STATUS OF DESIGN TOOLS FOR GROUND-SOURCE HEAT-PUMP SYSTEMS

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ABSTRACT

Design tools for ground-source heat pumps (GSHP) trace their history back to the period after the first horizontal loop installation in 1945. Simple engineering formulas have evolved to user-friendly design software and detailed simulation models for the dynamic interaction between complete energy systems, internal heat sources, and weather conditions.

The quest for reliable and sustainable long-term operation, improved efficiency, and reduced costs has led to a development of more elaborate descriptions of system components: ground properties, borehole heat exchanger, ground loop layout, hydraulic coupling of loop field, circulation pumps, and heat pumps. Heat conduction is usually the main heat transport mode in the ground, but the influence of regional ground water and natural convection has also been assessed. Analytical methods and advanced numerical methods for the thermal performance of GSHP have been compared and validated with numerous field tests. The use of in-situ thermal response tests has been important in determining the critical design parameters for the ground and to assess the borehole thermal resistance, which has also been studied theoretically and in the laboratory.

The paper treats the current status of GSHP design tools. The knowledge of system components and in-situ techniques to obtain necessary ground properties makes it possible to do reliable simulations of GSHP system performance for both domestic and commercial applications. The future challenge for GSHP designers is to use these tools to find the optimum system configuration and control in different situations.