP degradation compared with other catalytic processes. This increase was due to the increase of active sites to adsorb CIP and catalytic degradation of it by radicals. Scavenging experiments using tert butyl-alcohol and ethanol showed that both radicals sulfate ($SO_4^{\bullet-}$) and hydroxyl ($^{\bullet}OH$) are produced in the reaction and the $SO_4^{\bullet-}$ is the main radical for the CIP degradation. The results of continuous experiments showed the high efficiency of the PMS/G-$CoFe_2O_4$ process (91.9%) in CIP degradation. The G-$CoFe_2O_4$ nanocatalyst as the heterogeneous activator of PMS showed the high structural stability, good reusability, high catalytic activity and easy separation by the magnetic field.

Keywords: Ciprofloxacin; Peroxymonosulfate; G-$CoFe_2O_4$; Degradation

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