# Current Status of Research Activities Related to THM-Coupled Processes in Buffer

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## 1. Introduction

The major components of engineered barrier system in a geological disposal system for HLW are a disposal canister and a buffer. The major role of the buffer is to prevent groundwater from contacting a disposal canister. The buffer is made of swelling clay, bentonite, which swells well when it soaks water. Due to a heat from a disposal canister and groundwater from the surrounding rock, the bentonite buffer changes its intrinsic properties, porosities, hydraulic conductivities, thermal conductivities, and so on. Those changes result in a T-H-M coupled behavior in the buffer.

Several kinds of commercial computer programs are used to analyze the THM behavior. TOUGH2-FLAC3D, THAMES, Code-BRIGHT, and COMPASS are well-known and widely-used programs. Several countries couple two computer programs, TOUGH2 and FLAD3D, for THM analysis. Generally, TOUGH2 is developed to solve the TH-coupled problem and FLAC3D is for the TM-coupled problem. KAERI developed a computer program, KAERI-SIMULATOR, to couple and solve the THM problems using TOUGH2 and FLAC3D. The verification of the code has been carried out by participating in the Decovalex-2015 international joint study.

A small scale experiment for the TH-coupled process has been carried out in order to enhance the understanding of THM behavior in buffer. To simplify the experiment, only temperature (T) and relative humidity (H) in buffer were selected as the major measurement parameters.

Finally, an in-situ experiment facility called In-DEBS (In-situ Demonstration of EBS performance at KURT) was being designed, and its performance was analyzed. The facility was designed at 1/3 scale of A-KRS which was developed for the geological disposal of HLW from pyro-processing of PWR spent nuclear fuels.

The main purpose of this paper is to outline the current development of KAERI-SIMULATOR for THM analysis and the future plan for the laboratory and in-situ experiment related to the THM-coupled processes.

## 2. KAERI-SIMULATOR

The well-known computer programs such as TOUGH2 and FLAC3D are developed to analyze the TH or TM behaviors, respectively[1]. Code_Bright and COMPASS are developed for the simultaneous analysis of THM behavior. However, due to the difficulties in the analysis, most of the techniques show the unsatisfactory results.

KAERI team tried to use TOUGH2 developed by LBNL and FLAC3D by ITASCA for THM analysis in buffer and its surroundings. Both the codes use the totally different element and node system. Also, TOUGH2 can be used only for the homogeneous media in the thermal and hydraulic analysis. KAERI simulator based on FLAC3D mesh generation was developed to solve the THM coupled process for anisotropic media for thermal and hydraulic analysis (Fig. 1). The verification of the code has been carried out by participating in the DECOVALEX-2015 task B1.

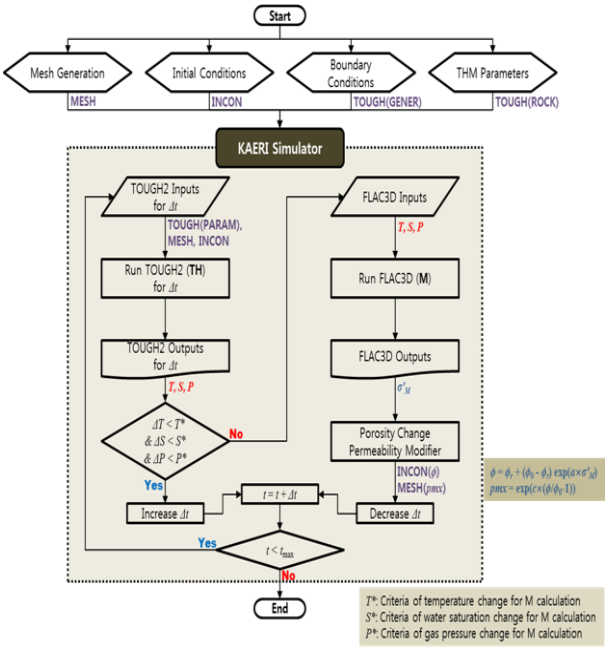


Fig. 1. Algorithm for KAERI-SIMULATOR.

## 3. Laboratory TH experiment

An experimental apparatus for TH-coupled behavior in buffer was set up at a laboratory scale (Fig. 2). The major purpose of this experiment was to know the effect of heat flux on the unsaturated flow. The size of buffer block is 340 × 120 × 70 mm, and the dry density of bentonite block is 1.6 g/cm$^3$. The effect of temperature will be compared at 30℃, 90℃, and 125℃. Five kinds

of sensors-temperature, relative humidity, pore pressure, water content, and total pressure- were installed in buffer to measure the TH and M behavior. More than 200 days, the THM data have been collected from two sets of TH apparatuses.

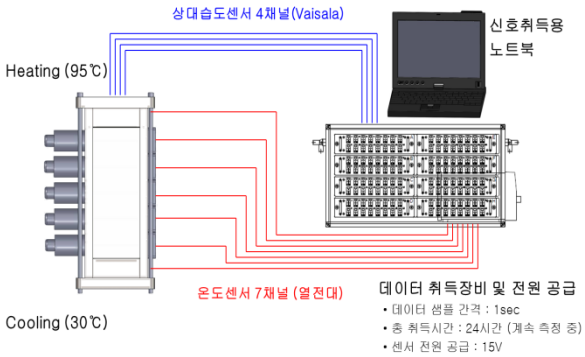


Fig. 2. TH experiment in a laboratory.

## 4. In-situ experiment at KURT

KAERI has developed a geological disposal system for HLW from pyro-processing of PWR spent fuels, called, A-KRS [2, 3]. A small scale, around 1/3, demonstration facility was designed to study the manufacturability and THM behavior at the in-situ state. In-DEBS (In-situ demonstration of EBS performance) facility was designed with the KURT geological data, and the preliminary performance assessment was carried out. The following research activities are planned:

- Demonstration of manufacturing technique
- Demonstration of installation of a unit disposal module (disposal canister and buffer)
- Acquisition of the long-term THM behavior data
- Validation of the modeling technique, KAERI-simulator
- Measurement of in-situ corrosion rates of copper canister
- Development and demonstration of monitoring techniques for major parameters in buffer: temperature, total pressure, and hydraulic conductivity.

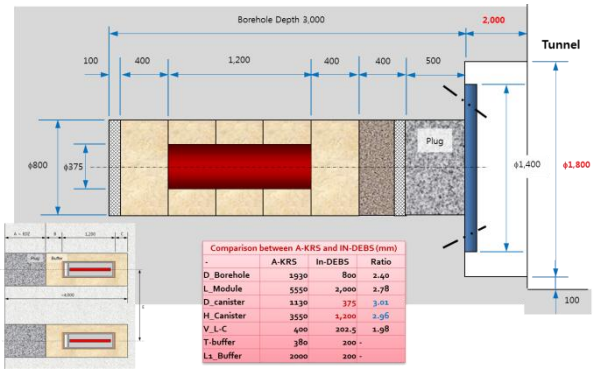


Fig. 3. In-DEBS facility for the in-situ demonstration of EBS performance.

## 5. Conclusions

For the purpose of enhancing the understanding of THM-coupled behavior in and around buffer, a computer code, KAERI-SIMULATOR, is being developed and verified by participating in Decovalex-2015 project. Also, a laboratory scale TH experiment apparatus has operated for more than 200 days at 30℃ and 90℃. TH measurement data will be used to validate the KAERI-simulator. In order to demonstrate the manufacturability and in-situ installation of EBS components, an in-situ demonstration facility (In-DEBS) was designed and will be installed at the KURT. The THM data collected from this facility will be used to validate the KAERI-SIMULATOR.

## Acknowledgement

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