LaFeO₃ and BiFeO₃ perovskites as nanocatalysts for contaminant degradation in heterogeneous Fenton-like reactions

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Chem. Eng. J. 239 (2014) 322–331

DOI: 10.1016/j.cej.2013.11.025

The present study examines the applicability of two iron-containing perovskites, LaFeO₃ (LFO) and BiFeO₃ (BFO), as nanocatalysts for heterogeneous Fenton-like reactions using phenol and methyl tert-butyl ether (MTBE) as model contaminants. LFO and BFO synthesized according to a sol–gel method using citric acid as complexing agent have a crystallite size of about 60–70 nm with specific surface areas of 5.2 m² g⁻¹ for LFO and 3.2 m² g⁻¹ for BFO. In heterogeneous Fenton-like reactions, LFO and BFO showed similar pseudo-first order rate constants for phenol oxidation (k (LFO) = 0.13 h⁻¹ and k (BFO) = 0.15 h⁻¹) at pH = 7 when 0.1 g L⁻¹ catalyst and 3.0 g L⁻¹ H₂O₂ were applied. Degradation efficiency was improved for both perovskites by a factor of approximately three when the pH value was slightly decreased to pH = 5. An increase of the reaction temperature from 20 °C to 60 °C during the BFO-catalyzed reaction led to a significant acceleration of phenol removal of about one order of magnitude k (BFO) = 1.9 h⁻¹). High stability and reusability of the BFO particles was confirmed in four successive oxidation batches using MTBE as model contaminant. In addition, the mechanism of the perovskite-catalyzed Fenton-like system was studied by applying compound-specific stable isotope analysis (CSIA). The perovskite-catalyzed oxidation appears to follow a pathway similar to that of the homogeneous Fenton reaction, i.e. OH radicals play a dominant role as primary reactive species.