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Photocatalytic degradation of sulfamethoxazole by hierarchical magnetic ZnO@g-C_3N_4: RSM optimization, kinetic study, reaction pathway and toxicity evaluation

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Highlights

- In situ growth of g-C_3N_4 on hierarchical magnetic ZnO obtained nanocomposite.
- Operating parameters were optimized by response surface methodology.
- Partial mineralization and high loss of antibacterial activity follow SMX removal.
- Degradation pathways include cleavage of S-N bound and sulfone moiety abstraction.
- Hierarchical photocatalysts are easily separated by external magnetic force.

Abstract

The degradation of sulfamethoxazole (SMX) by a synthesized hierarchical magnetic zinc oxide based composite ZnO@g-C_3N_4 (FZG) was examined. Hierarchical FZG was synthesized by using Fe_3O_4 nanoparticle as the magnetic core and urea as the precursor for *in situ* growth of g-C_3N_4 on the surface of petal-like ZnO. The effect of catalyst dosage (0.4-0.8 g/L), solution pH (3-11) and airflow rate (0.5-2.5 L/min) on the SMX removal efficiency and the optimization of process was studied by response surface methodology (RSM) based on central composite design (CCD). The obtained RSM model with R^2=0.9896 showed a satisfactory correlation between the predicted values and experimental results of SMX removal. Under the optimum conditions, i.e. 0.65 g/L photocatalyst concentration, pH=5.6 and airflow rate=1.89 L/min, 90.4% SMX removal was achieved after 60 min reaction. The first-order kinetic rate constant for SMX removal by using FZG was 0.0384 min^{-1} while the rate constant by commercial ZnO was 0.0165 min^-