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EXPERIMENTAL DETERMINATION OF ND(III) SOLUBILITY IN MIXTURES NACL AND $MGCL_2$: APPLICATIONS TO NUCLEAR WASTE MANAGEMENT

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Salt formations are ideal for nuclear waste isolation, as salt formations have the following advantages: (1) low permeability; (2) plastic deformation after closure of a repository to encapsulate wastes, (3) self-healing of fractures, and (4) high thermal conductivity of salt. As the estimated release of actinides calculated in performance assessment (PA) of geological repositories is directly influenced by the solubility of actinides, accurate predictions of actinide solubilities under the conditions relevant to disposal of nuclear waste in geological repositories are fundamentally important to PA. Nd(III) is a good non-radioactive analog for actinides in the +III oxidation state [An(III)]. Nd(III) is a very good analog to Am(III), as they have the very close ionic radii. In previous studies on Am(III)/Nd(III) solubilities, the media used were simple solutions, such as NaCl, $MgCl_2$, and $CaCl_2$. However, brines associated with salt formations are usually multiple component solutions in which Na, Mg and Cl are commonly major components. A good example would be the Generic Weep Brine (GWB) at the Waste Isolation Pilot Plant (WIPP) in which Na, Mg and Cl have concentrations of 4.04, 1.16, and 6.40 mol•kg^{-1}, respectively. Therefore, the solubilities of Nd(III)/Am(III) in mixtures of NaCl and $MgCl_2$ need to be studied.

In this study, we investigate Nd(III) solubilities in the mixtures of NaCl and $MgCl_2$ at 25°C in our long-term solubility measurements lasting more than 334 days. In the mixtures employed in our experiments, molalities of NaCl range from 0.50 mol•kg^{-1} to 5.0 mol•kg^{-1}, and molalities of $MgCl_2$ range from 0.50 mol•kg^{-1} to 2.0 mol•kg^{-1}. In our experiments, the solubility-controlling phase for Nd(III) is $Nd(OH)_3$(micro cr). In synthesis of $Nd(OH)_3$(micro cr), we followed the procedure from the literature. $Nd(OH)_3$(micro cr) was synthesized at 200°C by using the high purity Nd_2O_3. The synthesized starting material was characterized by using XRD and SEM-EDS techniques. The negative logarithms of hydrogen ion concentrations on a molal scale, pH_m, in our experiments, were determined based on the pH readings by applying correction factors for the mixtures of NaCl and $MgCl_2$ determined in our lab. The Nd(III) concentrations were determined by using an ICP-MS. The Nd(III) concentrations range from ~10^{-7} mol•kg^{-1} to ~10^{-5} mol•kg^{-1}. Based on our experimental results, we develop a Pitzer model to describe $Nd(OH)_3$(micro cr) solubilities in mixtures of NaCl and $MgCl_2$.

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