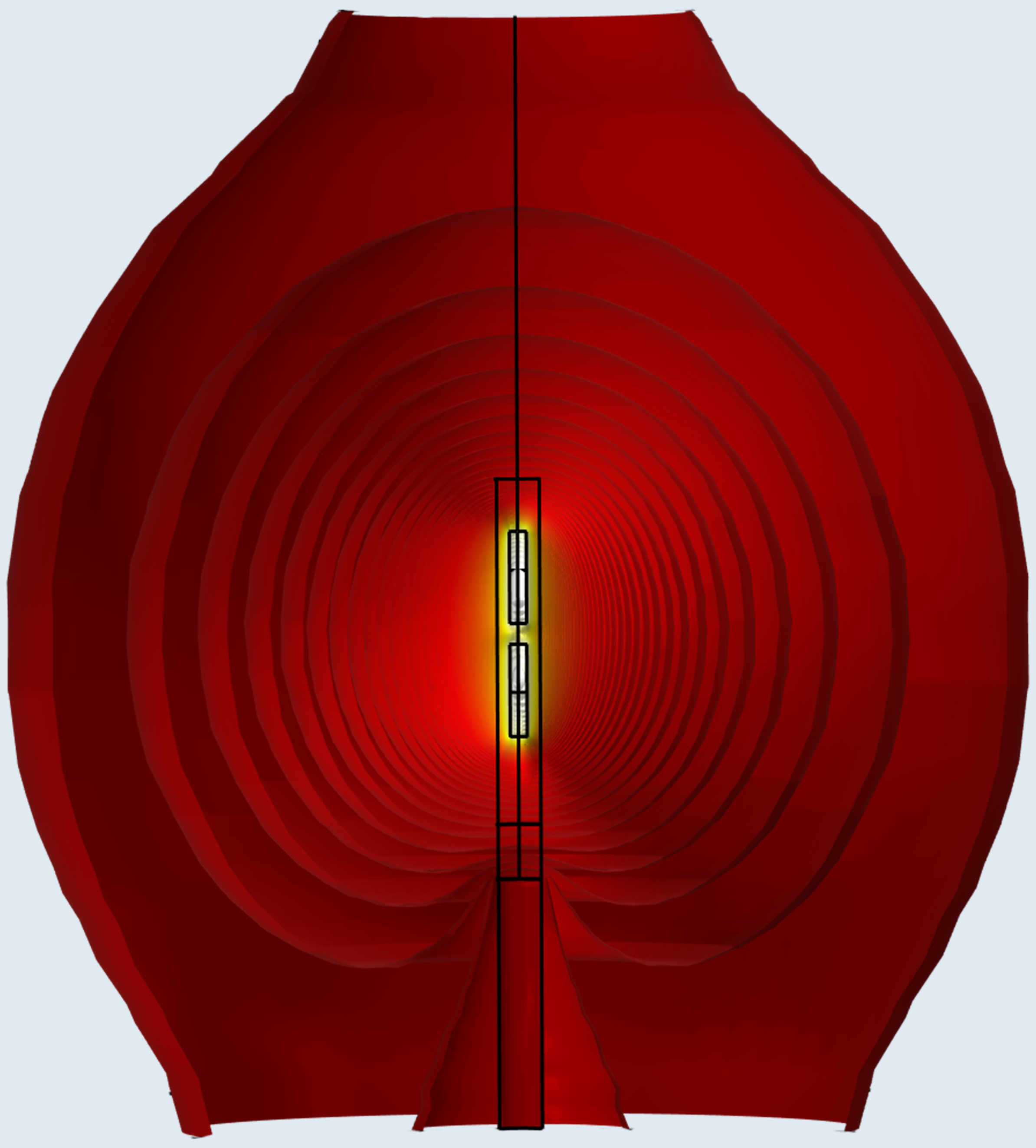

Development of a Special COMSOL® Interface Based for Bentonite Re-Saturation

A dedicated interface for bentonite re-saturation has been developed within COMSOL. A first validation is showing promising results.

M. Kröhn[1], L. Fromme[2]
1. Repository research department, GRS gGmbH, Braunschweig, Germany
2. Faculty of Engineering and Mathematics, Hochschule Bielefeld – University of Applied Sciences and Arts (HSBI), Bielefeld, Germany

Introduction

Waste canisters in a radioactive waste repository are envisaged to be protected against groundwater by bentonite barriers. The thermo-hydro-mechanically (THM) coupled process of water uptake by the bentonite is commonly based on two-phase flow. As an alternative to these THM-models, a thermo-hydraulically coupled saturation model for confined conditions has been developed and realised for 1D-problems with the experimental code VIPER [1].

To enhance the inherently limited range of possible applications of this code, an own interface, based on the VIPER equations, has been developed using the COMSOL Physics Builder.
The VIPER interface has then been validated using measured data from a laboratory test and from a large scale in-situ experiment.

