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# Deriving lumped parameters for DGR safety assessment by 3D transport model postprocessing

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The safety assessment (SA) of the spent nuclear fuel repository is often based on lumped-parameter models (LPM) of radionuclide transport between the source term and the biosphere (under various terminology like a compartment model, or a channel model). It profits e.g. from computational efficiency when used with stochastic data. Useful property of LPM is intuitively clear influence of most of its parameters, in terms of “the larger/smaller the better”. On the other hand, some parameters are not clearly defined and their values depend on expert choice.

Gradual improvements of computing hardware and simulation software also allow using physically-based models on real geometry for SA application. Migration of radionuclides is simulated by means of groundwater flow and advective-dispersive transport with linear sorption on the input (hydro)geological configuration of site. Defining a LPM based on the 3D transport input data and results, it actually represents a model upscaling method and can keep the LPM advantages with avoided compromises of their input data definition.

As the LPM, we consider a generic 1D channel with analytical advection-diffusion-sorption solution, in particular implemented in GoldSim software as “Pipe” object. The 3D flow and transport are solved with Flow123d simulation code (open-source developed at author’s institute), but the presented principles are theoretically applicable to any finite-element or finite-difference code.

We derived a procedure of integral processing of 3D model velocity field and trajectories and the fictitious pulse or step input breakthrough curve between the repository and the output to the biosphere. Four tracers have been used at the same time: non-sorbing, less/more sorbing, and decaying. The relevance of estimation was verified by optimization of the LPM parameters to the best fit between the 3D model and the LPM for all kinds of tracers. The optimization decrease the fit criterion by a small factor, but graphically, all three curves (3D transport, postprocessed LPM, and optimized LPM) are similar.

The resulting data (path length, cross-section, flow rate, travel time, dilution factor, etc.) are obtained with little computing cost compared to the optimization. With a reasonable precision, they can serve for quick comparison of candidate sites, without explicitly running the 3D model or the lumped-parameter model with full source term temporal evolution. On the other hand, some of the parameters are questionable whether physical realistic, which is a consequence of possible model oversimplification. Therefore, other LPM configurations with more blocks representing the real conceptual path segments are evaluated – two serial, three serial and two serial couples in parallel. Due to more constraints, the breakthrough curve fit between LPM and 3D is little worse but with important advantage of physically realistic parameters.

The method was demonstrated on hydrogeological configuration of 9 anonymized (and with partly synthetic features) candidate sites in Czechia.

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