Simulation of resaturation process in the engineered barrier system of a high-level waste repository

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1. intruduction

The engineered barrier system (EBS) of a high-level waste repository constructed in a deep rock formation consists of the waste form, the disposal container, and the bentonite buffer. The major role of the EBS is to control the intrusion of groundwater, and then to minimize the release of radionuclide to the surrounding host rock. The coupled processes occurring in the EBS such as the heat generation from the waste, the intrusion of groundwater from the surrounding rock, and the stress changes due to the swelling of buffer material are the important issues in the performance assessment of the repository.

2. KENTEX

An engineered scale experiment, the KENTEX is being performed at the Korea Atomic Energy Research Institute (KAERI) to study the thermal, hydraulic and mechanical (T-H-M) processes occurring in the EBS. The KENTEX consists of a confining cylinder with a cylindrical heater and bentonite blocks, a hydration tank, and a data logging and instrumentation system. The vertical steel confining cylinder simulates the deposition hole excavated in the host rock of the repository, and its inner diameter and height are 0,75 m and 1.36 m, respectively (Fig. 1). There are 24 nozzles at the side wall of the confining cylinder to supply groundwater to the bentonite buffer. The groundwater is injected through the nozzles from the hydration tank with a pressure of 5 atm.

The average dry density of bentonite block in the confining cylinder is 1.5 Mg/m^3. The temperature at the interface of a cylindrical heater simulating the disposal container and the bentonite buffer is being maintained at 90℃. The KENTEX is a third scale of the engineered barrier system for the repository concept proposes by KAERI.

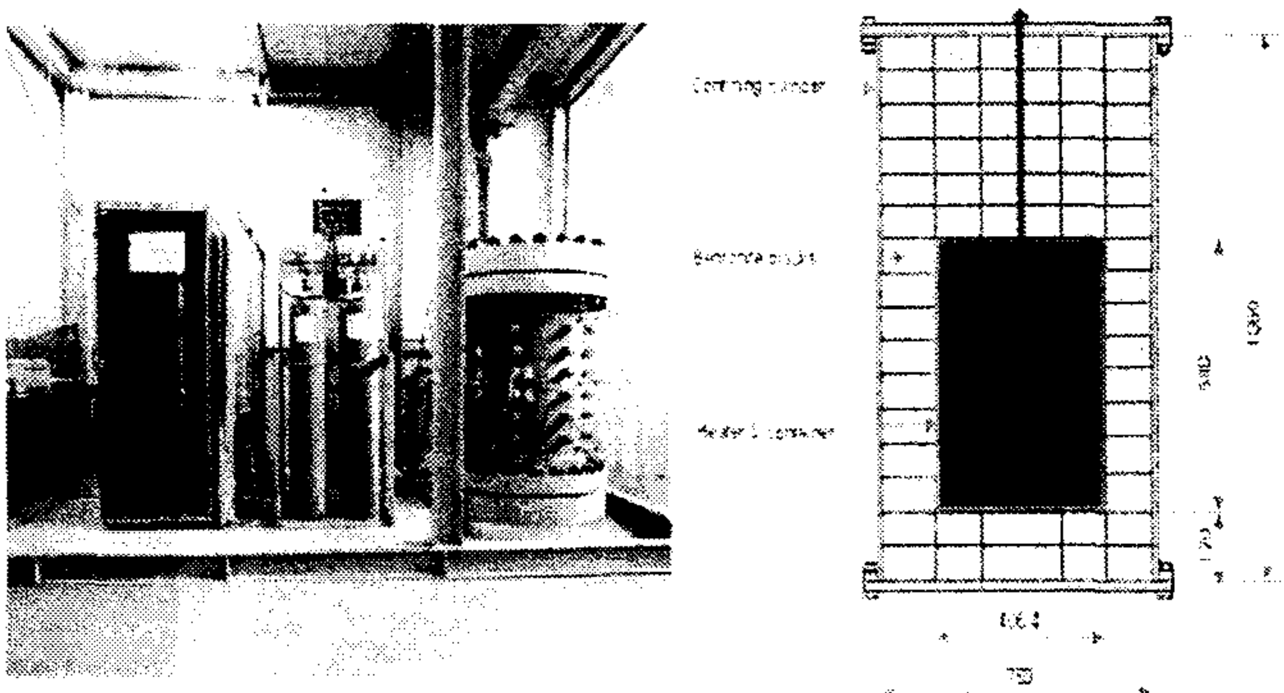

Fig.1 Schematic diagram of the KENTEX

3. Results and Discussion

The water content and temperature distribution in the EBS of the KENTEX with an intrusion of groundwater into the bentonite buffer were analyzed with the TOUGH2 computer code [1]. The detailed geometry of the KENTEX was incorporated in the model. The configuration of the KENTEX was modelled with a radially-symmetric mesh. The outer boundary was assumed to have a Dirichlet boundary condition. The hydraulic and thermal properties of the bentonite buffer were measured from the laboratory experiments, and the bentonite-water retention relationship was also obtained from the experimental data. These properties were then implemented in the TOUGH2 code. The calculated results were compared with the measured ones from the KENTEX experiment. Both agree well to indicate that the T-H coupled process in the KENTEX can be simulated reasonably well with TOUGH2 code (Fig. 2).

