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Detailed 3-D Models of a Large-Scale Underground Thermal Energy Storage with Consideration of Groundwater Conditions

A. Dahash, M. Bianchi Janetti and F. Ochs
Institute of Construction and Material Science; Unit for Energy Efficient Buildings; University of Innsbruck, Innsbruck, Austria

Research Motivation

- Large-scale thermal energy storage (TES) is a key component for transition to sustainable energy utilization in urban centers. The influence of TES on the surroundings is poorly investigated in literature. Complex geometries and influence of ground water flow cannot be modelled with existing tools.

- This paper describes the development of an axial symmetrical model for circular TES systems with its surrounding environment.

Simulation Results

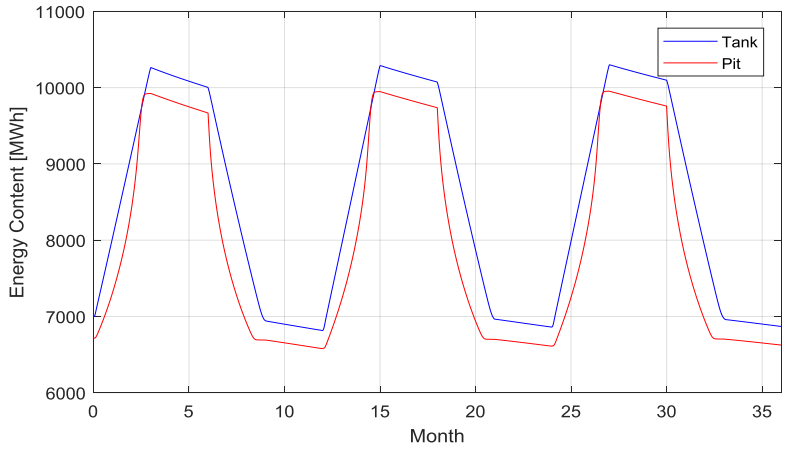

Fig. 3: Energy stored in the underground storage over 36 months.

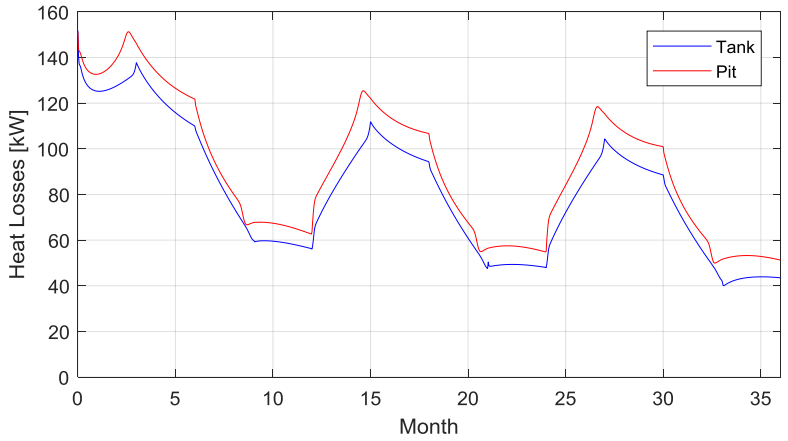

Fig. 4: Heat lost from the underground storage over 36 months.

