

Equilibrium constants for hydrolysis and associated equilibria in critical compilations

Iron(II)

| Equilibrium reactions | lgK at infinite dilution and $T = 298 \text{ K}$ | | |
|--|--|---------------------|------------------------|
| | Baes and Mesmer, 1976 | Lemire et al., 2013 | Brown and Ekberg, 2016 |
| $\text{Fe}^{2+} + \text{H}_2\text{O} \rightleftharpoons \text{FeOH}^+ + \text{H}^+$ | -9.5 | -9.1 ± 0.4 | -9.43 ± 0.10 |
| $\text{Fe}^{2+} + 2 \text{H}_2\text{O} \rightleftharpoons \text{Fe}(\text{OH})_2 + 2 \text{H}^+$ | -20.6 | -21.2 ± 1.1 | -20.52 ± 0.08 |
| $\text{Fe}^{2+} + 3 \text{H}_2\text{O} \rightleftharpoons \text{Fe}(\text{OH})_3^- + 3 \text{H}^+$ | -31 | -34.3 ± 0.2 | -32.68 ± 0.15 |
| $\text{Fe}^{2+} + 4 \text{H}_2\text{O} \rightleftharpoons \text{Fe}(\text{OH})_4^{2-} + 4 \text{H}^+$ | -46 | | |
| $\text{Fe}(\text{OH})_2(\text{s}) + 2 \text{H}^+ \rightleftharpoons \text{Fe}^{2+} + 2 \text{H}_2\text{O}$ | 12.85 | 12.5 ± 0.02 | 12.27 ± 0.88 |

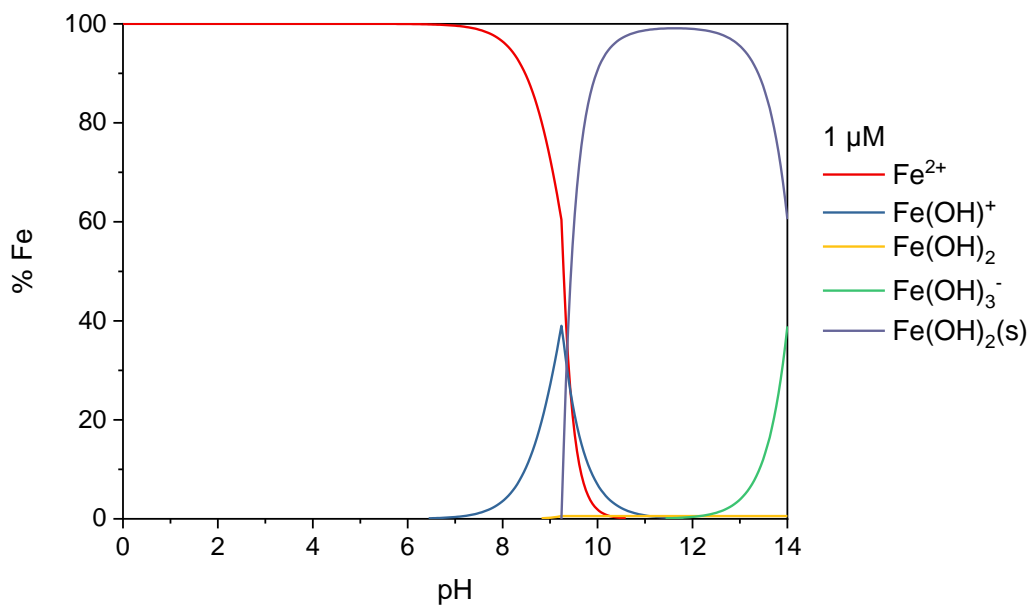
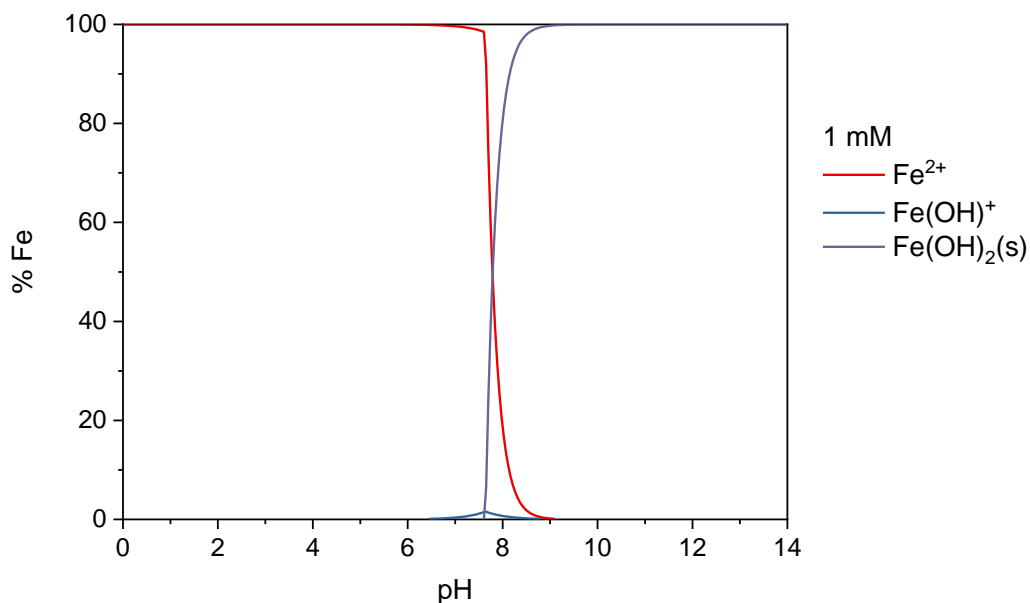
C.F. Baes and R.E. Mesmer, The Hydrolysis of Cations. Wiley, New York, 1976, p. 235.

