What are Required for Ensuring the Safe Disposal of Radioactive Wastes?

Sol-Chan Han, Yongheum Jo, and Jong-Il Yun

Department of Nuclear and Quantum Engineering, KAIST, 291 Daehak-ro, Yuseong-gu, Daejeon, Republic of Korea

jiyun@kaist.ac.kr

Placing a repository of spent fuel and/or high-level radioactive waste at depth in a long-term stable geological environment has been regarded as one of the most appropriate disposal methods. Usually, a deep geological repository is equipped with the multi-barrier system, namely canister, buffer, and geological overrock to prevent the radioactivity release into the biosphere and to protect human and environment.

Over the past decades, much efforts have been devoted to improve the disposal safety of radioactive waste repositories. Up to now, a number of researches have been conducted by not only fundamental and practical experiments to understand the migration behavior of radionuclides, but also the development of THMC (Thermo-Hydro-Mechanical-Chemical) coupled models to assess the safety of radioactive waste disposal.

Even though numerous studies have shed light on the field, a number of concerns remain still unclear. For instance, a sophisticated understanding on chemical behaviors related to the retention and migration of radionuclides including transuranics in natural aquatic environments, such as complexation with various inorganic/organic ligands, redox process, sorption, colloid formation, etc. is still challenging. Furthermore, detailed geochemical processes of radionuclides are to be implemented in a numerical simulation approach for safety assessment [1]. Besides, the in-depth knowledge about the radionuclide retention mechanism of highly mobile anionic species, such as I^-, HCO_3^-/CO_3^{2-}, TcO_4^-, and Cl^- should be gained and improved for enhancing the disposal safety.

The presentation will review the state of knowledge and requirements for the safe disposal of radioactive wastes. The following three topics are mainly covered in the talk: i) the brief review of the chemical thermodynamics of transuranic elements [2], ii) the safety assessment methods reinforcing the reliability of numerical models conjugated with complementary indicators [3], and iii) highly mobile anions such as $C(IV), Tc(-I/VII), I(-I/VII), Se(-I/IV)$ and the engineered strategy for mitigating their mobility in subsurface environments.

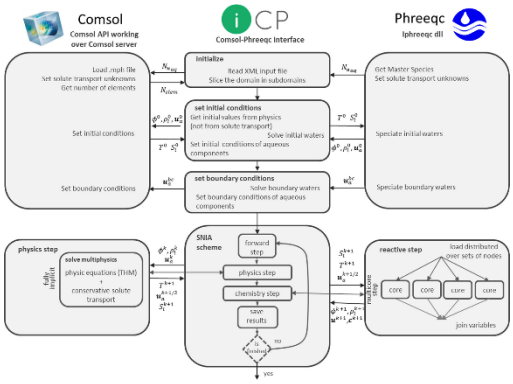

Fig. 1. Numerical model interfaces between COMSOL and PHREEQC [1].

REFERENCES

[1] A. Nardi, A. Idiar, P. Trinchero, L. M. de Vries, and J. Molinero, “Interface COMSOL-PHREEQC (iCP), an efficient numerical framework for the solution of coupled multiphyscis and geochemistry”, Computers & Geosciences, 69, 10-21 (2014).

[2] H. Geckeis and T. Rabung, “Actinide geochemistry: From the molecular level to the real system”, Journal of Contaminant Hydrology, 102, 187-195 (2008).

[3] D.-A. Becker, J.-L. Cormenzana, A. Delos, L. Duro, J. Grupa, J. Hart, J. Landa, J. Marivoet, L. Orzechowski, T.J. Schröder, A. Vokal, J. Weber, E. Weetjens, and J. Wolf, “Safety and Performance Indicators”, Deliverable 3.4.2 of the European Commission, PAMINA Project (2009).