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Ground Source Heat Pump Systems, Components and System Development Sessions

by Signhild Gehlin

The sessions on ground source heat pump systems provided valuable insights into the performance, optimization, and development of these systems. The presentations covered a wide range of topics, including long-term performance, utilization of abandoned mines, simulation studies, and innovative calculation methods.

Monica Brands presents "Simulation results comparing ground source heat pump systems to a natural gas reference system for a 44-storey building in Toronto, Canada". (Photo: Carlos Jones ORNL)

The studies highlighted the potential of ground source heat pump systems in achieving high energy efficiency, reducing greenhouse gas emissions, and optimizing control and operation. The results demonstrated the effectiveness of different ground source heat exchangers, such as horizontal and spiral ground heat exchangers, in providing efficient heating and cooling. The use of thermal response tests and simulation tools played a crucial role in assessing the performance and feasibility of these systems. In addition, the sessions on components and system development focused on advancements in steam-driven ejector heat pumps, metal-foam-enhanced tube bundles, membrane heat exchangers, and the use of CO_2 as a heat distribution fluid. These innovations aimed to improve heat transfer, energy efficiency, and overall system performance.

One session focused on heat pump systems that utilize different types of ground sources. It began with a keynote presentation by Dr. Signhild Gehlin, the operating agent of IEA HPT Annex 52, discussing the long-term performance of larger ground source heat pump systems. The presentation highlighted the results from system boundary 1, which focused on the heat pump unit. The measured performance values for heating, cooling, and combined heating and cooling were in line with literature results, ranging from 3.5 to 3.9 SPF1.

Lukas Oppelt shared results from using abandoned mines as a heat source for heating and cooling. The study included examples from a silver mine in Freiberg, Germany, and showed that flooded mines maintain a nearly constant temperature between 10-30°C throughout the year. Results from various locations demonstrated that heating and cooling can be achieved with an overall system SPF greater than 5.

Dr. Metkel Yebiyo conducted a simulation study on the optimization of a GSHP system using energy piles, heat pumps, and a dry air cooler. The study used a TRNSYS model to analyze control algorithms for optimal performance. The results indicated significant savings when the system was optimized for control and operation.

Ändra til: In another session Professor Katsunori Nagano and his GSHP research group from Japan presented new developments on horizontal and spiral ground heat exchangers. They also introduced a thermal response test (TRT) method for measuring the thermal conductivity of deep U-tube borehole heat exchangers. The TRT method utilized an oscillating heat source and was validated for different patterns of horizontal ground heat exchangers.

Sara Bordignon discussed a study that utilized manufacturers' data for water-to-water heat pumps in North American and European markets. The study developed simplified GSHP models for predicting heat extraction based on a limited number of heat pump operating points. The recommended models showed acceptable accuracy, with no more than 3% RMSE compared to catalogue data.

In a session about Components and System Development, Jeremy. Spitzberger presented an experimental study on a steam-driven ejector heat pump for water heating applications. The study focused on heating applications, and higher high-temperature evaporator temperatures resulted in higher condensing temperatures at the expense of ejector heat pump COP.

Cheng-Min Yang conducted a study on pool boiling on metal-foam-enhanced tube bundles for flooded evaporator configurations. The study visualized the flow and characterized the heat transfer using transparent test setups. The results showed that all three metal-foam-enhanced tube bundles outperformed bare tubes, with the compressed metal-foam-enhanced tube bundles showing better results than the uncompressed ones.