

Equilibrium constants for hydrolysis and associated equilibria in critical compilations

Lead(II)

Equilibrium reactions	lgK at infinite dilution and $T = 298 \text{ K}$				
	Baes and Mesmer, 1976	NIST46	Powell et al., 2009	Brown and Ekberg, 2016	Cataldo et al., 2018
$\text{Pb}^{2+} + \text{H}_2\text{O} \rightleftharpoons \text{PbOH}^+ + \text{H}^+$	-7.71 ± 0.1	-7.6	-7.46 ± 0.06	-7.49 ± 0.13	-6.47 ± 0.03
$\text{Pb}^{2+} + 2 \text{H}_2\text{O} \rightleftharpoons \text{Pb(OH)}_2 + 2 \text{H}^+$	-17.12 ± 0.1	-17.1	-16.94 ± 0.09	-16.99 ± 0.06	-16.12 ± 0.01
$\text{Pb}^{2+} + 3 \text{H}_2\text{O} \rightleftharpoons \text{Pb(OH)}_3^- + 3 \text{H}^+$	-28.06 ± 0.05	-28.1	-28.03 ± 0.06	-27.94 ± 0.21	-28.4 ± 0.1
$\text{Pb}^{2+} + 4 \text{H}_2\text{O} \rightleftharpoons \text{Pb(OH)}_4^{2-} + 4 \text{H}^+$			-40.8		
$2 \text{Pb}^{2+} + \text{H}_2\text{O} \rightleftharpoons \text{Pb}_2(\text{OH})^{3+} + \text{H}^+$	-6.36 ± 0.1	-6.4	-7.28 ± 0.09	-6.73 ± 0.31	
$3 \text{Pb}^{2+} + 4 \text{H}_2\text{O} \rightleftharpoons \text{Pb}_3(\text{OH})_4^{2+} + 4 \text{H}^+$	-23.88 ± 0.2	-23.9	-23.01 ± 0.07	-23.43 ± 0.10	

$3 \text{ Pb}^{2+} + 5 \text{ H}_2\text{O} \rightleftharpoons \text{Pb}_3(\text{OH})_5^+ + 5 \text{ H}^+$				-31.11 ± 0.10	
$4 \text{ Pb}^{2+} + 4 \text{ H}_2\text{O} \rightleftharpoons \text{Pb}_4(\text{OH})_4^{4+} + 4 \text{ H}^+$	-20.88 ± 0.1	-20.9	-20.57 ± 0.06	-20.71 ± 0.18	
$6 \text{ Pb}^{2+} + 8 \text{ H}_2\text{O} \rightleftharpoons \text{Pb}_6(\text{OH})_8^{4+} + 8 \text{ H}^+$	-43.61 ± 0.1	-43.6	-42.89 ± 0.07	-43.27 ± 0.47	
$\text{PbO}(\text{s}) + 2 \text{ H}^+ \rightleftharpoons \text{Pb}^{2+} + \text{H}_2\text{O}$			12.62 (red) 12.90 (yellow)		
$\text{PbO}(\text{s}) + \text{H}_2\text{O} \rightleftharpoons \text{Pb}^{2+} + 2 \text{ OH}^-$	-15.28 ± 0.05 (red)	-15.3	-15.3 (red) -15.1 (yellow)	-15.37 ± 0.04 (red) -15.1 ± 0.08 (yellow)	
$\text{Pb}_2\text{O}(\text{OH})_{2(\text{s})} + \text{H}_2\text{O} \rightleftharpoons 2 \text{ Pb}^{2+} + 4 \text{ OH}^-$			-14.9		
$\text{PbO}(\text{s}) + \text{H}_2\text{O} \rightleftharpoons \text{Pb}(\text{OH})_2$			-4.4 (red) -4.2 (yellow)		
$\text{Pb}_2\text{O}(\text{OH})_{2(\text{s})} + \text{H}_2\text{O} \rightleftharpoons 2 \text{ Pb}(\text{OH})_2$			-4.0		
$\text{PbO}(\text{s}) + 2 \text{ H}_2\text{O} \rightleftharpoons \text{Pb}(\text{OH})_3^- + \text{H}^+$			-1.4 (red) -1.2 (yellow)		

$\text{Pb}_2\text{O}(\text{OH})_2(\text{s}) + 2 \text{H}_2\text{O} \rightleftharpoons 2 \text{Pb}(\text{OH})_3^- + 2 \text{H}^+$			-1.0		
--	--	--	------	--	--

C.F. Baes and R.E. Mesmer, The Hydrolysis of Cations. Wiley, New York, 1976, p. 365.

P.L. Brown and C. Ekberg, Hydrolysis of Metal Ions. Wiley, 2016, pp. 135–145.

