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## Zirconium

Reaction	Baes and Mesmer, 1976	Hummel et al., 2002	Thoenen et al., 2014	Brown and Ekberg, 2016
$\text{Zr}^{4+} + \text{H}_2\text{O} \rightleftharpoons \text{ZrOH}^{3+} + \text{H}^+$	$0.3 \pm 0.05$	0.3	$0.32 \pm 0.22$	$0.12 \pm 0.12$
$\text{Zr}^{4+} + 2 \text{H}_2\text{O} \rightleftharpoons \text{Zr}(\text{OH})_2^{2+} + 2 \text{H}^+$	$\sim 1.7^*$		$0.98 \pm 1.06^*$	$-0.18 \pm 0.17^*$
$\text{Zr}^{4+} + 3 \text{H}_2\text{O} \rightleftharpoons \text{Zr}(\text{OH})_3^+ + 3 \text{H}^+$	$\sim 5.1$			
$\text{Zr}^{4+} + 4 \text{H}_2\text{O} \rightleftharpoons \text{Zr}(\text{OH})_4 + 4 \text{H}^+$	$-9.7 \pm 1^*$	$-9.7^*$	$-2.19 \pm 0.70^*$	$-4.53 \pm 0.37^*$
$\text{Zr}^{4+} + 5 \text{H}_2\text{O} \rightleftharpoons \text{Zr}(\text{OH})_5^- + 5 \text{H}^+$	$\sim -16.0$	$-16.0$		
$\text{Zr}^{4+} + 6 \text{H}_2\text{O} \rightleftharpoons \text{Zr}(\text{OH})_6^{2-} + 6 \text{H}^+$			$-29 \pm 0.70$	$-30.5 \pm 0.3$

$3 \text{Zr}^{4+} + 4 \text{H}_2\text{O} \rightleftharpoons \text{Zr}_3(\text{OH})_4^{8+} + 4 \text{H}^+$	$-0.6 \pm 0.1$		$0.4 \pm 0.3$	$0.90 \pm 0.18$
$3 \text{Zr}^{4+} + 5 \text{H}_2\text{O} \rightleftharpoons \text{Zr}_3(\text{OH})_5^{7+} + 5 \text{H}^+$	$3.70 \pm 0.1$			
$3 \text{Zr}^{4+} + 9 \text{H}_2\text{O} \rightleftharpoons \text{Zr}_3(\text{OH})_9^{3+} + 9 \text{H}^+$			$12.19 \pm 0.20$	$12.19 \pm 0.20$
$4 \text{Zr}^{4+} + 8 \text{H}_2\text{O} \rightleftharpoons \text{Zr}_4(\text{OH})_8^{8+} + 8 \text{H}^+$	$6.0 \pm 0.1$		$6.52 \pm 0.05$	$6.52 \pm 0.05$
$4 \text{Zr}^{4+} + 15 \text{H}_2\text{O} \rightleftharpoons \text{Zr}_4(\text{OH})_{15}^+ + 15 \text{H}^+$			$12.58 \pm 0.24$	
$4 \text{Zr}^{4+} + 16 \text{H}_2\text{O} \rightleftharpoons \text{Zr}_4(\text{OH})_{16} + 16 \text{H}^+$			$8.39 \pm 0.80$	
$\text{ZrO}_2(\text{s}) + 4 \text{H}^+ \rightleftharpoons \text{Zr}^{4+} + 2 \text{H}_2\text{O}$	$-1.9^*$	$-1.9^*$		$-5.37 \pm 0.42^*$
$\text{ZrO}_2(\text{s, baddeleyite}) + 4 \text{H}^+ \rightleftharpoons \text{Zr}^{4+} + 2 \text{H}_2\text{O}$			$-7 \pm 1.6$	
$\text{Zr}(\text{OH})_4(\text{am}) + 4 \text{H}^+ \rightleftharpoons \text{Zr}^{4+} + 4 \text{H}_2\text{O}$			$-3.24 \pm 0.10$	$-2.97 \pm 0.18$

\*Errors in compilations concerning equilibrium and/or data elaboration. Data not recommended. It is strongly suggested to refer to the original papers.

C.F. Baes and R.E. Mesmer, *The Hydrolysis of Cations*. Wiley, New York, 1976, pp. 152–157.

P.L. Brown and C. Ekberg, *Hydrolysis of Metal Ions*. Wiley, 2016, pp. 442–460.

W. Hummel, U. Berner, E. Curti, F.J. Pearson and T. Thoenen, National Cooperative for the Disposal of Radioactive Waste (Nagra), PSI Chemical Thermodynamic Data Base, Wettingen (Switzerland), 2002, pp. 491–518.

T. Thoenen, W. Hummel, U. Berner and E. Curti, The PSI/Nagra Chemical Thermodynamic Database 12/07, 2014.