ENVIRONMENTAL CHEMISTRY

Physical and chemical stabilization studies of ordinary Portland cement (OPC) and sulfoaluminate cement (SAC) mixtures for immobilizing natural boric acid B-11 and enriched boric acid B-10

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Nuclear power facilities employ natural boric acid (NBA) and B-10-enriched boric acid (EBA) as solutions for neutron absorption which are subsequently disposed as high-volume liquid waste, which is becoming an environmental concern with increasing global proliferation of nuclear energy. The objective of the research was to determine the ideal ratio of Portland and sulfoaluminate cement (OPC & SAC) in cement pastes to achieve successful boric acid waste immobilization.

To accomplish our goal, cement paste wasteform samples were made using OPC and SAC in ratios ranging from 0% SAC (i.e., 100% OPC), 10% SAC, 20% SAC, 30% SAC, and 40% SAC, respectively. These samples were then separately mixed with NBA and EBA simulated liquid waste and allowed to cure. Standard reference leaching test was carried out on the cured solid waste forms for 11 days and they were analyzed by standard compressive strength test, scanning electron microscopy (SEM) and X-ray diffraction (XRD). Liquid waste from the leaching tests was analyzed using Raman-spectroscopy and the solution samples, coming out of the leaching tests, were analyzed by inductively coupled plasma optical emission spectroscopy (ICP-OES).

According to the results of mechanical tests and measurements of the cumulative fraction leached (CFL) of NBA and EBA, the ideal composition for binding boric acid could be 20% SAC and 80% OPC. This conclusion can be drawn because SEM and XRD tests further demonstrated that adding boric acid to the mixture slows down the stability of cement pastes.