Deep and coaxial BHEs

Future work and research?

Tests – Asker / Stockholm

Challenges

Disadvantages

Advantages

Deep BHEs: status / background

Deep and coaxial BHEs

Pumps

Exchangers for Ground Source Heat

Deep and coaxial Borehole Heat

19/09/2016
Increased interest in drilling deeper holes: trend.

**Motivation?**

- Deep BHEs

**Deep and coaxial BHEs**

- SGU (2016)
- Gehlin et al. (2016)

- Increased interest in drilling deeper holes: trend.

**Deep Boreholes: status**

- Deep and coaxial BHEs

- SGU (2016)
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Deep and coaxial BHEs

Temperature measurements in on-shore boreholes in Norway

Source: NGU Report 2013.008, Evaluation of the deep geothermal potential in Moss area, Østfold County.

Source: Slagstad et al. 2009

Simulation of Coaxial BHEs

Simulation of BHEs - using TRCM models (in PhD)

Deep and coaxial BHEs

Simulation of Coaxial BHEs

from Acuña 2013

Coaxial borehole heat exchanger – comparison with experimental results

Deep and coaxial BHEs

Key findings:

Optimum configuration for a deep coaxial BHE for heat pump applications is a combination of a thin walled center pipe and a rather high mass flow rate. Increase in system performance with increasing depth outweighs the increase in pressure losses and pumping power.

Deep boreholes, advantages

- Built-up areas: lack of space
- Large soil layer (casing)
- Neighbor installations: low temperatures in shallow regions
- Possible in colder climate, northern Norway / Sweden
- Higher temperatures at larger depths (better COP or more energy (kWh/m/year))
- Can use water as the heat carrier

SGU (2016)

Gehlin et al. (2016)
Deep and coaxial BHEs

- Pressure drop / thermal effect
  - Lift
    - External pressure
  - Buoyancy forces, U-collector

- Collector design and installation
  - Economic considerations – drilling / collector

Deep boreholes, challenges

- Little experience with coaxial BHEs
  - U-collector
    - Pressure drop has to be considered for deep U-
  - (Only) for heat extraction
  - Risk – drilling depth / collector installation
  - Higher investment costs, drilling / collector
  - Economic limitations
Deep and coaxial BHEs

Krushelnitzky and Brechnmann (2009): vertical differential pressures up to 30 bar in 100 mm HDPE DR11 & DR26 with no evidence of buckling but deformation into elliptical shapes.

Deep boreholes, Limitations

Melinder (2007)

Gehlin et al. (2016)

Deep and coaxial BHEs
Deep and coaxial BHEs

Asker - 800 m coaxial pilot plant

- Asker kommune
- Båsum boring
- Enova
- Innovasjon Norge
- Asplan Viak

Drilling of 2 x 800 m (14.4 - 12.5.2016)
- Rotary hammer drilling, with booster air compressor (65 bar)
- 0-200 m, Ø165 mm
- 200 - 800 m, Ø140 (east borehole) and Ø150 mm (vest borehole)
Deep and coaxial BHEs

Asplan Viak / NTNU

Asker - 800 m coaxial pilot plant

Flexible outer flexible pipe ("hose").

PE 75mm SDR17 center pipe. 15.8.16

First cooling DRT performed 16.8.16 - 25.8.16.

Flexible outer flexible pipe ("hose").
Deep and coaxial BHEs
Installation of the center pipe + fiber optic: measuring system
Asker - 800 m coaxial pilot plant
Deep and coaxial BHEs

Temperature measurements

Calibration error

Asker - 800 m coaxial pilot plant

Asker - 800 m coaxial pilot plant
Deep and coaxial BHEs

Field tests / installations

Temperature measurements

510 m borehole in Stockholm

Deep boreholes, tests:
Deep and coaxial BHEs

1. Deep boreholes: advantages and drawbacks for existing and new projects
2. Development of a design method for multiple borehole fields using coaxial heat exchangers
3. Quantification of thermal influence between neighboring shallow and deep boreholes
4. Installation and experimental evaluation of deep borehole systems with shallow and deep boreholes
5. Laboratory model of ground storage in shallow and deep borehole heat exchangers

Deep and coaxial BHEs Project

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Thank you!
Deep and coaxial BHEs

Temperature measurement with optic fiber

Farahani and Gogolla (1999)

The Raman effect (Raman scattering)

Calibration

\[ \frac{N_Y}{\gamma} = \frac{N_T}{\gamma} \]

Hausner et al. (2011)

\[ \frac{N_Y}{\gamma} + \frac{N_T}{\gamma} \]

Hausner et al. (2011)

The Raman effect (Raman scattering)