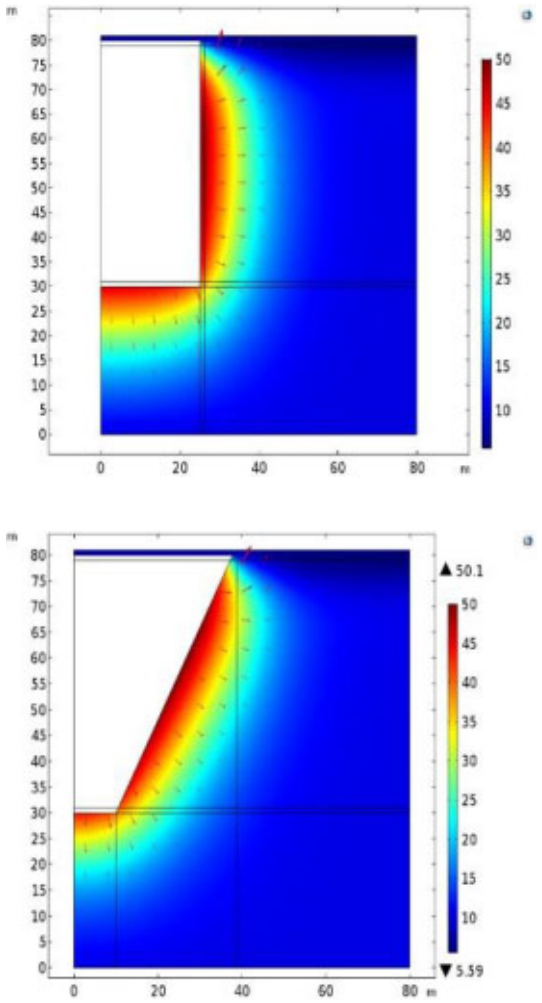

Fig. 5: Contour plots for the surroundings of the tank (upper) and the pit (lower) TES at the end of the 3rd year.

Simulation Results

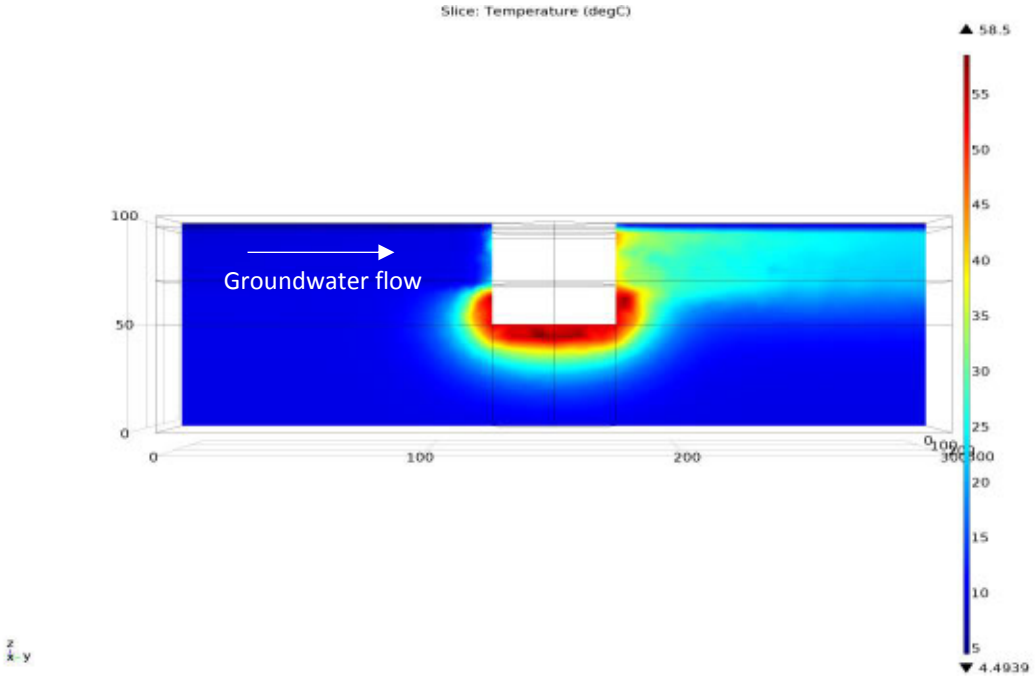

Fig. 6: Surroundings temperature in degree C for a tank with groundwater flow at the end of the 3rd year.

Table. 2: Comparison of energy losses in MWh calculated for a constant charging temperature with 90°C and constant discharging temperature of 60°C for a storage volume of 100,000 m^3, year three of simulation.

	Top	***Wall***	***Bottom***	***Total [MWh/a]***
Tank	112	422	77	**611**
Pit	244	444	17	**705**

Conclusions and Outlook

- The thermo-hydraulic behavior of the storage medium is correctly implemented and delivers qualitatively correct results. Validation of the model is ongoing.

- The ground is highly influenced, depending on the level of insulation and depending on the ground properties and ground water conditions. Surrounding's temperature can exceed 40°C.

- The developed model can assist the development of cost-effective TES constructions and investigate both, the thermal performance of the TES and its influence on the surroundings.

Acknowledgment

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