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Mechanism of Fe(III)-Precipitate Formation and Transformation in Circumneutral Aqueous Solutions in the Presence of Phosphate Under Conditions Relevant to Membrane Bioreactor Wastewater Treatment

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The formation of iron-phosphate minerals influences the transport and bioavailability of phosphate in natural systems, despite this importance, understanding of the mechanism and rate of this process is limited. Iron addition is also used to remove phosphorous during municipal wastewater treatment to prevent eutrophication and associated algal blooms in receiving waters. The poor understanding of the kinetics of the interaction between Fe and P and the ability of $\text{Fe}^{\text{III}}\text{PO}_4(\text{s})$ formation to compete with rapid Fe(III) hydrolysis to iron oxyhydroxides limits the effective use of this technology, which is one of the few available processes to treat wastewaters to increasingly stringent phosphate discharge limits.

This study has used Fe K-edge and P K-edge X-ray absorption spectroscopy experiments (undertaken at BL17C1 and BL16A1 at NSRRC Taiwan) to determine the composition of the Fe-P species in the sludge formed from Fe- and P-containing solutions under a range of initial Fe-oxidation states, relative Fe and P concentrations and also pH (which strongly influences the rate of Fe(II) oxidation and Fe(III)-precipitation). This data has been interpreted using a linear combination fitting scheme that has been adjusted to fit the sample composition to the Fe XANES and EXAFS as well as the P-XANES simultaneously. Coupling this solid-state chemical composition with the solution phase kinetics derived from standard chemical measurements allows the critical processes in the formation of the desired Fe- PO_4 minerals to be examined.

Keywords

multi-element, linear combination fitting, XANES, EXAFS, iron, phosphate, kinetics

Primary authors: Dr MILLER, Christopher (School of Civil and Environmental Engineering, The University of New South Wales); Mr WU, Hao (The University of New South Wales)

Co-authors: Dr IKEDA-OHNO, Atsushi (Helmholtz-Zentrum Dresden-Rossendorf); Prof. WAITE, T. David (The University of New South Wales); Dr WANG, Yuan (The University of New South Wales)

Presenter: Dr MILLER, Christopher (School of Civil and Environmental Engineering, The University of New South Wales)

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