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EXPERIMENTAL ANALYSIS OF A WATER-WATER HEAT PUMP THAT EXPLOIT GEOTHERMAL ENERGY

S. NEACŞU[1] C. EPARU[1] R. RĂDULESCU[1] G. AVRAMESCU[2]

Abstract: *An ecological, alternative solution to heating buildings is represented by the use of heat pumps of water-water type which exploit the surface geothermal energy. Sensors and a performing real time data acquisition system have been installed on the heat pump built in the laboratory for Renewable energy source. A software was designed for the analysis of parameters and performance. This paper analyzes the thermodynamic performance and the balance of power of the heat pump.*

Key words: *heat, pump, thermodynamic, energy*

1. Introduction

The heat pump is a device that has the ability to retrieve and transfer the heat from a source of low temperature in the form of useful heat to the technological process.

An important source of renewable energy is geothermal energy of the soil contained in the superficial layers of the earth's crust, at depths of up to 200 m. The temperature of these layers is between 10 – 30^{o}C and is constant from a depth of 10 m.

Heat pumps using the surface geothermal energy have high coefficients of performance 3.5 - 4.5, so that their use leads to reduced consumption of fossil fuels, the pollutants and greenhouse gases.

2. Description of the heat pump

A heat pump from the laboratory of Renewable Energy Sources in the Hydraulics, Thermotechnics and Reservoir Engineering Department of the Petroleum-Gas University of Ploiesti was used for heating oil (Figure 1).

The heat pump is a reversible pump with mechanical vapor compression, rotary compressor Hitachi SL-232 CV C7LU and two heat exchangers Alfa Laval AC-30-EQ-40H as a vaporizer and condenser. Laminar air valve is adjustable.

The heat pump is coupled to 4 systems to extract heat from the soil:

- a groundwater well dug at 15m depth, with the hydrostatic level at 4m
- a polyethylene spiral loop with a length of 180m buried at a depth of 2m
- a 40 meters vertical shaft where a simple loop of polyethylene has been inserted
- a simple loop of buried polyethylene at 1m with the total length of 60m.

3. The data acquisition system

A performing data acquisition system was realized, system with which operating parameters of the heat pump with a sampling rate of 20 seconds were

[1] Hydraulics, Thermotechnics and Reservoir Engineering, *Petroleum-Gas* University of Ploieşti
[2] Student, *Petroleum-Gas* University of Ploieşti

continuously monitored. Figure 2 presents the monitoring pump.

With the functional parameters of the pump gathered in real time by the data acquisition system, the thermodynamic parameters of the pump cycle are calculated and the graph is represented every 20 seconds (Figure 3).