P.L. Brown and C. Ekberg, Hydrolysis of Metal Ions. Wiley, 2016, pp. 573–585.

R.J. Lemire, U. Berner, C. Musikas, D.A. Palmer, P. Taylor, O. Tochiyama, Chemical Thermodynamics Volume 13a in the OECD Nuclear Energy Agency (NEA) Chemical Thermodynamics series, Chemical Thermodynamics of Iron, Part 1, 2013.

Distribution diagrams

These diagrams have been computed at two Fe(II) concentrations (1 mM = 1×10^{-3} mol L⁻¹ and 1 μ M = 1×10^{-6} mol L⁻¹) with the 'best' equilibrium constants above (in green). Calculations assume $T = 298$ K for the limiting case of zero ionic strength (*i.e.*, even neglecting plotted ions).



Equilibrium constants for hydrolysis and associated equilibria in critical compilations

Iron(III)

| Equilibrium reactions | lgK at infinite dilution and $T = 298 \text{ K}$ | | |
|--|--|---------------------|------------------------|
| | Baes and Mesmer, 1976 | Lemire et al., 2013 | Brown and Ekberg, 2016 |
| $\text{Fe}^{3+} + \text{H}_2\text{O} \rightleftharpoons \text{FeOH}^{2+} + \text{H}^+$ | -2.19 | -2.15 ± 0.07 | -2.20 ± 0.02 |
| $\text{Fe}^{3+} + 2 \text{H}_2\text{O} \rightleftharpoons \text{Fe}(\text{OH})_2^+ + 2 \text{H}^+$ | -5.67 | -4.8 ± 0.4 | -5.71 ± 0.10 |
| $\text{Fe}^{3+} + 3 \text{H}_2\text{O} \rightleftharpoons \text{Fe}(\text{OH})_3 + 3 \text{H}^+$ | <-12 | <-14 | -12.42 ± 0.20 |
| $\text{Fe}^{3+} + 4 \text{H}_2\text{O} \rightleftharpoons \text{Fe}(\text{OH})_4^- + 4 \text{H}^+$ | -21.6 | -21.5 ± 0.5 | -21.60 ± 0.23 |
| $2 \text{Fe}^{3+} + 2 \text{H}_2\text{O} \rightleftharpoons \text{Fe}_2(\text{OH})_2^{4+} + 2 \text{H}^+$ | -2.95 | -2.91 ± 0.07 | -2.91 ± 0.07 |
| $3 \text{Fe}^{3+} + 4 \text{H}_2\text{O} \rightleftharpoons \text{Fe}_3(\text{OH})_4^{5+} + 4 \text{H}^+$ | -6.3 | | -6.3 ± 0.1 |
| $\text{Fe}(\text{OH})_3(\text{s}) + 3 \text{H}^+ \rightleftharpoons \text{Fe}^{3+} + 3 \text{H}_2\text{O}$ 2-line ferrihydrite | 2.5 | 3.5 | 3.50 ± 0.20 |
| $\text{Fe}(\text{OH})_3(\text{s}) \rightleftharpoons \text{Fe}^{3+} + 3 \text{OH}^-$ 6-line ferrihydrite | | -38.97 ± 0.64 | |
| $\alpha\text{-FeOOH}(\text{s}) + 3 \text{H}^+ \rightleftharpoons \text{Fe}^{3+} + 2 \text{H}_2\text{O}$ goethite | 0.5 | | 0.33 ± 0.10 |
| $\alpha\text{-FeOOH} + \text{H}_2\text{O} \rightleftharpoons \text{Fe}^{3+} + 3 \text{OH}^-$ goethite | | -41.83 ± 0.37 | |
| $0.5 \alpha\text{-Fe}_2\text{O}_3(\text{s}) + 3 \text{H}^+ \rightleftharpoons \text{Fe}^{3+} + 1.5 \text{H}_2\text{O}$ hematite | | | 0.36 ± 0.40 |

| | | | |
|---|--|-------------------|-------------------|
| $0.5 \alpha\text{-Fe}_2\text{O}_3 + 1.5 \text{H}_2\text{O} \rightleftharpoons \text{Fe}^{3+} + 3 \text{OH}^-$ hematite | | -42.05 ± 0.26 | |
| $0.5 \gamma\text{-Fe}_2\text{O}_3(\text{s}) + 3 \text{H}^+ \rightleftharpoons \text{Fe}^{3+} + 1.5 \text{H}_2\text{O}$ maghemite | | | 1.61 ± 0.61 |
| $0.5 \gamma\text{-Fe}_2\text{O}_3 + 1.5 \text{H}_2\text{O} \rightleftharpoons \text{Fe}^{3+} + 3 \text{OH}^-$ maghemite | | -40.59 ± 0.29 | |
| $\alpha\text{-FeOOH}(\text{s}) + 3 \text{H}^+ \rightleftharpoons \text{Fe}^{3+} + 2 \text{H}_2\text{O}$ lepidocrocite | | | 1.85 ± 0.37 |
| $\gamma\text{-FeOOH} + \text{H}_2\text{O} \rightleftharpoons \text{Fe}^{3+} + 3 \text{OH}^-$ lepidocrocite | | -40.13 ± 0.37 | |
| $\text{Fe}(\text{OH})_3(\text{s}) + 3 \text{H}^+ \rightleftharpoons \text{Fe}^{3+} + 3 \text{H}_2\text{O}$ magnetite | | | -12.26 ± 0.26 |

C.F. Baes and R.E. Mesmer, *The Hydrolysis of Cations*. Wiley, New York, 1976, p. 235.

P.L. Brown and C. Ekberg, *Hydrolysis of Metal Ions*. Wiley, 2016, pp. 585–620.

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