Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12726

Study on characteristics of gas migration in the compacted bentonite core used as the artificial barrier in the spent nuclear fuel (SNF) repository site of Korea

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South Korea is planning to build a deep geological repository for the permanent disposal of spent nuclear fuel (SNF) generated by nuclear power generation. Study for the effect of gas on the radionuclide migration in the SNF repository barriers becomes necessary to mitigate the global concerns such as radiation leak and radioactive contamination around the SNF repository sites. Before the construction stage of repository site, the understanding of gas-radionuclides migration in barriers is very important to prevent the spread of outflowing gases and radionuclides from the site. This study includes the reviews for the main gas generation mechanisms of the SNF repository site designed in the South Korea. Mechanisms of H_2 gas generation due to the corrosion of SNF disposal canister were reviewed from previous researches and the migration of H_2 gas from the canister wall to the artificial barrier medium (compacted bentonite core) was simulated in the laboratory scale experiment. The H_2 gas injection pressure into the compacted bentonite core as an artificial barrier was investigated on the simulated repository site conditions in experiments. Quantification of gas movement in pore space through micro-scale visual experiments were also performed. The cylindrical core (5 cm in diameter and 5-10 cm in length) from the compacted bentonite block was used in experiment. The high pressurized stainless cell with the facility controlling the confining pressure, piston pump, and back pressure regulator were used.

From experimental results, the H_2 gas entry pressure on various confining pressure and water saturation conditions and the change of its flow rate in the compacted bentonite core were determined. The physical and mineralogical changes of the compacted bentonite core after the experiment were also measured to evaluate its resistance against the chemical reaction. Utilizing the migration governing equations that matche the gas migration scenario in the compacted bentonite medium, the gas migration model in the artificial barrier was also presented. Information and data from this study will be applied to determine the most suitable barrier medium for the Korean SNF repository site and to support meaningful parameter values for the long-term gas migration modeling around the repository site.