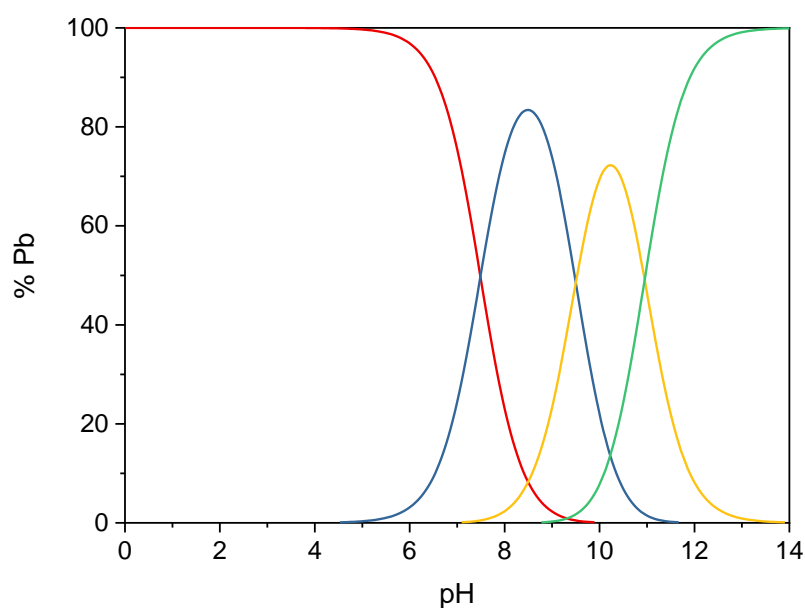
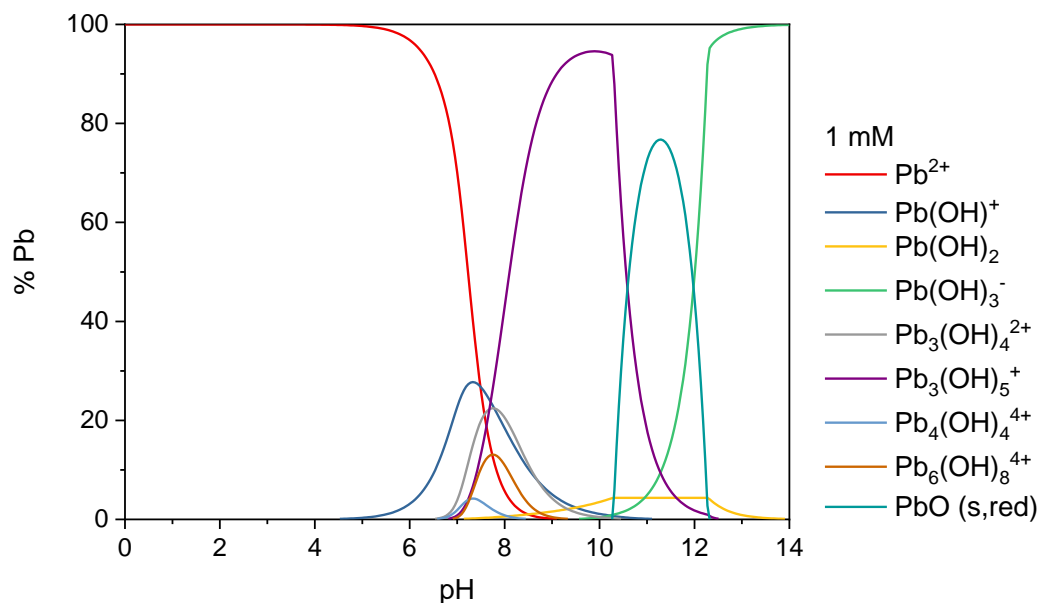
S. Cataldo, G. Lando, D. Milea, S. Orecchio, A. Pettignano, S. Sammartano, A novel thermodynamic approach for the complexation study of toxic metal cations by a landfill leachate. New J. Chem., 42, 7640–7648 (2018).

NIST46, NIST Critically Selected Stability Constants of Metal Complexes: Version 8.0. Available at: www.nist.gov/srd/nist46

K.J. Powell, P.L. Brown, R.H. Byrne, T. Gajda, G. Hefter, A.K. Leuz, S. Sjöberg, H. Wanner, Chemical speciation of environmentally significant metals with inorganic ligands. Part 3: The $\text{Pb}^{2+} + \text{OH}^-$, Cl^- , CO_3^{2-} , SO_4^{2-} , and PO_4^{3-} systems (IUPAC Technical Report). Pure Appl. Chem., 81, 2425–2476 (2009).

Distribution diagrams

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



Equilibrium constants for hydrolysis and associated equilibria in critical compilations

Lead(IV)

Equilibrium reactions	lgK at infinite dilution and $T = 298\text{ K}$
	Feitknecht and Schindler, 1963
$\beta\text{-PbO}_2 + 2\text{ H}_2\text{O} \rightleftharpoons \text{Pb}^{4+} + 4\text{ OH}^-$	−64
$\beta\text{-PbO}_2 + 2\text{ H}_2\text{O} + 2\text{ OH}^- \rightleftharpoons \text{Pb}(\text{OH})_6^{2-}$	−4.5

W. Feitknecht and P. Schindler, Solubility constants of metal oxides, metal hydroxides and metal hydroxide salts in aqueous solution. Pure Appl. Chem., 6, 125–206 (1963).

Distribution diagrams

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

