Reactive Transport and Multiphase Gas Model of Coal Tailings to Predict Potential Long-Term Seepage Quality

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# ABSTRACT

A geochemical reactive transport model was developed to predict the long-term seepage quality from coal mine tailings backfilled into an opencast pit. The model results serve as a "source term" for further contaminant transport simulations as part of the groundwater modelling.

The study incorporated a one-dimensional gas transport model to simulate oxygen ingress into the tailings, considering the sulfide and moisture content of the material. Key factors influencing gas migration included the Oxygen Consumption Rate (OCR), Oxygen Diffusion Coefficient (ODC), soil water retention characteristics, and the hydraulic properties of the tailings.

Thermodynamic rate parameters were derived from kinetic tests on tailings samples. These parameters, along with gas transport model results, were incorporated into the reactive transport model, which was calibrated to site-specific conditions. The model domain was designed to evaluate multiple seepage pathways, including migration into adjacent mine spoil backfill and the underlying aquifer.

Various geochemical model sensitivity scenarios were performed based on the variation in the tailings composition including reduced Acid Neutralisation Capacity (ANC) effectivity. Although the average tailings composition has limited potential to generate acidity, reducing the ANC effectiveness does increase this potential. The risk for acidification of the tailings pore water is also mostly limited to the upper part of the unsaturated zone. A pseudo-two-dimensional model was used to model the lateral flow from the backfilled tailings towards the adjacent spoils. These results could be used to calibrate and validate the model results.

The modelling highlighted that although static and kinetic tests are an important tool for acid-mine drainage (AMD) classification, site-specific conditions have a significant influence on the mechanisms creating AMD. Geochemical modelling can be a useful tool to bridge the gap between laboratory testing and site-specific conditions.