Fig. 1. *The heat pump*

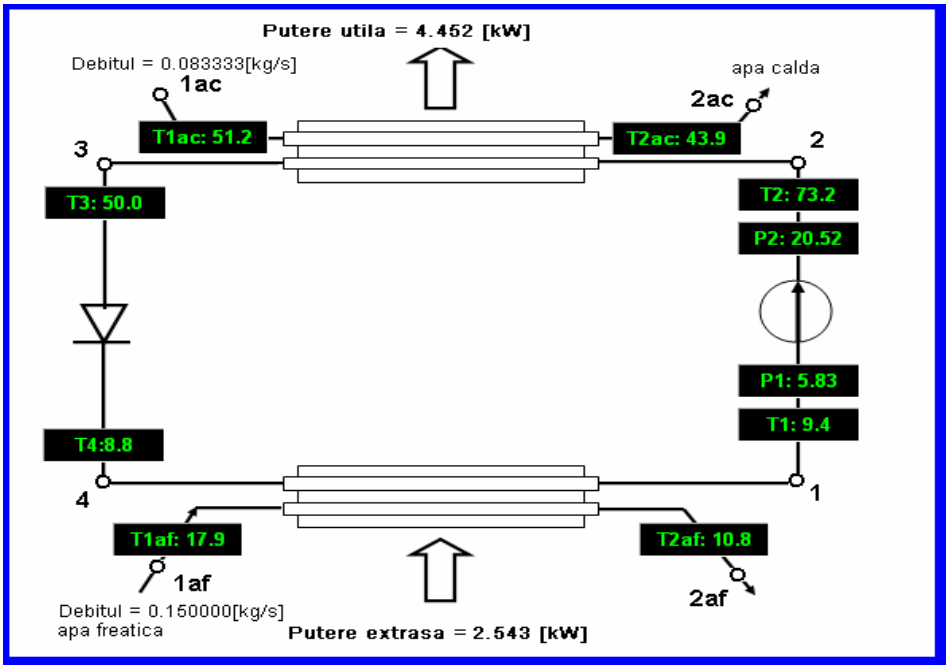

Fig. 2. *The monitoring heat pump*

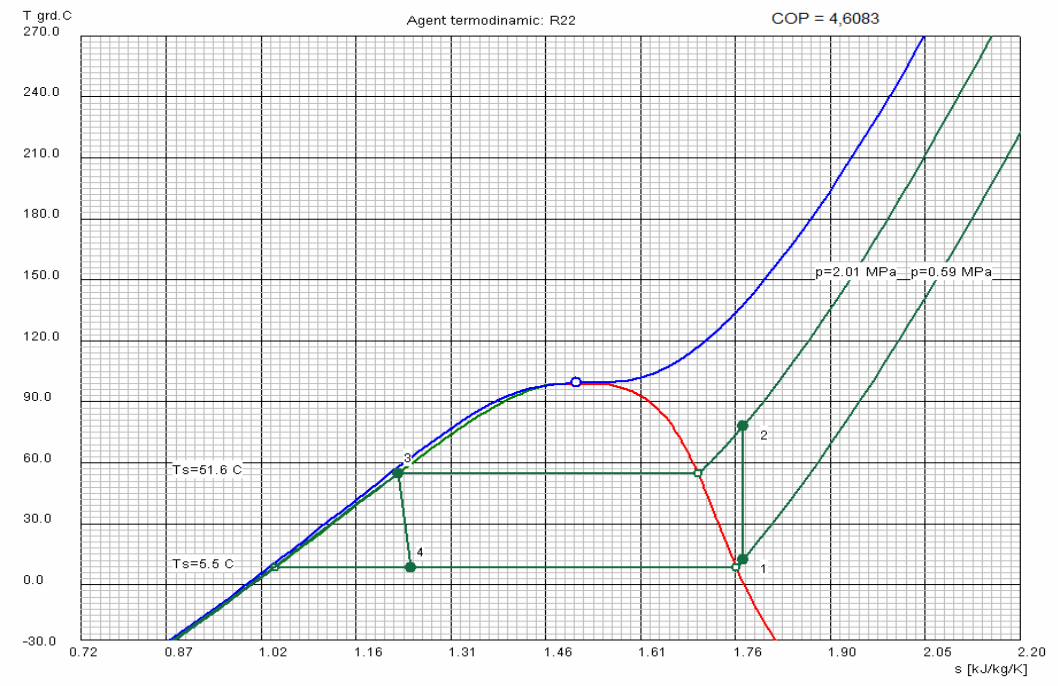

Fig. 3. *The heat pump cycle*

4. Tests for pump calibration

The following are the results of calibration of the heat pump operating on the four systems.

- small loop of 60 m (Figure 4)
- 40-meter well (Figure 5)
- Spiral loop (Figure 6)
- Groundwater well (Figure 7)

