Contribution ID: **620** Type: **Poster Presentation**

Predicting thermal potential of a shallow ground to support design of low-temperature district heating and cooling networks

Thursday, 2 June 2022 10:10 (1h 10m)

To limit the global temperature rise to 1.5℃, significant reduction of fossil fuel usage and promotion of zero-carbon, renewable energy solutions are essential. Energy sector is one of the largest emitters of greenhouse gases (GHG), dominated by space heating and cooling demand. The 5th generation district heating and cooling networks, that are designed to operate at near ground temperature, offer cost-effective, zero-carbon energy solution. For successful design and optimum performance of such network, detailed investigation of ground processes and accurate estimation thermal storage and recharge potential are of great importance. Thermal potential of shallow grounds is influenced by atmospheric conditions as well as subsurface soil types or profiles. Numerical studies which incorporated the complex boundary conditions and coupled soil heat and moisture processes in support of ground energy network design and assessment are limited.
Therefore, in this study, an advanced numerical model, based on a coupled Thermal-Hydraulic (TH) modelling framework, is developed to evaluate a shallow horizontal ground loop system. It calculates and predicts temperature and soil-moisture behaviour of a shallow ground under complex and coupled atmospheric, temperature and hydraulic boundary conditions. Atmospheric data e.g., solar radiation, rainfall, humidity, air temperature, wind velocity is incorporated in the model with soil-soil boundary and diverse layered soil profiles to investigate thermal and hydraulic responses of the ground, and performance of a DHC network. The model is applied to predict evolution of long-term ground temperature and saturation level of a potential site located at the Warwickshire County in the UK. The total and net heat content per unit area of the site per annum/ season/ month are simulated for a five-year period. The heat content varied between 2.0-55 MJ/m2 depending on the subsurface soil layers. The simulations also revealed that a considerable amount of heating and cooling demand of the site could be met sustainably, solely from the shallow ground, implementing the proposed horizontal ground loop system. In addition, sensitivity of the model parameters investigating the effects of soil types and hydraulic drainage conditions on the ground heat supply potential revealed significant impact of underlying soil layers on spatio-temporal distributions of ground heat. The findings of this study highlight the influences of atmospheric conditions and coupled ground processes on accurate design of a 5th generation low-temperature heat network and estimation of ground thermal behaviour.

Acceptance of the Terms & Conditions

Click here to agree

MDPI Energies Student Poster Award

No, do not submit my presenation for the student posters award.

Country

United Kingdom

References

Time Block Preference

Time Block B (14:00-17:00 CET)

Participation

In person

Primary authors: MASUM, Shakil (Cardiff University); Dr GAO, Wu (Cardiff University); Prof. THOMAS, Hywel (Cardiff Unviersity)

Presenter: MASUM, Shakil (Cardiff University)

Session Classification: Poster

Track Classification: (MS17) Thermal Processes, Thermal Coupling and Thermal Properties of Porous Media: modeling and experiments at different scales