Simulation of a vertical ground heat exchanger as low temperature heat source for a closed adsorption seasonal storage of solar heat

Samuel HENNAUT[1*], Sébastien THOMAS[1], Elisabeth DAVIN[1], Alexandre SKRYLNYK[2], Marc FRERE[2] and Philippe ANDRE[1]

[1]University of Liège, Building Energy Monitoring and Simulation, Belgium

[2]University of Mons, Energy Research Centre, Belgium

[*] shennaut@ulg.ac.be

***Objective: To* study the suitability of a geothermal heat exchanger (GHX) as cold source/sink for a closed adsorption seasonal storage reaching a nearly 100% solar fraction for space heating (SH) of a "low energy building"**

Methodology

The analysis is conducted in **dynamic simulation**, using TRNSYS 17.

The influence of **3 parameters** is studied:

- Pinch point ΔT of the evapo/condenser: **3 to 7 °C**
- Borehole depth: **60 to 160 m**
- Flow rate in the borehole: **700 to 1400 kg/h**

No consideration of pump parasitic consumption.

Performance Indicator

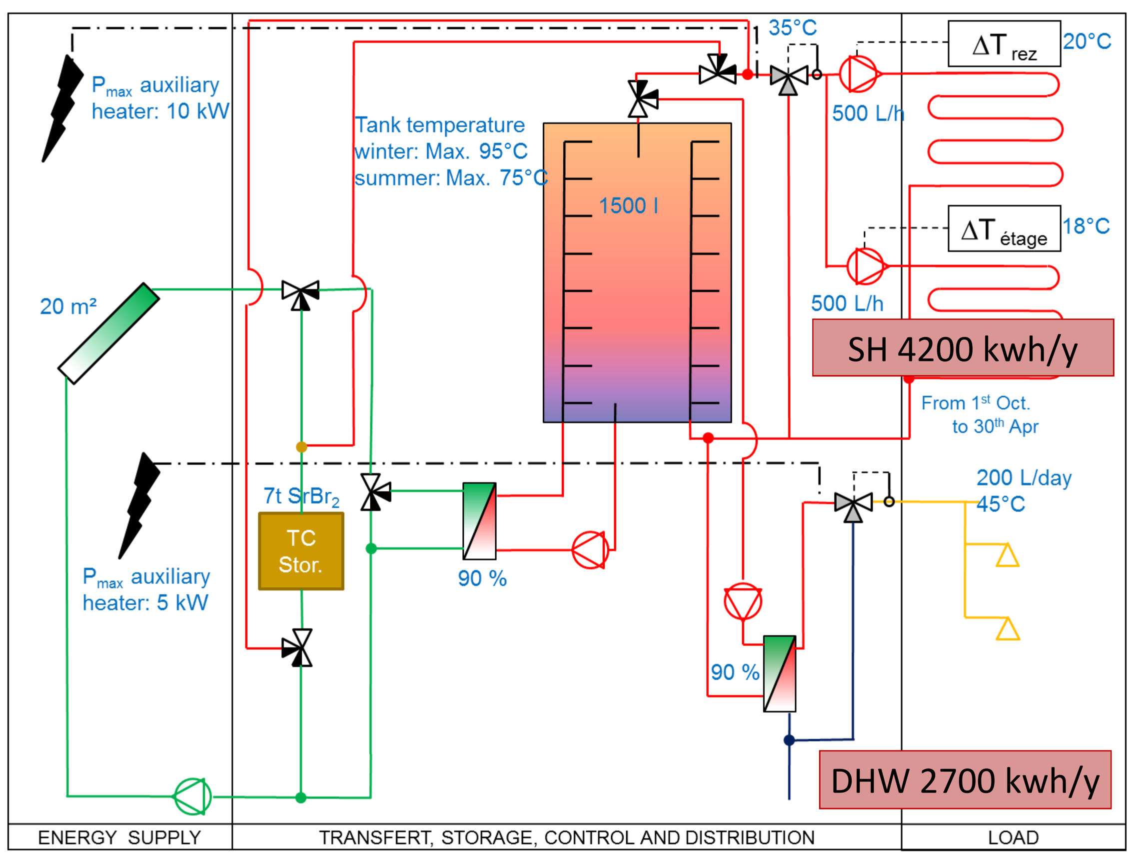
The fractional thermal energy savings[1]:

$$f_{sav,therm} = 1 - \frac{E_{backup}}{E_{ref}} = 1 - \frac{\frac{Q_{backup}}{\eta_{backup}}}{\frac{Q_{boiler,ref}}{\eta_{boiler,ref}}}$$