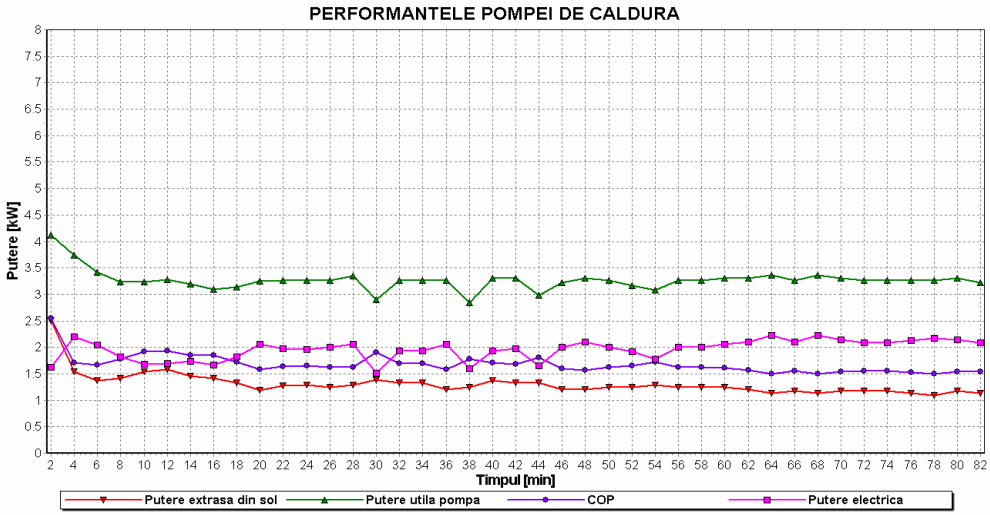

Fig. 4. *The heat pump performances – the small loop*

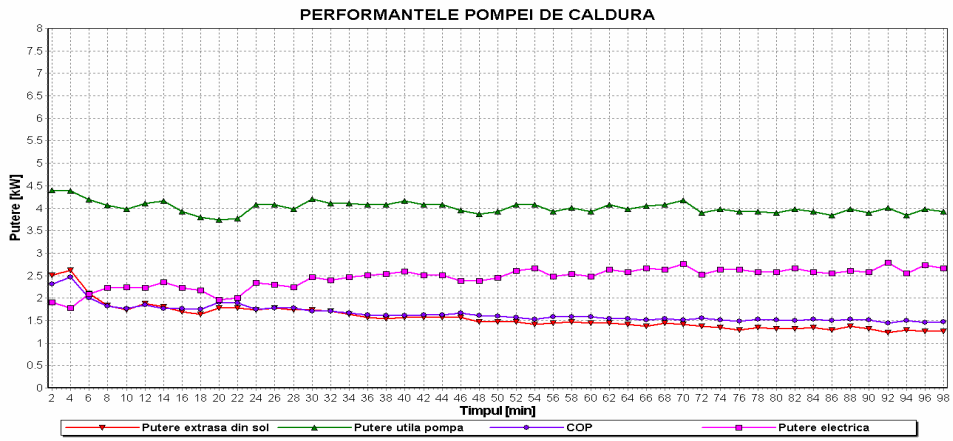

Fig. 5. *The heat pump performances – the 40-meter well*

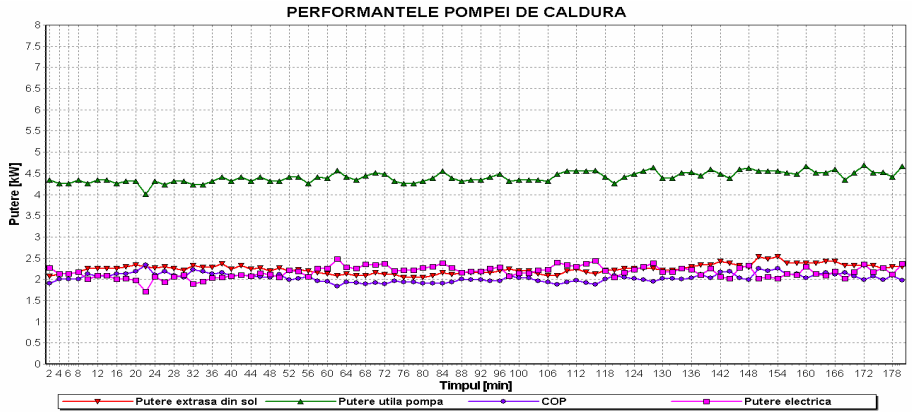

Fig. 6. *The heat pump performances – the spiral loop*

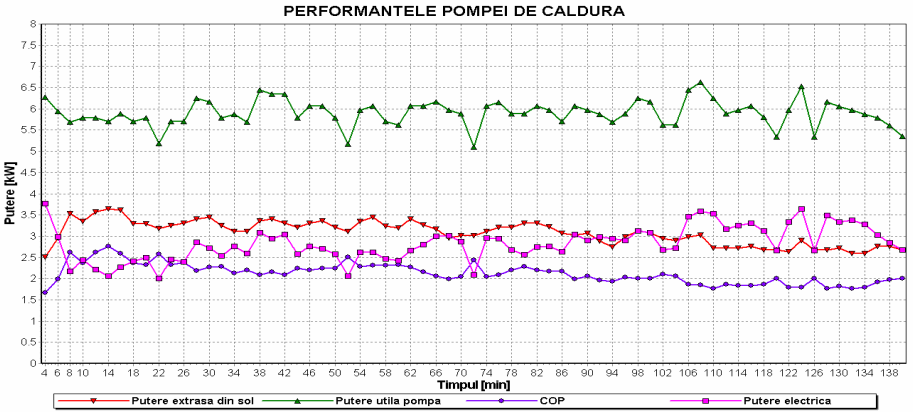

Fig. 7. *The heat pump performances – the groundwater well*

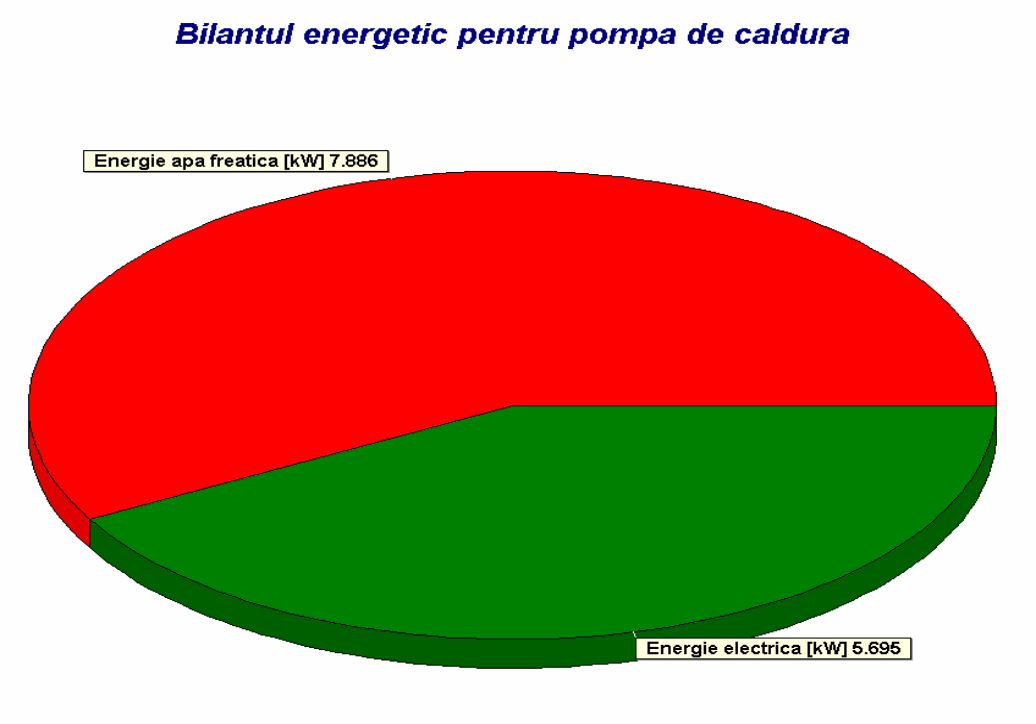

Fig. 8. *The energy balance of the heat pump*

The energy balance of the heat pump operating on groundwater throughout the heating process is shown in Figure 8. One can observe that from the total energy needed for the heating process (13,501KWh) more than half (7,886 KWh) is ensured from groundwater and only 5,695 KWh represents electricity.

5. Conclusions

Since the heat pump is used for the first time in industrial application, heating oil, it is provided with a complete monitoring system for all functional parameters, which allows real-time view of the thermodynamic processes.

Production of thermal energy from heat pumps that use geothermal energy from the surface layers depends on the proper sizing of the heat exchanger mounted in the ground.

Useful thermal energy produced by the pump is taken up to 60-70% from soil or groundwater, the rest is the equivalent of electricity consumed by the compressor. The use of heat pumps leads to lower consumption of fossil fuel to produce heat, reduced pollutants and greenhouse gases.

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