



Modelling of leaching and geochemical processes in an aged MSWIBA subbase layer

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David Bendz, Pascal Suer, Hans van der Sloot, David Kosson, Peter Flyhammar

In a previous project: Vändöra Q4-241 (report 964), funded by Värmeforsk (Swedish Thermal Engineering Research Institute), the accumulated effects of leaching and aging in a subbase layer of bottom ash in a test road were investigated. The test road were constructed in 1987 in Linköping, Sweden, and was in use until the start of the Vändöra Q4-241 study in September 2003. The overall objective of the present study is to bring the evaluation of the previous project (Q4-241) further by taking advantage of the existing data, perform complementary laboratory experiments on four composite samples reflecting different degree of exposure to atmosphere and leaching. The specific objectives were to investigate: (i) what processes and mineral phases that govern leaching of macro- and trace elements and DOC in the bottom ash after 16 years (1987-2003) of aging under field conditions. (ii) how the hydrologic conditions, infiltration of water and leachate production has evolved with time. The following tests were performed on the composite samples: pH-stat test, column test, Fe/Al oxide extraction and TOC fractioning. Geochemical and hydrological modelling where performed with LeachXS/Orchestra and Hydrus 2-D.

Daily precipitation data from the Swedish Meteorological and Hydrological Institute (SMHI) from the Malmslätt (Linköping) measurement station was used in the hydrological modelling of January 1988 to the 1th of september 2003. The hydraulic modeling results show that the bottom ash subbase layer endure seasonal wet and dry cycles. The results confirm that, depending on the boundary conditions along the shoulders the capillary potential may drive moisture either in or out of the road body. The water retention parameters for bottom ash were crucial in the hydraulic modeling and the capillary forces in bottom ash were found to be significant with a water retention curve close to silt. This explains the observed depletion of easily soluble salts in the test road. The results showed that the accumulated LS ratio for the bottom ash subbase layer reached about LS:10 in average with a

spatial variability in the sub base layer ranging from LS:1 to LS:50.

The geochemical speciation modeling was carried out for major, minor and trace elements and integrate mineral dissolution/precipitation, iron-oxide adsorption, incorporation in ettringite solid solution, clay interaction and interaction with dissolved and particulate organic matter. The geochemical model was parameterized with data on HFO, TOC and IC. The governing mineral assembly was selected, based on this experience. Iron-oxide sorption was shown to be important for many trace elements (metals as well as oxyanions). The role of organic matter (both dissolved and particulate) is important for elements like Cu, Cr, Cd, Pb (although the major fraction of the available content is associated with the mineral phases). Obviously, proper mineral solubility data are limited for some elements, like Sb, B, Se. The model fit for macroelements was good and for trace elements the match is quite acceptable. The model confirms that Cu, Cr, Pb, and partially Zn, in solution is bound to DOC. The elements Zn, Cd and Ni are present in the solution mainly as free ions. It is important to realize that for ecotoxicity evaluations the free element is of importance and the DOC associated metal is not affecting many organisms. In the solid phase As is entirely associated with iron oxides. Other elements where iron oxides plays an important role are: Pb, Cd and Cu. The elements Cu, Zn and Ni are mainly associated with the solid phase as minerals: malachite (copper hydroxide carbonate) willemite (zinc silicate), nickel silicate and iron chromate. The result implies that release of elements could be predicted for a bottom ash under certain environmental conditions if available HFO and TOC are measured. The major environmental conditions that needs to be specified are: pH, DOC and DIC of intruding water and degree of exposure to atmosphere.

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