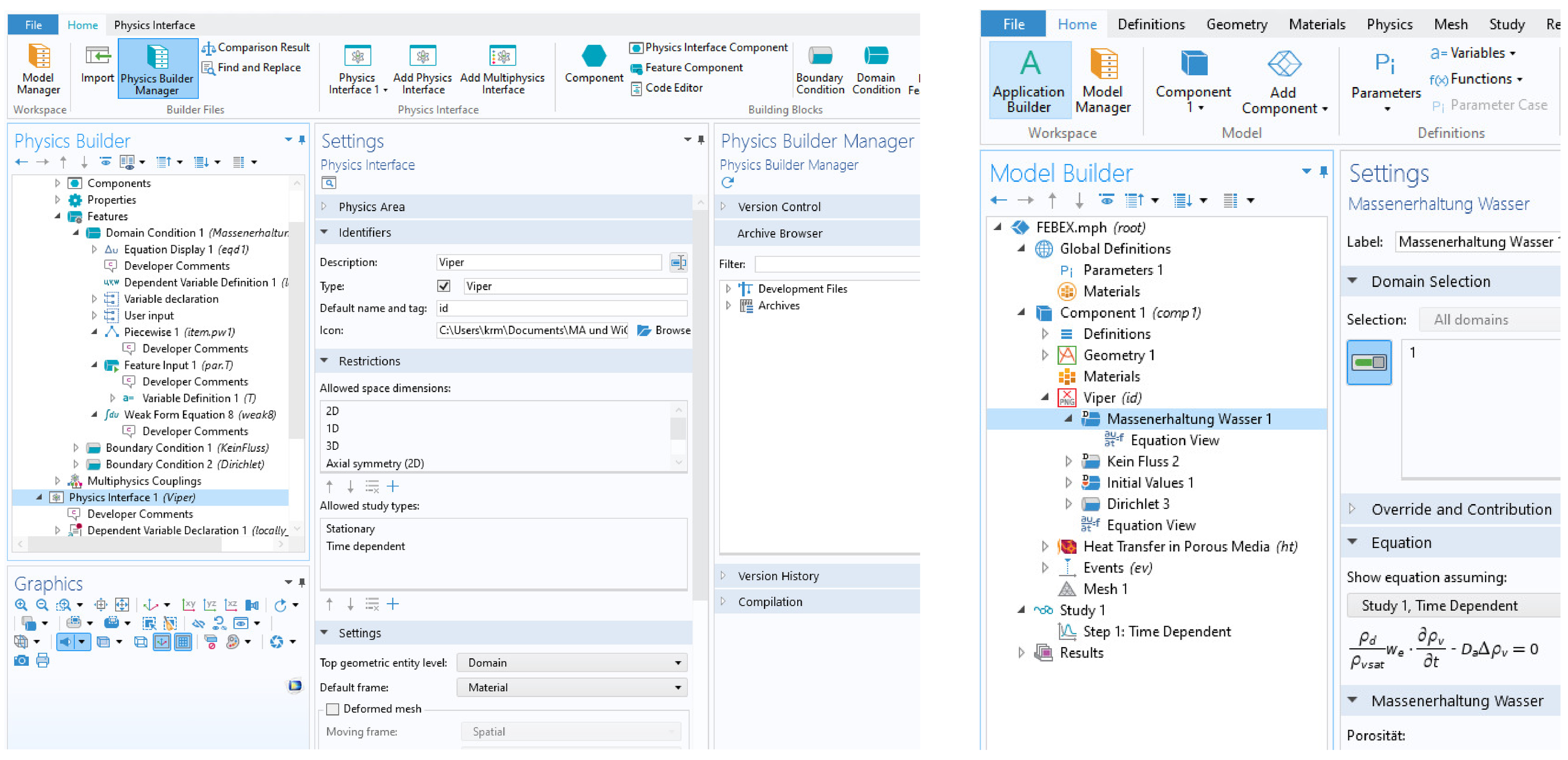

Figure 1. left: Screenshot of the COMSOL Physics Builder user interface.
right: Screenshot of the VIPER interface.

Methodology

Beside the option of implementing PDEs in COMSOLs mathematical interfaces, it is also possible to create own interfaces with the COMSOL Physics Builder. An own interface based on the VIPER equations [1] has been created in stages with increasing complexity.
First, only PDEs describing an isothermal system have been implemented and validated successfully by a comparison with data from lab experiments. The complexity increased when terms for non-isothermal conditions were added. The preparation for a multiphysics coupling with a COMSOL own heat transfer interface was challenging as the present COMSOL version does not provide means to extract parameters from the existing interfaces.