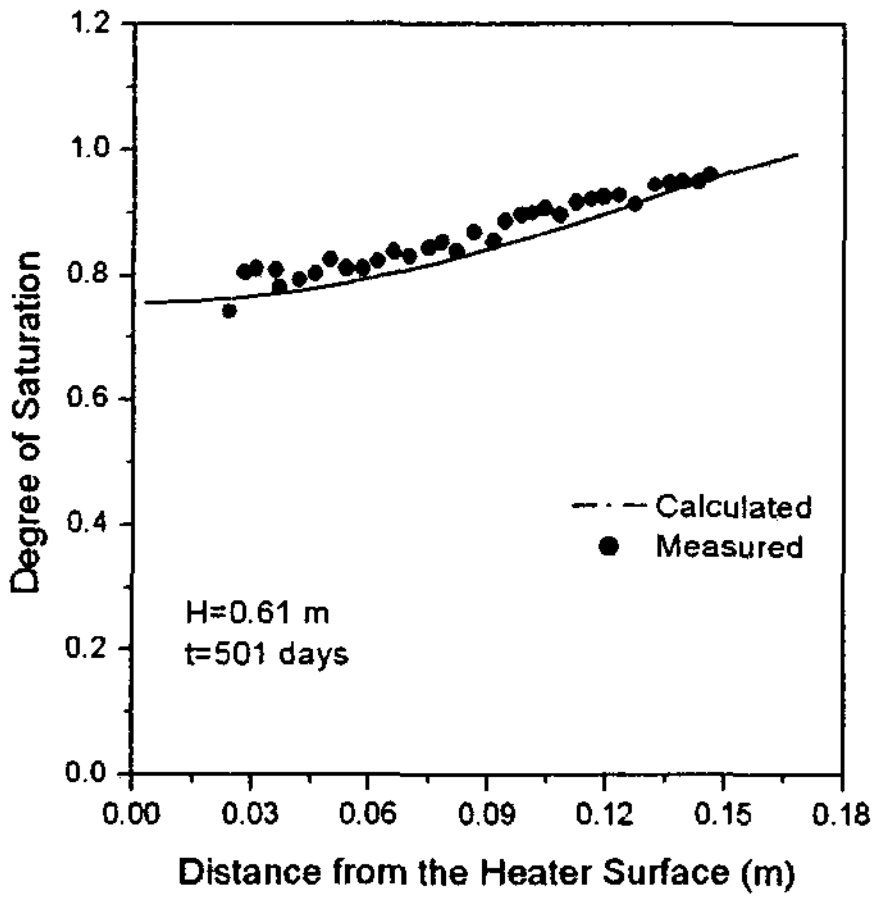

Fig.2 Calculated and measured water content distribution

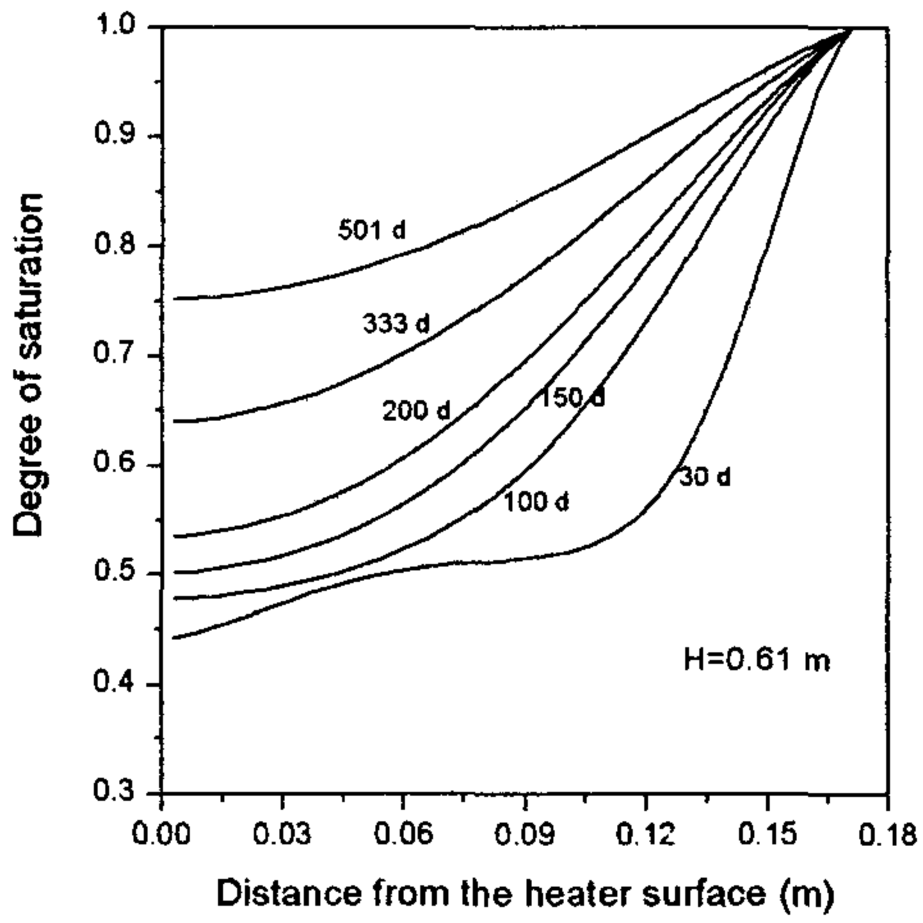

Fig.3 Time dependent change of the degree of saturation distribution

4. Conclusion

The water and temperature distributions in the engineered barrier system due to the intrusion of groundwater into the bentonite buffer were analyzed with the TOUGH2 computer program. Both the calculated results and measured ones agree well with each other which indicates that the coupled thermal and hydraulic process in KENTEX can be simulated reasonably well with the TOUGH2 computer program.

REFERENCES

[1] K. Pruess, C. Oldenburg and G. Moridis, "TOUGH2 User's Guide, Version 2.0, Lawrence Berkeley National Laboratory, LBNL-43134 (1990).