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Enhancing Energy Efficiency Through Geothermal Heat Pumps: A Performance Analysis Using the KTENG-7000GH Simulator

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Abstract

The geothermal heat pump (GHP) system is increasingly recognized as a highly efficient, sustainable, and environmentally friendly solution for heating and cooling applications, primarily due to its reliance on the earth's stable and renewable subsurface temperature. Unlike conventional systems that are affected by fluctuating ambient conditions, GHPs maintain consistent performance and significantly reduce greenhouse gas emissions and energy consumption.

This study employs the KTENG-7000GH geothermal heat pump simulator to experimentally assess system performance and accurately visualize the operational cycle through integrated advanced control panels and high-precision sensors. A detailed comparative analysis between the geothermal and conventional heat pumps was conducted based on the coefficient of performance (COP) across varying temperature levels.

At 4°C, the GHP demonstrated an 11.11% improvement over the conventional heat pump. As temperatures increased, the advantages of the GHP became more pronounced, with performance gains of 32.00% at 6°C, 60.26% at 8°C, and an impressive 71.95% at 10°C. These results highlight the superior energy efficiency, thermal stability, and adaptability of geothermal systems, particularly in moderate to high-temperature environments.

The KTENG-7000GH simulator not only facilitated a clear visualization of operational dynamics but also reinforced the conclusion that geothermal heat pumps provide a more reliable and cost-effective long-term solution. This study underscores the transformative potential of geothermal energy in reducing energy demand, lowering operational costs, and supporting global sustainability goals.

Keywords: Geothermal Energy, Heat Pump Efficiency, KTENG-7000GH Simulator, Coefficient of Performance (COP), Sustainable Heating and Cooling