Contribution ID: **153** Type: **Poster**

Sensitivity analysis of geological parameters influencing a solute transport from a deep repository of spent nuclear fuel

Thursday, May 15, 2014 5:30 PM (1h 15m)

When evaluating Nuclear Waste DGR Safety [1] it is necessary to confirm its safety in a long run and above all its safety towards the biosphere, more precisely that the biosphere will not be in any hazard caused by radioactive substances. With the aid of geologists a model of a hypothetical area (the Melechov Massif) was elaborated and described with the use of geological (38 types of rocks possessing different hydraulic conductivity depending on the depth) and hydrogeological parameters [2]. The model covered the area of about 100 km2, the depth went up to 600m and it was mathematically meshed with 37 000 elements. The volume of isotopes released out of the massif at the borderline of the near/far field from the DGR was determined (according to the reference project - measurements of 40 isotopes had to be carried out). For the most critical isotopes were considered C14, Cl36, Sr90, I129, Cs135 and Ra226.

The paper results showed that ground water flow and transport of substances within the area were the first ones to be determined. The Flow123D SW [3] developed at the Technical University of Liberec was used for the determination. The SW allows flow and transport calculations in the 3D geometry (a feature that makes it different from the similar SW available at the market). The resulting outcome represents a determination of transported substances concentration (in particular elements within the area) depending on time and its "function"is shown graphically or in the map form. To model the transport it was necessary to do calculations of all isotopes particularly.

The disadvantage of the model is the fact that all the input parameters were set deterministically [4]. The problem is being solved using the sensitivity analysis (changing the input parameters) or using the Monte Carlo Method [5].

The sensitivity analysis changing the input parameters is based on the "defined change"of (given) input parameters, i.e. hydraulic conductivity of particular types of rocks or fissures, opening of fissures, porosity and sorption parameters of transported substances. A set of new functions has been reached and followed with transport calculations.

The sensitivity analysis using the Monte Carlo method is based on defined changes of input parameters that are supposed to be stochastic ones. In this case it was necessary to know the expected (mean) value, variance and the type of the expected statistical distribution describing the given parameter.

The major paper results are: (1) calculations of the radionuclide concentrations in the elements depending on time, (2) explanation of the (basic) principal of the sensitivity analysis applications in the particular model parameters and (3) determination of parameters that have the biggest impact on the sensitivity of the whole model.

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Session Classification: Poster Session - Chemistry of Nuclear Fuel Cycle / 1st ASGARD International Workshop

Track Classification: Chemistry of Nuclear Fuel Cycle / 1st ASGARD International Workshop