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The Case for Thermally Enhanced Grouts

Thermally enhanced grouts have been widely used for ground source heat pump (GSHP) installations. There are a number of versions of these products on the market today, and more are being studied and developed as of this writing. This article will be used to discuss some key points about this market and the use of thermally enhanced grouts.

The use of ground source heat pump systems has become very popular in recent years. Even with the downturn in the economy, interest in this type of heating and cooling has remained fairly strong. There are good reasons for this. GSHP systems are extremely efficient, and they are a clean source of energy. They are highly regarded by the Environmental Protection Agency (EPA). GHSP is a very green way to heat and cool homes, hospitals, schools, government buildings and virtually any structure requiring heat and air conditioning. GHSP uses renewable energy, and reduces consumption of crude oil and other types of fuel used in heating.

In fact, the U.S. government is offering substantial tax credits for both residential and commercial GHSP systems. The residential tax credit amounts to 30 percent of the GSHP system with no cap, and is retroactive to Jan. 1, 2008. The commercial tax credit is 10 percent of the cost of system with no cap, and is effective on installations after Oct. 3, 2008. These tax credits are in place until 2016.

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The GSHP system makes use of the heat of the earth through a loop system for heating homes or other structures. In the summer or warmer times of the year, the heat in these buildings is transferred into the earth, thus cooling the building. This transfer is accomplished by placing loops in the ground, either vertically or horizontally. The loops are connected to a heat pump for circulation of the fluid in the loops from the earth to the building to be heated or cooled.

Once these loops are placed in the ground, there is a need to fill the area in the borehole around the loops with a fill material, usually a bentonite or cement grout. It is important that this grout be able to conduct heat efficiently from the earth to the loop for heating, or from the loop to the earth for cooling. Pumpable bentonite slurries often are used to accomplish this. However, bentonite grouts alone generally have a thermal conductivity of approximately 0.40 Btu/ft/hr/F. Therefore, it is advisable to enhance the grout with an additive that will raise the conductivity. This can be accomplished by adding fine sand that has a high percentage of silica. The amount of sand added is dependent on the desired or specified thermal conductivity rating. Thermally enhanced grout accomplishes two goals for the client and contractor:

- It produces the desired thermal conductivity in the borehole to accommodate the GSHP system.
- It helps to prevent the co-mingling of any aquifers encountered in the borehole, and prevents surface contamination into the borehole,

The addition of silica sand to bentonite has an added benefit to the grout column besides increasing thermal conductivity. Recent studies have shown that the sand reduces shrinking and cracking of the bentonite grout column in the unsaturated portion of the borehole. This not only helps the thermal conductivity, but also protects the grout column, which, in turn, helps to protect ground water.

As mentioned earlier, there are a number of thermally enhanced products available on the market for this application. GSHP grouts are formulated to suspend large quantities of silica sand. Grouts that have been formulated for use in water wells and other grouting applications will not work for GSHP because they will not suspend large quantities of sand, and the sand tends to settle in the grout column, leaving areas in the grout column with less than desired thermal conductivity.

Keep in mind that thermally enhanced grout produces the desired thermal conductivity in the borehole to accommodate the GSHP system, and helps to prevent the co-mingling of any aquifers encountered in the borehole.

GSHP grouts have been formulated that will mix and pump easily when large quantities of sand are added. It is very important to select one of these grouts that are user-friendly, and that, at the same time, will suspend the sand. These grouts can vary in terms of how well they suspend sand, so it is critical that the contractor be aware and check the grout for its ability to suspend the sand, and also for its ease of mixing and pumping. It also is critical to follow the manufacturer's specifications for mixing and pumping so that the grout will perform as it is designed to perform.

The addition of sand to the grout is so important because it provides a better heat transfer, and reduces the number of boreholes needed to run the system, thus requiring less power to operate the system. This reduction of costs gives a faster pay-back on the initial cost of installing the GSHP system. Some contractors choose to use a straight bentonite grout without sand additions. This adds more boreholes and more loops to the system.

There are some thermally enhanced grouts available that do not require additions of sand. These products provide convenience because they reduce labor and handling costs. However, these products are more expensive per bag than a typical bag of grout to which sand is added during the mixing process. Contractors need to weigh the savings in labor and handling with the more expensive one-step grout vs. the lower cost of the two-step blends, which normally are used. Manufacturers are continuing to develop new products, which should give more choices of enhanced grouts in the future.

Selection of the sand to be used is just as important as the grout selection. A high percentage of silica in the sand is recommended. There are a number of suppliers of high-quality silica sands, making them easy to access and at a reasonable price. Sand for thermally enhanced grouts should be rounded in shape and not angular. Thermally enhanced grouts require fine sands for better suspension. Sand used for gravel pack in water wells will not work in thermally enhanced grouts because they are too coarse. Contractors should check with the grout manufacturers to determine an approved sand source. Manufacturers normally will test an unapproved source of sand for contractors.

Thermally enhanced grouts typically are mixed and pumped with a paddle mixer. These mixers need to be placed as close to the boreholes as possible with the tremie line in place in the borehole before any mixing begins. Bentonite grouts need not be fully hydrated before sand is added. Once the required sand has been added, and the grout weighed with a mud balance to assure proper weight, pumping can begin immediately. All of the drilling mud or water in the borehole must be displaced with the enhanced grout. Another grout-weight test should be conducted with the mud balance as the grout exits the borehole to assure that all drilling mud or water has been displaced, and that the grout exiting the borehole meets manufacturer specifications.

Because of possible voids in the borehole, some settling of the grout may occur in the borehole. If this happens, the grout column should be topped off with additional grout.

There are several choices in thermally enhanced grouts and sand, as mentioned earlier, and there will be more as research and development is conducted. Please contact your supplier or manufacturer to find out which ones are best for your project.

If you have questions or comments on this article, please contact me through *National Driller*. ND

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