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Comparative study of glyphosate removal on goethite and magnetite: adsorption and photo-degradation

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Abstract: Glyphosate (PMG) has been demonstrated to be strongly adsorbed on iron oxides, but few studies have been made on the subsequent degradation process. As the mechanism and process of PMG degradation plays a crucial role on its existence in the environment, this study aims to investigate the comparative adsorption and photo-degradation of PMG on goethite and magnetite. The results show that the Langmuir adsorption capacity of goethite (7.9 mg/g) was higher than that of magnetite (6.7 mg/g) at pH=7. Further clarifying of Zeta potential and attenuated total reflectance Fourier-transform infrared spectroscopy measurements revealed that PMG was adsorbed through the coordination of phosphonate moiety. In contrast, PMG degradation due to the photo-catalysis effectiveness of magnetite ($k_{app}=1.2 \text{ h}^{-1}$) was significantly higher than that of goethite ($k_{app}=0.4 \text{ h}^{-1}$) at pH=7. This phenomenon was primarily due to the greater release of the dissolved iron in magnetite which led to the promotion of reactive oxygen species generation in the magnetite/UV system. DFT results show that the formation of Fe-O-P bonds in the presence of iron oxide would change the electron density distribution around the phosphorus center of PMG, and potentially made the C-P bond more assailable to ROS. Furthermore, electron spin resonance results identified the existence of $\bullet\text{OH}$ and $\text{O}_2^{\bullet-}$, and further tests by adding radical captures proved the domination of $\bullet\text{OH}$ in degrading PMG. In addition, intermediate identification of PMG revealed that amino acid, carboxyl acid and other inorganic

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