Evaluating the suitability of NORM disposal options using coupled migration and dose calculations

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Abstract

Assessing the impact of NORM waste disposal can be challenging, particularly for heterogeneous wastes of variable activity concentration, composition and character. The dose consequences arising from NORM disposal are clearly dependent on the amount of waste and the activity concentration and leachability of the radionuclides present. However, site specific parameters also influence radionuclide release and migration from the deposit into local water sources and their uptake into the human food chain. These include the rate of rainwater infiltration through the waste, the position of the disposal site relative to the nearest groundwater aquifer and its influence on that aquifer (i.e. dilution), the mineralogy of the aquifer material and the distance to a water source recipient. The mineralogy of the aquifer material influences sorption of radionuclides during migration, and therefore the degree to which the transport of each individual radioelement is retarded. Differential leaching and transport lead to the disruption of parent/daughter relationships, thus decay and ingrowth need to be accounted for along the transport pathway. All of these factors have a significant influence on the magnitude and temporal evolution of the doses received by the most exposed individuals.

Kemakta AB has developed the DOS2U model to assess doses arising from specific NORM disposal options over time. DOS2U couples radionuclide leaching and migration processes with biosphere transfer and dose calculations. The model contains data on the decay properties and dose coefficients of naturally-occurring radionuclides, as well as their distribution coefficients (K_d values) in selected types of soil and sediment and relevant food chain transfer factors. These values are updated as and when new robust values are published. Age-dependent dose coefficients are included to allow different critical groups to be assessed, and these are supported by age-consistent behavioral and consumption habits. Site specific hydrological and physical data are entered for each disposal site of interest. A large number of different waste types can be deposited at a single site, therefore the mass, activity concentration and leach characteristics of the radioisotopes in the different waste types can be provided as model input.

Applications of the DOS2U model will be presented, focusing on an analysis of dose consequences of various disposal options for NORM-contaminated decommissioning wastes. The model has allowed us to optimize the disposal of low risk wastes at purpose-built on-site facilities, while identifying the wastes that require disposal in a specialized hazardous waste facility. This dose-based evaluation, given as a function of time, provides a clear numerical risk analysis that gives support for the decision-making process. Additional benefits of the model include the simultaneous calculation of the doses to workers at the site, as well as doses to the public in an intrusion scenario.