Results

The in-situ experiment FEBEX [2] has been used for the validation of the non-isothermal VIPER interface as well as the implemented full coupling. As the experiment was well monitored by many temperature and humidity sensors, much pointwise data is available for a comparison with the model results. Also, the power uptake of the used heaters has been monitored.
The model results at several measurement points matched the measured data quite well. Exemplarily, the fit for power uptake and the fit for the relative humidity evolution are shown in Figure 2, demonstrating that the VIPER equations have been successfully transferred to a dedicated COMSOL interface. Nevertheless, more testing is necessary and further development of the interface is planned.

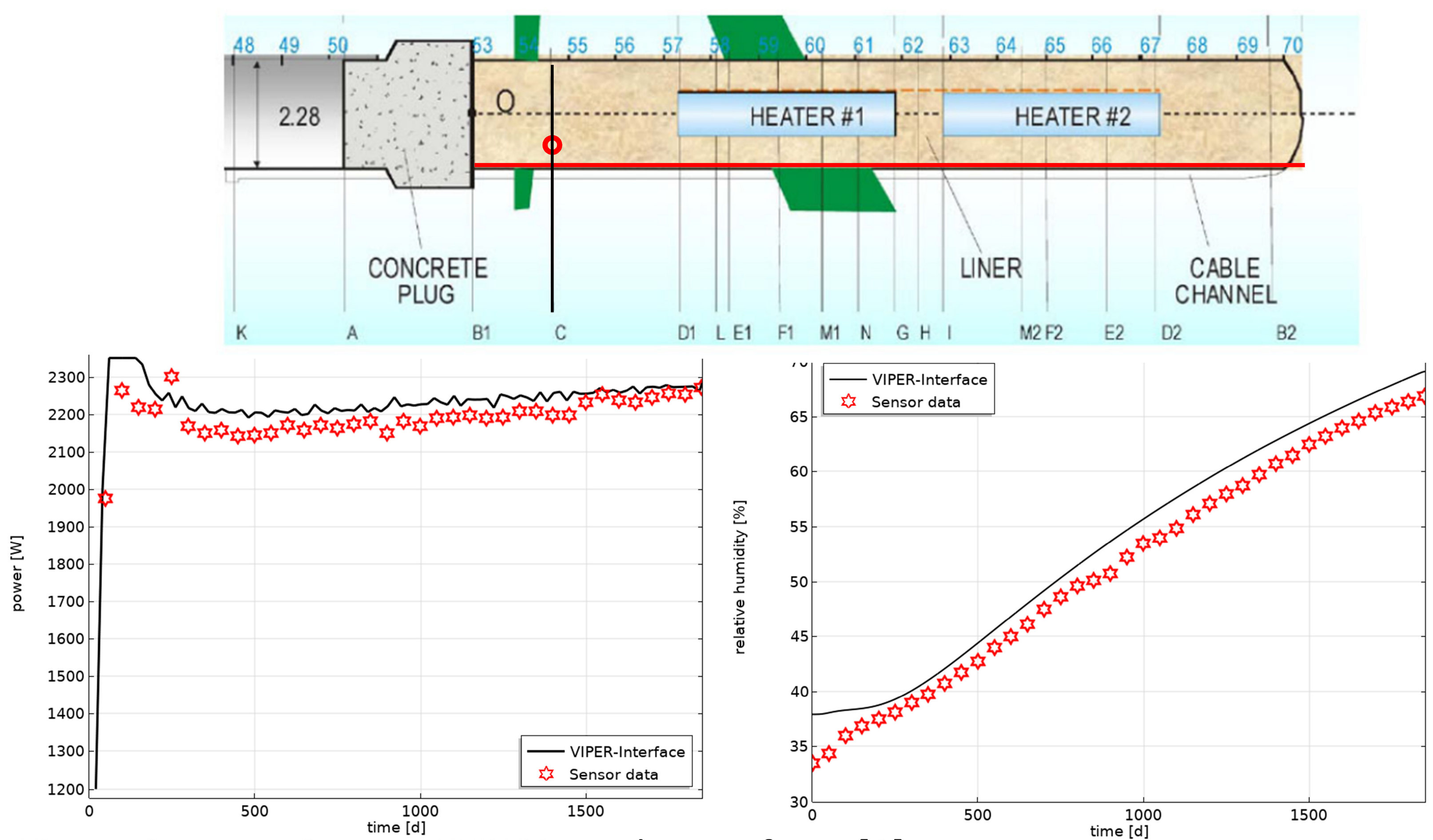

Figure 2. upper image: FEBEX test layout from [2].
left: comparison of measured and calculated heater power uptake.
right: comparison of humidity evolution.

REFERENCES

[1] Kröhn, K.-P.: Code VIPER - Theory and Current Status. Status report, FKZ 02 E 10548 (BMWi), Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, GRS-269, Köln, 2011.
[2] Gens, A., 2022. Engineered Barrier System (EBS) Task Force, Task 9: FEBEX in situ test, Final Report. Svensk Kärnbränslehantering AB (SKB)

Hochschule Bielefeld
University of Applied Sciences and Arts

Excerpt from the Proceedings of the COMSOL Conference 2023 Munich