SURVEY OF GEOTHERMAL HEAT PUMP REGULATIONS IN THE UNITED STATES

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ABSTRACT

Geothermal heat pump systems (GHPs) are becoming more common. As more of these systems are installed, and practitioners move into new operating areas, it is becoming increasingly important that designers and installers be aware of the pertinent environmental regulations which affect system design and installation.

To this end, a survey has been conducted of US Federal and State Regulations which govern the design and installation of both open and closed loop geothermal heat pump systems. The appropriate officials in the Federal and state governments were located, and copies of the regulations were obtained.

The regulations which affect GHPs show no uniformity across the nation. Most (but not all) states simply apply their water well regulations to open loop systems. The status of regulations for closed loop (borehole) systems is more disorganized. While a few states have adopted industry standard practice in their regulations, many have no specific regulations whatsoever, while others have adopted (or are in the process of adopting) regulations which are proscriptive, and likely to hamper the industry.

A summary of the regulations was written, and was approved by the governing officials. The summaries and copies of the regulations themselves are available on the World Wide Web at http://www.uidaho.edu/ghpc/. Contact information for governing officials, including addresses and phone numbers, is also available at the site.

While there is no nationwide consensus among regulators concerning appropriate regulations for drilling open loop geothermal heat pump systems, each state tends to apply its water well regulations to these systems. In addition, the National Ground Water Association disseminates information to its members on what is considered good well drilling practice. Forty six of the fifty states require licensing of well drillers, while about half also require separate licensing for pump installers.

On the discharge side, there are Federal regulations which govern both above-ground and below ground discharge. The Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) regulations specifically govern surface discharge, unless a state has applied for and received "primacy" from EPA (the right to govern discharges at the state level). In addition, nothing in Federal statutes prevents a state or other governing body from adopting regulations which are more strict than the NPDES. Some states will prefer surface discharge for systems, while others will forbid it. Many are only worried about surface discharge if the change in the water temperature through the geothermal system is large, which is typically not the case for a geothermal heat pump system.

The situation is similar for reinjection. Since water is being reinjected underground, these wells are covered by the Underground Injection Control (UIC) regulations. Many states have regulations governing spacing of wells, allowable depths, etc.

2.2 Closed Loop Geothermal Heat Pump Systems

Closed loop geothermal heat pump systems are unlike any technology which has been used before. While it makes some sense to apply water well regulations to open loop supply wells, there is no existing body of regulations which are immediately appropriate for closed loop systems.

As the number of systems increases, environmental concerns are also coming to the forefront. Responsibility for groundwater quality can come under the purview of Federal, state, and local or regional governmental entities.

The Federal UIC and NPDES regulations were designed to prevent contamination of groundwater, aquifer, and surface water. However, the UIC portion of the Safe Water Drinking Act (40 CFR, Parts 144-147) precludes a closed-loop ground source system from being defined as an injection well as it is not used for the emplacement of fluids underground. Similarly, the NPDES portion of the Clean Water Act (40 CFR, Parts 122-124) which covers surface discharge of fluids, does not include ground-coupled heat pump systems under the definition it uses for "waters of the United States", which specifically limits its influence to such water bodies as wetlands, ponds, streams, sloughs, and navigable waterways. However, nothing in either the UIC or NPDES regulations precludes any state, county, parish, water district, municipality, etc. from adopting more stringent regulations. The majority of regulatory activity concerning closed loop ground-coupled heat pump systems has occurred at the state level.

Every antifreeze in use represents a compromise in the above characteristics. The most commonly used fluids to this point in time have been aqueous mixtures of:

- ethylene glycol,
- propylene glycol,
- methanol,
- ethanol,
- sodium chloride,
- calcium chloride, and
- potassium acetate.

Each of these has benefits and drawbacks. Each is acceptable in some locations in the United States, while at the same time being unacceptable in others. Ethylene glycol is the most common automotive antifreeze. However, it is toxic, and is not commonly used in ground-coupled heat pump systems, except in Europe [Heinonen, Tapscott, Wildin, and Beall, (1997)]. The salt solutions are non-toxic and non-flammable, but present potentially serious corrosion problems. Methanol is common, but is toxic, and is flammable in high concentrations. Ethanol is also common, and is less toxic than methanol, but can also be flammable, requiring care in handling. Potassium acetate is non-toxic and non-flammable, but its use can cause leakage and consequent corrosive problems which have resulted in litigation. Propylene glycol is non-toxic, and if food- or pharmaceutical-grade, is acceptable as a food additive. However, propylene glycol is more viscous than the other fluids, resulting in higher energy usage for the system. This higher viscosity also makes it more difficult to handle in cold weather. Three fluids have been recommended for use by the International Ground Source Heat Pump Association (IGSHPA) (a ground source heat pump industry association) in their standards. These are potable water, water plus potassium acetate, and water plus propylene glycol.

A detailed study of the relative advantages and disadvantages of numerous antifreeze solutions was recently completed by Heinonen, Tapscott, Wildin, and Beall, (1997), which is summarized in [Heinonen, Wildin, Beall, and Tapscott, (1997)]. Their conclusions detail:

- life cycle costs,
- corrosive risks,
- leakage risks,
- health, fire and environmental concerns, and
- regulatory risks (termed concern for future risk).

They also identified two other potential antifreezes which may be worth considering due to their characteristics and use in similar applications: calcium magnesium acetate (CMA), and urea ($CO(NH_2)_2$). They note CMA has high leakage potential and high long-term costs, while urea is also prone to leakage and is also corrosive. In general, the authors agree with IGSHPA, which recommended potable water, water plus potassium acetate, or water plus propylene glycol.

At present, twenty-six (26) of the fifty (50) states have no specific regulations or recommendations about what fluids are acceptable for use in ground-coupled heat pump ground

TABLE 1: *FLUIDS ACCEPTABLE TO THE STATES*
(of the sixteen states who specify fluids)

FLUID	**NUMBER WHICH ACCEPT THE FLUID**
Potable Water	All
Aqueous propylene glycol	13
Aqueous potassium acetate	10
Aqueous calcium chloride	6
Aqueous sodium chloride	3
Aqueous ethanol	3
HCFC-22	2
Glycerin (Pharmaceutical grade)	2
Dipotassium phosphate	2
Aqueous methanol	2
Calcium carbonate	1
Aqueous ethylene glycol	1
Salt water	1
"Others on approval"	1

2.3 Local Regulations

In addition to the state regulations, a number of localities have adopted regulations concerning geothermal heat pump systems. We are in the process of collecting local regulations. Once again there is no systematic agreement on the part of local officials on appropriate regulations for this technology. Local regulations often exist due to the efforts (for good or ill) of only one or a few individuals. The situation is even more variable than on the state level.

By way of example, we have discovered the following:

-In Washington, thirteen counties have authority to expand on the state's water well construction standards as they see fit.

-Several counties in Montana have the authority to regulate water wells and driller licensing.

The totality of state regulations in the US is so broad that is impossible to cover them thoroughly in this short paper. It is recommended that the reader consult the Web site mentioned before and their state regulators for complete information.

ACKNOWLEDGMENTS

The support of EPRI and NRECA in the original idea for regulations gathering is acknowledged and appreciated. The support by the Geothermal Heat Pump Consortium in the furthering of the regulations and construction of the Website is also greatly appreciated.

The hard work by my past and present students at the University of Idaho in gathering regulations and converting them to Web pages made all of this possible.

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