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Diclofenac Degradation Using Persulfate Activated by Metal-Based Activators and Biochar

SUJIN HWANG AND CHEOLYONG KIM

Incheon national university

Persulfate activation ($S_2O_8^{2-}$, HSO_5^-) has been widely studied for wastewater pollutant removal, traditionally using metal- and carbon-based activators. This study evaluates the effectiveness of metal-based ($CuFe_2O_4$, $CoFe_2O_4$) and carbon-based (leap biochar, sea string biochar) activators in activating persulfate for pollutant degradation. Potassium peroxymonosulfate (Oxone, Sigma-Aldrich) was used as an oxidant. $CuFe_2O_4$ was synthesized via co-precipitation of $Cu(NO_3)_2 \cdot 3H_2O$ and $Fe(NO_3)_3 \cdot 9H_2O$, followed by calcination at 350°C for 4 hours. Biochars were prepared from leaves and sea string by washing with distilled water, followed by complete oven-drying. Then, the dried samples were pyrolyzed in a tube furnace at 800°C for 1 hour with a heating rate of 10°C/min. The resulting biochar was washed again with distilled water and oven-dried at 60°C.

Batch experiments were conducted to assess diclofenac (DCF) degradation. The reaction was initiated by adding persulfate to the pollutant solution containing activator. Removal efficiency was evaluated based on $CuFe_2O_4$ dosage (2 g/L), $CoFe_2O_4$ dosage (0.02 g/L) and peroxymonosulfate concentration (1 mM). For biochar activators, removal efficiency was evaluated based on leap BC dosage (2 g/L) and peroxydisulfate or peroxymonosulfate concentration (1 mM). Sampling was performed at regular intervals, with DCF concentration measured via high-performance liquid chromatography and persulfate concentration via UV-Vis spectroscopy. The pH was maintained between 6.9 and 7.3.

DCF removal reached 60% after 6 hours with $CuFe_2O_4$ and peroxymonosulfate, while 97% removal was achieved with $CoFe_2O_4$ and peroxymonosulfate after 30 minutes. DCF removal reached 51% after 6 hours with leap BC and peroxymonosulfate, while 87% removal was achieved with leap BC and peroxydisulfate under the same conditions. DCF removal reached 66% after 6 hours with sea string BC and peroxymonosulfate, while 60% removal was achieved with sea string BC and peroxydisulfate under the same conditions. These results confirm metal-based activators and biochar as effective persulfate activators, with their dosage significantly influencing pollutant removal. Future research will focus on developing practical pollutants removal technologies utilizing metal-based activators, biochar and persulfate.