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# EXPERIMENTAL ANALYSIS OF SOIL HEAT EXTRACTION SYSTEMS

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***Abstract:*** *A 5 kW heat pump water-water function on R22 was built in the Renewable Energy Source Laboratory within the Petroleum - Gas University of Ploiesti. The pomp was equipped with 4 types of heat extraction systems from the soil: a groundwater well, a 40 m vertical well with a recirculation loop, a system of spiral loops buried at 2 m depth and a 60 m simple loop. This paper deals with the description of the performance obtained with the heat pump operating on these systems.*

***Key words:*** *soil, heat, extraction*

## Introduction

Several systems to extract heat from the soil using a heat pump were realized in the Laboratory of Renewable Energy Sources within Petroleum - Gas University of Ploiesti.

The useful heat of a heat pump comes mostly (60-70%) from the low temperature source, the rest being the heat equivalent of power consumed by the compressor.

This paper analyzes some experimental data obtained in the laboratory of renewable energy sources for various systems of heat extraction from the soil.

## Presentation of extracting heat systems

The heat pump realized in the renewable energy sources laboratory is coupled to 4 systems that extract heat from soil.

- Groundwater cased well of a 300 mm diameter digged at 15m, with the hydrostatic level at 4m (Figure 1)
- Spiral loop of polyethylene with a length of 180m buried at 2m (Figure 2)

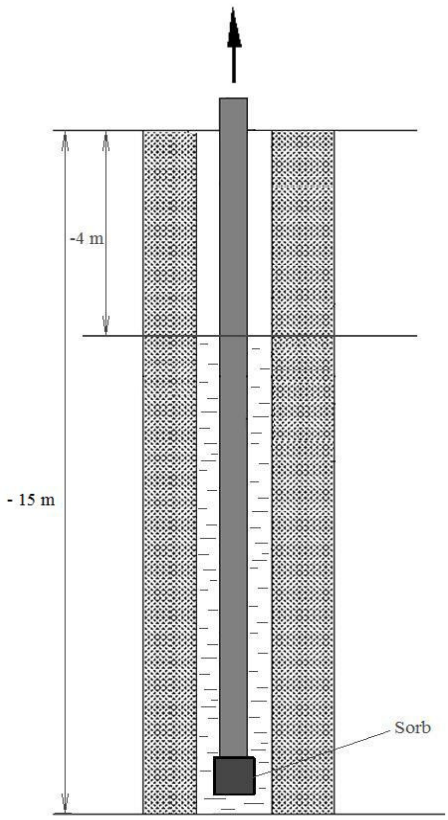


Fig. 1

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Fig. 2

- Simple loop of polyethylene inserted into a 40 meters vertical shaft (Figure 3)

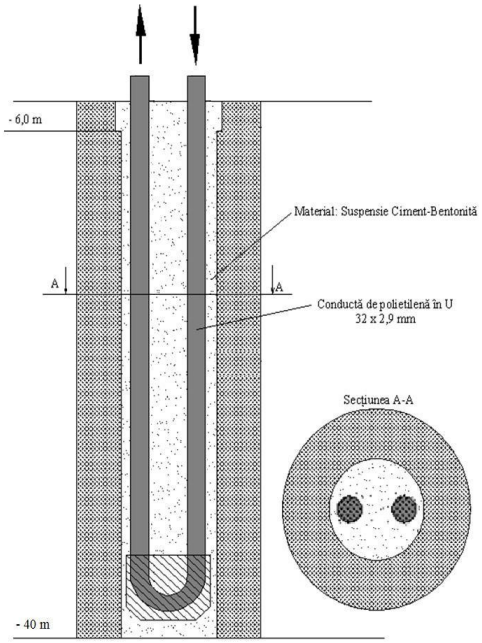


Fig. 3

- Simple loop of polyethylene buried at 1m, with a total length of 60m (Figure 4)

Fig. 4

The advantages of exchangers made from polyethylene pipes installed in ditches or wells are that the heat carrier fluid does not come into contact with the ground so there is no risk of pollution.

Due to polyethylene properties, there is no question of pipe corrosion; hence the system can be used for a long period of time (over 50 years).

Thermal conductivity of polyethylene is higher than that of the soil, so it is not a thermal barrier within heat exchange.

**Experimental results obtained**

For each of the four systems the dependency of heat extracted from the soil with time is shown.

- Simple loop of polyethylene with a total length of 60m.

Figure 5 presents the thermal power decrease per linear meter from 33.33 W/m to 20 W/m in about 80 minutes.

