Building America Case Study
Technology Solutions for New and Existing Homes

Foundation Heat Exchanger (FHX)

Oak Ridge, TN

PROJECT INFORMATION

Project Name: Foundation Heat Exchanger (FHX)

Location: Oak Ridge, TN.

Partners: Oak Ridge National Laboratory, www.ornl.gov

Building Component: HVAC and water heating

Application: New, single and/or multi-family

Year Tested: 2009 through 2012

Applicable Climate Zone(s): Zone 1-4, part of 5 and 6

PERFORMANCE DATA

Cost of Energy-Efficiency Measure (including labor): $1,000/ton (compared with conventional vertical loop and horizontal loop for $3,000/ton and $2,250/ton, respectively)

Projected Energy Savings: Same as for conventional GSHP systems

Projected Energy Cost Savings: Same as for conventional GSHP systems

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The foundation heat exchanger (FHX) is a new concept for a cost-effective horizontal ground heat exchanger (HGHX) that can be connected to water-to-water or water-to-air heat pump systems for space conditioning as well as domestic water heating.

This new FHX technology could reduce costs by placing the HGHX into the excavations made during the course of construction (e.g., the overcut for the basement and/or foundation and run-outs for the water supply and septic field). Since they reduce or eliminate the need for additional drilling or excavation, FHXs have the potential to significantly reduce or eliminate the cost premium associated with the use of ground-source heat pumps. In general, the total length of the borehole or excavation needed for a building is a function of the building's space-conditioning and water-heating loads. Therefore, in the case of highly energy-efficient homes, the space-conditioning and water-heating loads may be so low that the excavations required to construct the buildings are sufficient for installing the ground heat exchanger.

Two side-by-side, three-level unoccupied research houses with walkout basements, identical 3,700 ft^2 floor plans, and hybrid FHX/HGHX systems were constructed to provide validation data sets for the energy performance model and design tool. The envelopes of both houses are very energy efficient and airtight, and the Home Energy Rating System (HERS) ratings of the homes are 44 and 45, respectively. At House 1, the hybrid FHX/HGHX system was installed in a 300 linear foot excavation, and 60% of that was construction excavation (needed to construct the home). At House 2, the hybrid FHX/HGHX system was installed in a 360 ft. excavation, 50% of which was construction excavation. There are six pipes in all the excavations (three parallel circuits—out and back), and the multiple instances of FHX and/or HGHX are all connected in series. The working fluid is 20% by weight propylene glycol in water.

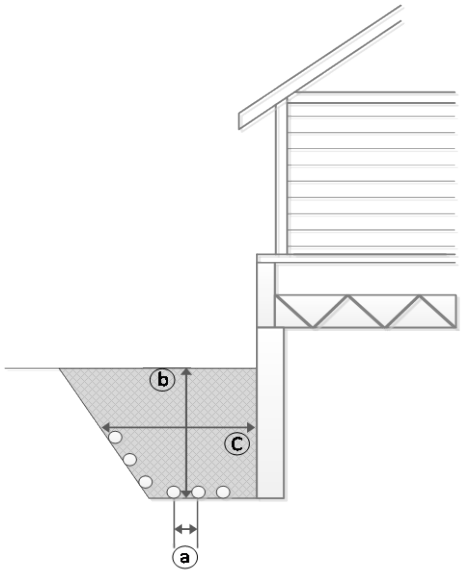
DESCRIPTION

An FHX can be installed in the overcut around the basement wall, and in one of the utility trenches. Figure shows the FHX installed in electrical utility trench

The three parallel circuits comprising the FHX/HGHX tap off of the supply and return headers

Once the FHX is installed, the excavated soil can be used to backfill the trench. It is also important to compact the soil to ensure sound contact between the soil and the FHX pipes.

For more Information, see the Building America Solution Center guides. www.basc.pnnl.gov



The case study houses have a six-pipe, meaning six ¾ in. diameter high-density polyethylene pipes in the excavations (three fluid circuits—out and back) with a minimum spacing of 1 ft between pipes (a). The depth from the ground surface to the bottom of the foundation excavation (b) is about 7–8 ft, and the distance from the excavation wall to the foundation wall (c) is about 3–4 ft.

Lessons Learned

- An FHX can perform as well as a conventional HGHX if sized correctly.
- An FHX in the overcut around the basement or an HGHX in utility trenches may be feasible at $1,000 per ton (compared with a conventional vertical loop and horizontal loop for $3,000 per ton and $2,250 per ton, respectively)
- Further research shows that installing the loop under the basement floor as well as in the excavations around the foundation would provide sufficient capacity to offset any need for additional conventional loop in these case study houses.

Looking Ahead

Production-basis approaches to implementing FHX or hybrid FHX/HGHX systems should be developed for market penetration. The materials, products, tools, and installation techniques used for this two-house demonstration leave considerable room for improvement. Better approaches that are fast and foolproof in the hands of site laborers must be invented (e.g., spray a layer of grout onto the trench side walls using a new device akin to those for spraying or blowing insulation; lay prefabricated mats of cross-linked, parallel, reduced-diameter high-density polyethylene tubes onto the grout; spray another layer of grout; let the grout set; finish backfill with bulldozer, and so forth).

Note: Because code requirements can vary by jurisdiction, be sure to confirm approval from your local code official prior to installation.

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