APSENSING.

SOLEXPERTS

Temperature Monitoring of Multiple Borehole Heat Exchangers

Hamburg, Germany

Project Overview

The Hamburg Ministry of Urban Development and Environment integrated an energy-efficient heating and cooling system in its new office complex, leveraging geothermal heat exchange through bore piles. To enhance monitoring and optimization, Distributed Temperature Sensing (DTS) system was implemented, offering continuous, high-resolution thermal data. This advanced monitoring approach ensures real-time insights into subsurface temperature variations, enabling proactive energy management and environmental assessment.

Over 1600 boreholes and bore piles were drilled for geothermal heat exchangers, with 27 boreholes equipped with fiber optic sensor cables. Unlike conventional thermistor chains, the DTS system provides real-time, spatially continuous temperature monitoring along the entire length of the fiber optic cables, delivering a more comprehensive understanding of geothermal dynamics. This innovative approach allows for better detection of temperature fluctuations and ensures optimal energy utilization.

The collected data also supports a University of Hamburg research project focused on long-term geothermal energy management and environmental impact. The highly insulated buildings consume approximately 70 kWh/m² annually, earning the „Platin" certification from the German Sustainable Building Council, making them among the most energy-efficient office structures in Germany.

Solution

The fiber optic DTS system ensures precise, continuous temperature measurements across the geothermal

Background

- Hamburg's Ministry of Urban Development and Environment employs geothermal energy and DTS for efficient heating, cooling, and monitoring
- 1,600 boreholes, 27 with fiber optic sensors, support a system consuming 70 kWh/m² annually

Solution & Benefits

- AP Sensing's DTS instrument, with two channels and a two km range, enables real-time thermal monitoring with high spatial resolution
- Project-specific program provides real-time temperature profiles and historical data, accessible via the Ministry's network, ensuring continuous system optimization and operational efficiency

Map of the 27 borehole locations

field. Installed in a control room, the DTS instrument features two channels and a two-kilometer measurement range, providing extensive coverage of the monitored boreholes. The system continuously records temperature profiles, detecting variations that indicate thermal imbalances or inefficiencies in heat exchange operations.

Unlike traditional sensors, fiber optic DTS technology captures temperature data along the entire cable length, enabling operators to track gradual changes and anomalies. This capability is essential for balancing geothermal heat input and withdrawal, ensuring stable ground temperatures and efficient long-term usage. By analysing temperature trends, operators can optimize heat pump operations and free cooling strategies to maximize energy efficiency.

Formerly GTC Kappelmeyer and now part of the Solexperts group, developed a project-specific program for real-time temperature visualization. The program provides live temperature profiles and historical data for each monitored borehole, accessible through the Ministry's internal network, supporting operational efficiency and geothermal system optimization.

Results & Benefits

The integration of fiber optic temperature sensing has significantly enhanced geothermal system performance by ensuring continuous, precise monitoring. Real-time data allows for proactive adjustments to heating and cooling strategies, preventing long-term thermal imbalances that could degrade system efficiency. The DTS system plays a crucial role in monitoring environmental impact, ensuring that geothermal usage does not lead to unintended subsurface temperature shifts or long-term disturbances.

By leveraging fiber optic sensing technology, the Hamburg geothermal project serves as a model for large-scale urban energy infrastructure. The system not only optimizes energy efficiency but also provides valuable insights into the long-term behaviour of geothermal heat exchangers. The success of this project highlights the potential of fiber optic-based DTS solutions in advancing sustainable and efficient geothermal energy utilization.

19" AP Sensing DTS device mounted in a flat wall cabinet

The AP Sensing's Distributed Temperature Sensing (DTS)

More detail about energy efficient building can be found in the paper:
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