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Power Analysis of a Heat Pump with Horizontal Collectors

Adrian-Virgil Craciun, Florin Sandu, IEEE Member**, Gheorghe Pana**
Transilvania University of Brasov, Romania

Abstract

This paper presents some practical considerations for a residential heat pump system: the implementation of the ground loop, the power consumption during the 2010-2011 heating season, a comparison between a heat pump and a gas furnace heating system and the ground temperature monitoring for one year period.

The main goal of the paper is to demonstrate the heat pump advantages: main advantage is the reduce power consumption by utilizing the earth energy, the disadvantage is the initial higher price of the system.

The next table presents the comparison results of two heating systems: a high efficiency condensing gas furnace and heat pump with horizontal collectors; these systems work alternatively in (almost) similar conditions; the average power consumption of the heat pump is 26% and the price per hour is 87% compared to the gas furnace.

Parameter	Time	t_on	t_on	Gas	El.En	Avg/h	Price/h
Heating system	(hours)	(hours)	(%)	(mc)	(kWh)	(kW)	(RoL)
Gas furnace	249	86.0	34.5%	98.58	5.214	4.16	0.503
Heat pump	421	160.7	38.2%	-	462.83	1.10	0.440
Total (28 days)	670	246.7	36.8%			26.4%	87.4%

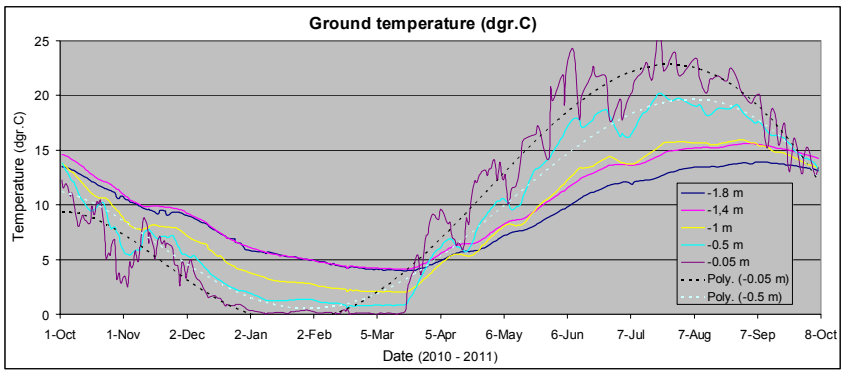
ANALYSIS OF ENERGY CONSUMPTION FOR COMPARISON OF HEAT PUMP AND GAS FURNACE

Next figures presents the temperature variations: in the ground, at a depth of –1.8 to zero meters, from October 2010 to September 2011 in figure 1; during a heat pump working cycle, at the end of heating season, in figure 2.

Some practical conclusions of this study are:

- The electrical energy consumption for a 130 square meters house (underfloor heating) with a heat pump system was of about 3750 kWh for one year (during 2010 – 2011 heating period);
- For a spiral pipe ground loop with a length of 50 m / kW [1], [2], the maximum energy reserve in the ground seems to be twice the value that has been used.
- The horizontal ground loop depth is not critical as long as it is less than –1.4 m [3];
- The heat pump power consumption is 26% and the price is 87% of the ones for the gas furnace.

The results can be used for a new heat pump system with horizontal ground-loop.



The temperature variation: Fig 1. - In the ground

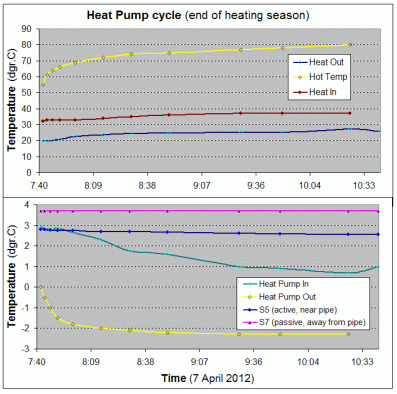


Fig.2. - During a heat-pump cycles.

References

[1] Worcester-Bosh Group, *Greenstore Ground Source Heat Pumps - Technical and Specification Info*, June 2006.
[2] Serban Cristian, *Curs Pompe de caldura CTC EcoHeat/EcoAir (CTC Heat Pumps Course)*, TermoMax Romania, 2007.
[3] Craciun A.V., Sandu F., Pana Ghe. "Monitoring of a Ground Source Heat Pump with Horizontal Collectors" *Proceedings of the 12-th International Conference on Optimisation of Electric and Electronic Equipment*, Brasov, May 20-22, 2010, 978-1-4244-7020-4.