



Energy Performance of Deep Heat Exchangers (DHE) by Numerical Simulation

Webinar hold on 23rd Oct. 2024

Event summary

Quick recap

The webinar was hold on October 23, 2024, organized in the frame of the DeepU project.

The scope of the webinar was to discuss the overcoming of DHE constrained limits, e.g., heat and power thermal performances, key parameters for the simulation and performance indicators, borehole design, management and production design. It saw the participation of the DeepU Team and European expert, who engaged in a lively discussion in the form of round table. After the welcome and brief introduction to the DeepU Project by the coordinator Luc Pockelè (RED), Giordano Montegrossi (CNR) presented the main results for the numerical simulation in progress by DeepU and Antonio Galgaro (University of Padua) chaired the Round Table, which saw the contribution of Gianluca Gola, CNR, Isa Kolo, University of Glasgow, Thomas Kohl, Karlsruhe Institute of Technology, Claudio Alimonti, Sapienza Università di Roma, Daniele Fiaschi, Università di Firenze, Keaton Lechelt, Eavor, Kaiu Piipponen, Geological Survey of Finland GTK, Martin O. Saar, ETH Zürich.

The team engaged in a technical discussion on the modeling of a deep heat exchanger in closed loop systems, focusing on mesh generation, geological setting, and the importance of analytical solutions. The group also explored strategies for optimising the efficiency of closed loop systems, such as innovative designs and the utilisation of alternative heat transfer fluids. Additionally, the potential for repurposing depleted oil and gas areas for geothermal energy production was considered, along with the importance of understanding temperature gradients and fluid flow conditions (permeability controlled) in the borehole area.

Introducing the Webinar

Antonio Galgaro, the moderator of the meeting, commenced the webinar by introducing the topic of energy performance analysis by numerical simulation of deep heat exchangers, with a focus on numerical modelling. He acknowledged and thanked the panellists for their participation and sought their agreement to record the webinar. Then, Luc Pockelè, the project leader of the European DeepU Project organizing the event, was invited to present a general introduction to the project.

Deep Heat Exchanger Modelling Challenges

Giordano Montegrossi presented a detailed discussion on the modelling of a deep heat exchanger in a closed loop system, focusing on the challenges of mesh generation and the importance of analytical solutions for understanding the correct mesh. He also highlighted the need for a high-resolution mesh around the borehole and the importance of considering the geological setting and the physics of the system. Other participants, including Isa Kolo, Gianluca Gola, Thomas Kohl, Claudio Alimonti, and Keaton Lechelt, shared their experiences and approaches regarding mesh generation and simulation, emphasizing the importance of understanding temperature gradients and fluid flow patterns within the borehole area. The discussion also delved into potential strategies for improving efficiency



in closed-loop systems, such as the utilisation of high thermal conductive grouts, spiral tubes, and insulation of parts of the borehole.

Eavor's Technology and Techno-Economic Challenges

Keaton Lechelt provided an overview of Eavor's diverse technological prospects, including Eavorlight and Eavorloop versions 1.0 and 2.0, and analysed their techno-economic implications. He emphasised the importance of balancing between accuracy in reservoir modeling and the economic feasibility of projects to facilitate commercialization. Challenges associated with data scarcity in green fields and the subsequent need for comprehensive geological investigations were highlighted. Antonio Galgaro raised a question about insulation and heat loss reduction, to which Keaton responded that they have not extensively explored insulation methods due to cost considerations. Claudio Alimonti interjected, highlighting the critical role of insulation for efficient heat transfer and suggesting the utilisation of vacuum-insulated tubing.

Geothermal Energy Extraction Project

Giordano Montegrossi mentioned the possibility of using secondary fluids different from water. Daniele Fiaschi discussed a running project involving a closed loop system for geothermal energy extraction (EU-HOCLOOP Project). The project aims to investigate alternative fluids, like supercritical carbon dioxide, as heat transfer media and assess their technical viability and social acceptability. Daniele Fiaschi outlined plans to conduct a comprehensive study of thermophysical properties of these fluids, their heat transfer performance, and the design of a closed-loop system. The project scope includes simulations, lab experiments, and field tests to evaluate system performance under various geological conditions and fluid combinations. The overarching objective is to develop an efficient and environmentally sustainable geothermal technology.

Improving Project Execution and Communication

The team recognized the necessity of adopting a more comprehensive and detailed approach to their project, with a focus on understanding the customer's needs and expectations. The importance of a structured and organized process, with well-defined roles and responsibilities for each team member, was emphasised. The team agreed to prioritize the enhancement of their communication and collaboration skills to ensure efficient and effective project execution.

Improving User Experience and Planning

The participants discussed the need for a more comprehensive and detailed approach to their projects, with a focus on improving the user experience. They agreed on the importance of involving the production teams in the process and ensuring the project's alignment with the company's overall goals. The team also decided to prioritize the projects' requirements and develop a more detailed plan for the next steps. The conversation concluded with the team acknowledging the need for further discussion and planning to address any potential issues that may arise.

Induced Convection and Advection Efficiency

Antonio Galgaro led a discussion on the role of induced convective circulation and advection in improving the thermal-transfer process, particularly in relation to the efficiency of groundwater mobility induced by heat exchanger. Thomas Kohl shared his team's experience with large circulation sites and the potential for enhancing system performance.



Isa Kolo discussed the effect of background groundwater flow on heat extraction efficiency, noting that significant effects are only observed at very high flow velocities. Martin Saar expressed surprise at the required flow velocity for significant effects, while Antonio Galgaro sought the team's opinion on the feasibility of producing electricity from closed-loop systems. Keaton Lechelt and Claudio Alimonti shared their experiences with commercial projects in Germany and Italy, respectively, highlighting the potential for electricity generation and the importance of balancing system life and cost considerations. The team also explored the potential for seasonal use of heat and electricity production, and the challenges associated with modeling such modulated usage.

Geothermal Energy from Depleted Oil and Gas wells

Claudio Alimonti presented the potential for repurposing depleted oil and gas areas for geothermal energy production, highlighting the resource value and the requirement for specific wellbore geometry to accommodate multilateral drilling. Keaton Lechelt reinforced these points, adding that the metallurgy of the casing is crucial for multilateral drilling and that there are technical challenges associated with converting depleted wells. Antonio Galgaro suggested that leveraging the knowledge gained from the previous drilling activities could be beneficial in mitigating mineral risk and evaluating thermal properties. Keaton Lechelt agreed, noting the value of existing geothermal exploration data in the area.

The conversation ended with Antonio Galgaro expressing optimism for future collaborative efforts and the potential for the emergence of innovative ideas.