Transformation kinetics of nanosized iron oxides and elemental iron in natural and engineered systems

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Nanosized particles occur **naturally** in aquatic systems and are typically formed via precipitation when solubility constraints are exceeded. Amorphous ferric oxides (AFO) represent such an example with nanosized particulates forming in the first instance which subsequently transform to more crystalline and typically larger-sized oxides. The precursor to formation of these nanosized ferric oxides appears to be the uncharged $Fe(OH)_3^0$ species with the second order rate constant of precipitation exhibiting a similar trend with pH to that of the $Fe(OH)_3^0$ species concentration [1]. The precipitation reaction can be represented as:

$$Fe(OH)_3^0 + Fe_T \rightarrow AFO; \ k_f$$

where the magnitude of the forward rate constant, k_f, is determined by the rate of water loss from $Fe(OH)_3^0$.

The solubility of the so-formed AFO will be determined by the dissociation kinetics of these oxyhydroxides. Particles in the nanosize range are highly reactive both because of their small size and low crystallinity. As such, dissociation rates of the freshly formed nanosized AFO particulates are high, resulting in higher dissolved ferric iron concentrations than are evident once the reactivity of the particulate phase has decreased [2].

Nanosized particles may also be **introduced** to natural sysetms to induce removal of contaminants by either adsorptive or degradative processes. One such example is the injection of nanosized zero valent iron (nZVI) particles into subsurface systems. These nZVI particles, particularly if stabilised by addition of highly charged surface groups, may be transported to zones of contamination where they may induce reductive dehalogenation of the contaminant of concern. Given the high reactivity of nanosized ZVI, these particulates have also been shown to have the capacity to generate oxidising free radical species if oxygen is present [3]. As such, both reductive and oxidative transformations of contaminants may result.

References

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