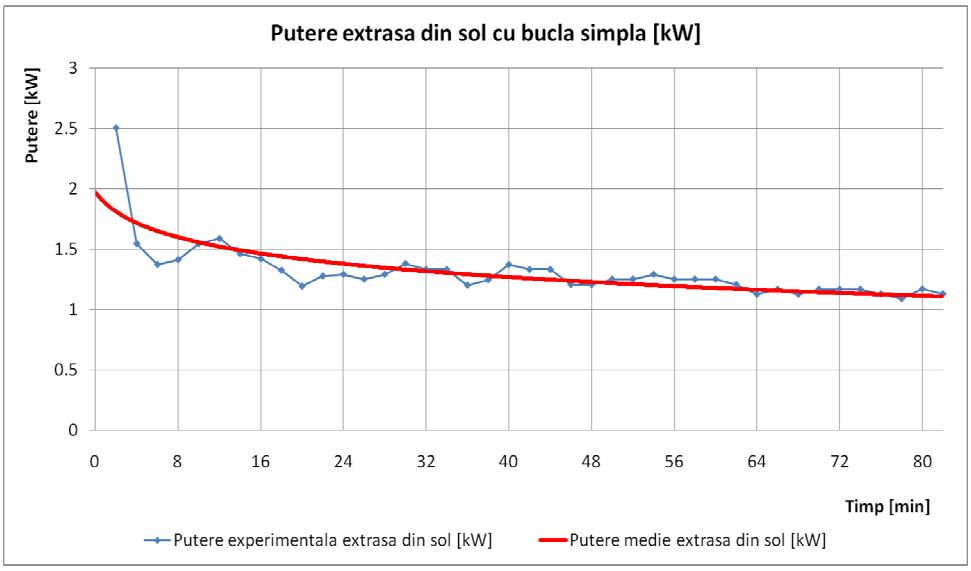


Fig. 5

- Loop of polyethylene placed in a pit with a depth of 40m.

In figure 6 we can see the way in which the thermal power per linear meter varies from 34.2 W/m to 19.3 W/m in about 90 minutes.

