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Degradation of Acetaminophen with Fe3O4 and Fe2+ as Activator of Peroxymonosulfate

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Abstract : Perxymonosulfate (PMS)-based oxidation processes, as an alternative of hydrogen peroxide-based oxidation processes, are more and more popular because of reactive radical species (SO4-•, OH•) produced in systems. Magnetic nano-scaled particles Fe3O4 and ferrous anion (Fe2+) were studied for the activation of PMS for degradation of acetaminophen (APAP) in water. The Fe3O4 MNPs were found to effectively catalyze PMS for APAP and the reactions well followed a pseudo-first-order kinetics pattern (R2 > 0.95), while the degradation of APAP in PMS-Fe2+ system proceeds through two stages: a fast stage and a much slower stage. Within 5 min, approximately 7% and 18% of 10 ppm APAP was accomplished by 0.2 mM PMS in Fe3O4 (0.8g/L) and Fe2+ (0.1mM) activation process. However, as reaction proceed to 120 min, approximately 75% and 35% of APAP was removed in Fe3O4 activation process and Fe2+ activation process, respectively. Within 120 min, the mineralization of APAP was about 7.5% and 5.0% (initial APAP of 10 ppm and [PMS]0 of 0.2 mM) in Fe3O4-PMS and Fe2+-PMS system, while the mineralization could be greatly increased to about 31% and 40% as [PMS]0 increased to 2.0 mM in in Fe3O4-PMS and Fe2+-PMS system, respectively. At last, the production of reactive radical species were validated directly from Electron Paramagnetic Resonance (ESR) tests with 0.1 M 5,5-dimethyl-1-pyrrolidine N-oxide (DMPO). Plausible mechanisms on the radical generation from Fe3O4 and Fe2+ activation of PMS are proposed on the results of radial identification tests. The results demonstrated that Fe3O4 MNPs activated PMS and Fe2+ anion activated PMS systems are promising technologies for water pollution caused by contaminants such as pharmaceutical. Fe3O4-PMS system is more suitable for slowly remediation, while Fe2+-PMS system is more suitable for fast remediation.

Keywords : acetaminophen, peroxymonosulfate, radicals, Fe3O4
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