$F_{sav,SH}$ computes the solar fraction only for space heating.

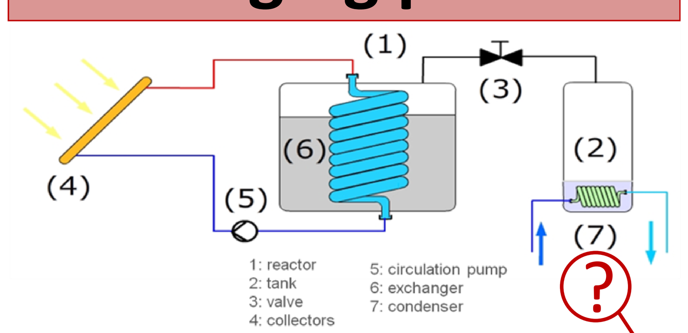
[1] Reference: *IEA-SHC Task 26 (Letz 2002)*

Simulated System

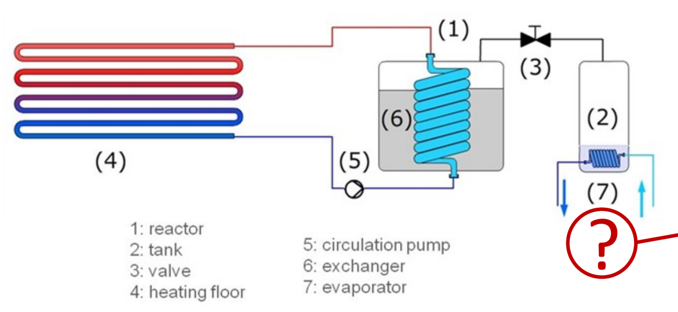


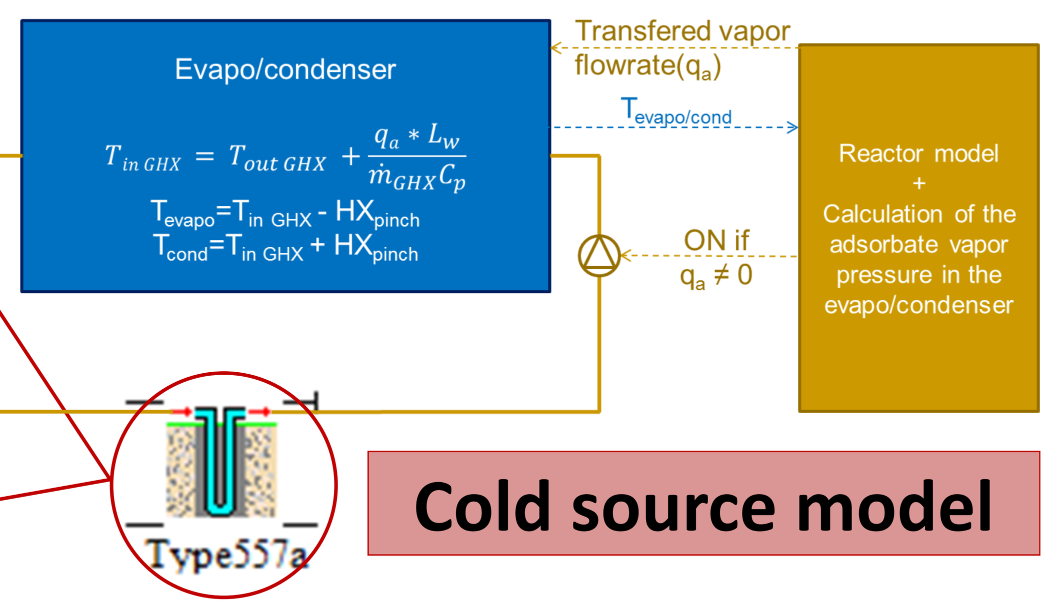
- **Working pair:** $SrBr_2/H_2O$
- **Ground :** λ = 2 W/(m.K), C_p = 2 MJ/(m³.K)
- **GHX:** double U-tube PE pipe

