DESIGN ASPECTS OF COMMERCIAL OPEN-LOOP HEAT PUMP SYSTEMS

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ABSTRACT

Open loop (or groundwater heat pump systems are the oldest of the ground-source systems. Common design variations include direct (groundwater used directly in the heat pump units), indirect (building loop isolated with a plate heat exchanger), and standing column (water produced and returned to the same well). Direct systems are typically limited to the smallest applications. Standing column systems are employed in hard rock geology sites where it is not possible to produce sufficient water for a conventional system. Due to its greater potential application, this paper reviews key design aspects of the indirect approach. The general design procedure is reviewed, identification of optimum groundwater flow, heat exchanger selection guidelines, well pump control, disposal options, well spacing, piping connections and related issues.

INTRODUCTION

Open-loop or Groundwater Heat Pump (GWHP) systems are the oldest and most well established of the ground- source heat pump systems. Despite this, little formal design information has been available for them until recently. Although seemingly simple in nature, these systems require careful consideration of well design, groundwater flow, heat exchanger selection and disposal in order that an efficient and reliable system results.

Several variations on the open loop system are in use. The most common of these are illustrated in Figure 1. The direct use of the groundwater in the heat pump units is largely an extension of residential design and is sometimes used in very small commercial applications. It is very susceptible to water quality induced problems, the most common of which is scaling of the refrigerant-to-water heat exchangers. This design is recommended in only the smallest applications in which practicality or economics precludes the use of an isolation heat exchanger and/or groundwater quality is excellent (the determination of which requires extensive testing). The standing column system has been installed in many locations in the northeast portion of the U.S. Like the direct groundwater system, it too is subject to water quality induced problems. In general, water quality in the area where most of the installations have been made (New England) is extremely good with low pH and hardness (little scaling potential). Standing column systems are used in locations underlain by hard rock geology; where, wells do not produce sufficient water for conventional open loop