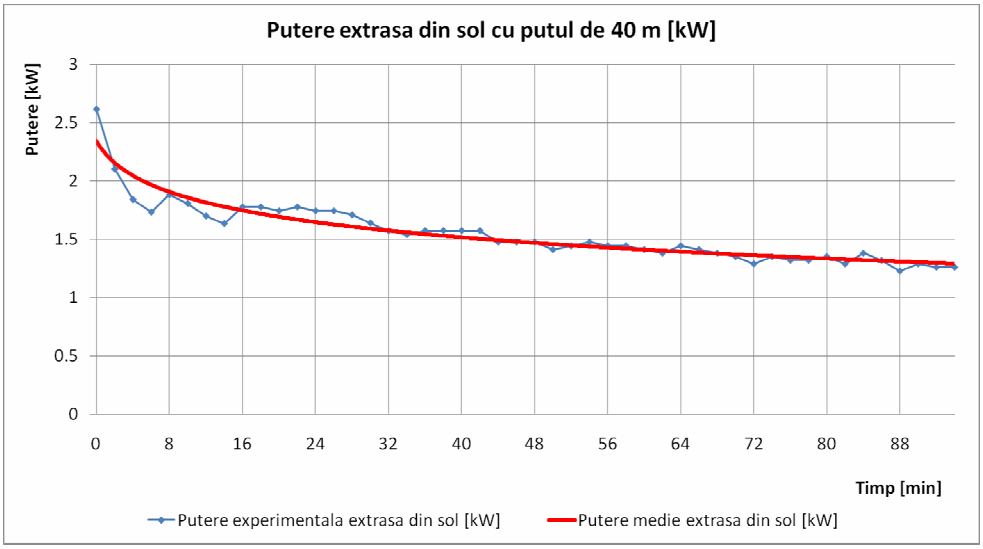


Fig. 6

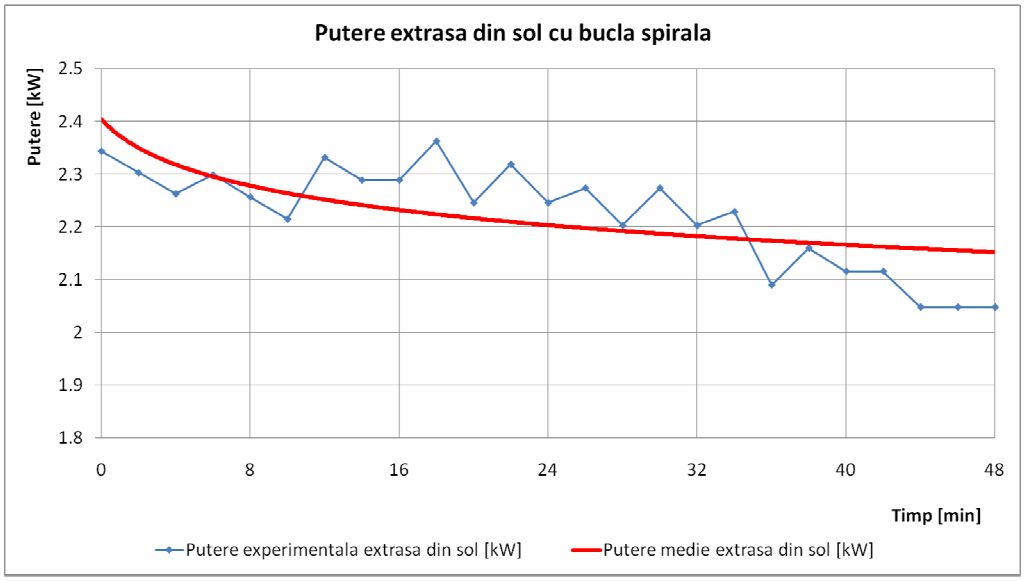


Fig. 7

- Spiral loop of polyethylene with a length of 180m

In figure 7 we can notice a decrease in thermal power per linear meter from 13.33 W/m to 11.95 W/m in about 48 minutes.

- Groundwater well with a hydrostatic level at 4m

In figure 8 we can see the way in which the thermal power varies from 3.6 kW to 2.8 kW in approximately 130 minutes.

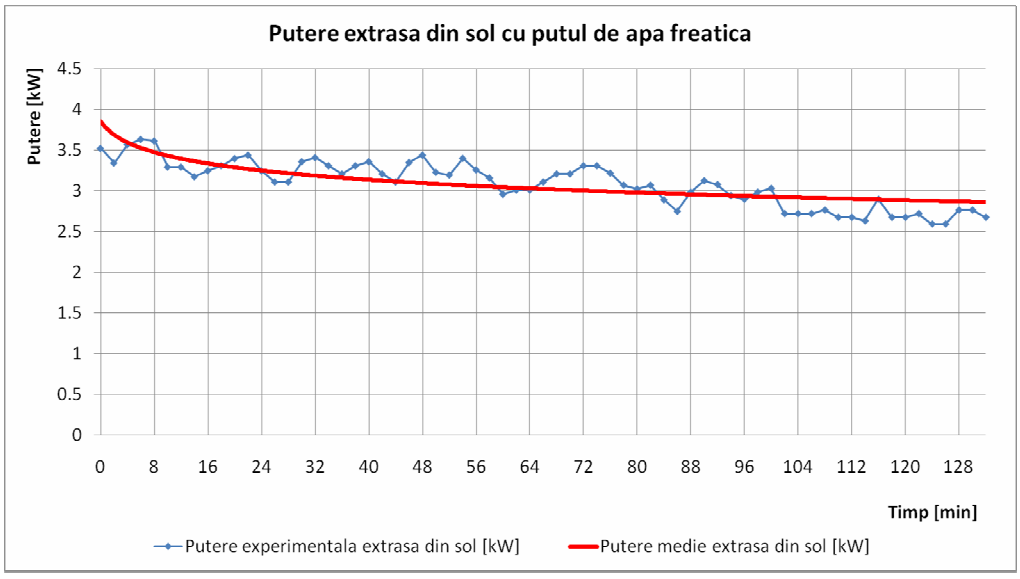


Fig. 8

The first part of the curve is influenced by local conditions (temperature) around the pipe at the beginning of heat pump running.

Because the necessary groundwater flow is low (~ 0.2 l/s), the stabilization of the thermodynamic conditions around the pipe takes about 60 minutes.

After this interval the thermal power extracted from groundwater remains constant throughout the duration of pump operation.

## Conclusions

After analyzing all data one can see that the maximum thermal power is obtained using the groundwater system, while it is constant throughout all pump operation.

All other closed systems with recirculation of water present limitations of the maximum power that can be extracted, but also a decline in time. For the spiral loop the variation of extracted power is influenced by the complicated geometry of the system.

The decline law of extracted heat from the soil is similar to the decline of oil wells production.

This is the subject of a study developed in the laboratory for renewable energy sources.

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