Charging phase



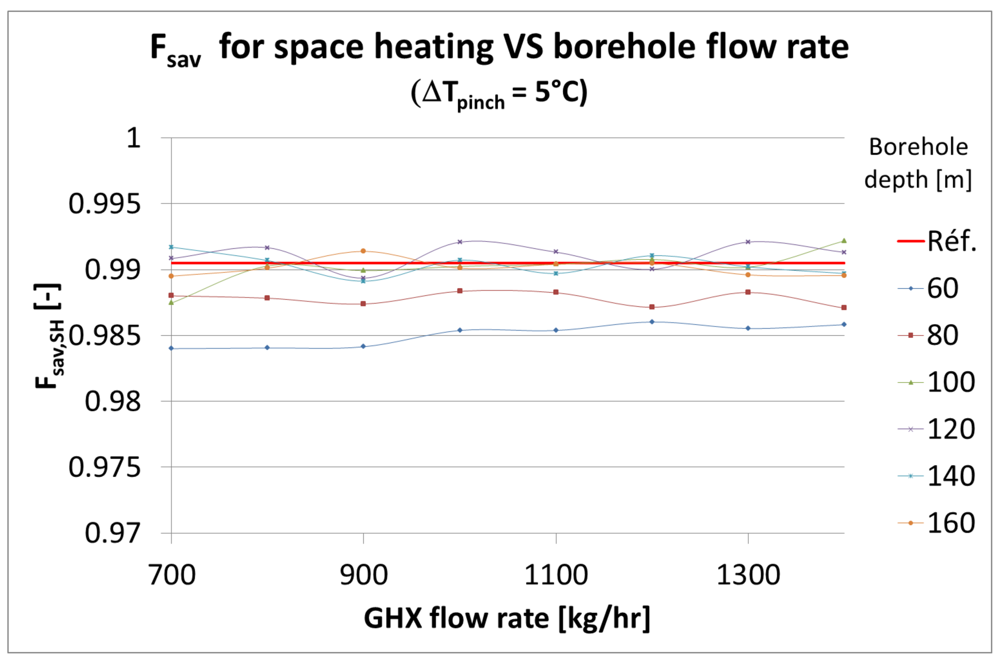
Discharging phase



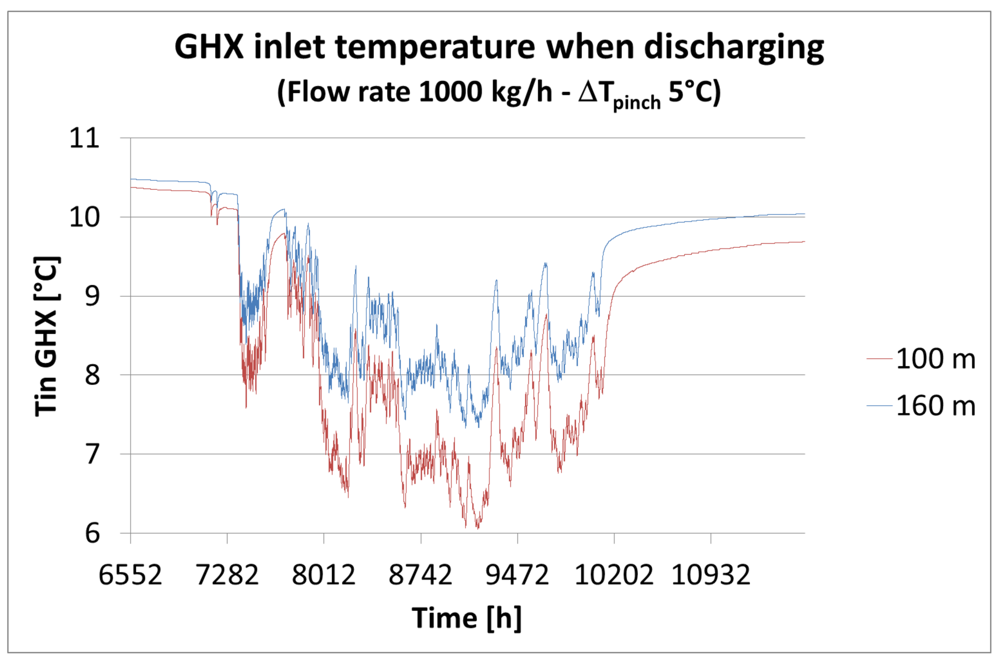


Cold source model

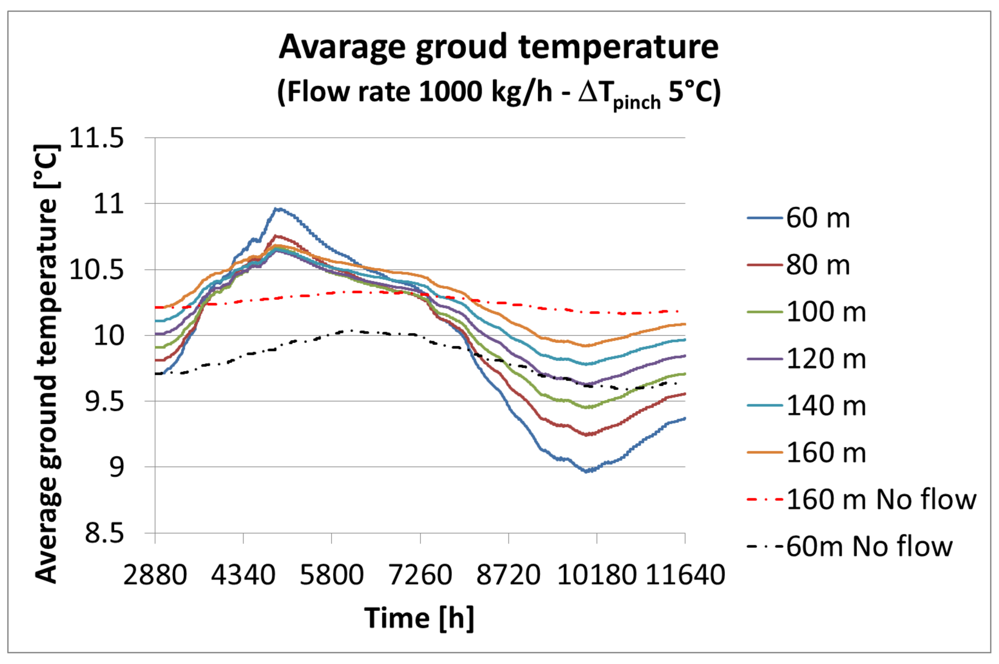
Results



A 100 m borehole reach the reference performance



Evaporation temperature very close to 0°C for 100 m



Decreasing ground temperature after 1 year for all GHX

- Working time of the GHX loop pump: around 5300 h
- Estimated power of the pump: 100 W

Conclusion and Outlook

- Considering energy balance, a 100m borehole is able to reach expected global performance of the system.
- 100 m depth is probably not enough to avoid freezing in the evaporator when discharging.
- For future work, parasitic consumption and investment cost have to be integrated in GHX sizing.

Les recherches présentées dans cet article sont menées dans le cadre du projet "SOLAUTARK", auquel participent les partenaires suivants : ESE, ArcelorMittal Liège R&D, Atelier d'architecture Ph. Jaspard, ULB, CTIB, M5, UMons et ULg. Projet financé par Plan Marshall Région Wallonne.