Experimental assessment of interaction between boric acid enriched in boron-10 and cementitious matrix

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After some decades in applying boric acid with natural isotopic abundance (natural boric acid, NBA) solution as a neutron absorber, some nuclear facilities have started to use boric acid enriched in B-10 (enriched boric acid, EBA) to increase the control ability and parallelly, decrease the amount of liquid waste. Meanwhile, the stabilization condition of EBA in the cementitious matrix and durability of the waste form in disposal facilities have not been assessed or at least have not been reported yet. However, high relative mass difference between the two stable isotopes of boron (B-10 and B-11) implies a different leachability index for cementitious matrix prepared with NBA and EBA wastes.

In this study, the leachability (ASTM C1308-08 standard, 2017) of boron isotopes from cementitious matrix and its geochemical background will be assessed using ICP-OES, XRD, SEM-EDX and Raman-spectroscopy. The effects of parameters such as temperature, water to cement ratio (w/c), boric acid concentration and shape of the waste form will be studied. Geochemical modeling of the experiments will be done via PHREEQC software, which should support our understanding of the different geochemical behavior of NBA and EBA.

Based on the theoretical knowledge, a significant increase in leachability of boron from the cementitious matrix is expected when EBA is used instead of NBA because of the geochemical behavior of the two stable isotopes. Increase in leachability is expected when temperature and w/c increased, whereas the leachability will decrease when the normal cylindrical shape of samples are changed to spherical shape.

References:

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