

MARTIN VANTÚCH¹
ANDREJ KAPJOR²
MILAN MALCHO³
JOZEF HUŽVÁR⁴
ŠTEFAN PAPUČÍK⁵

University of Zilina, Slovakia

¹ martin.vantuch@fstroj.uniza.sk

² andrej.kapjor@fstroj.uniza.sk

³ milan.malcho@fstroj.uniza.sk

⁴ jozef.huzvar@fstroj.uniza.sk

⁵ stefan.papucik@fstroj.uniza.sk

OPERATIONAL MEASUREMENT OF GROUND/WATER HEAT PUMP IN COLD WEATHER

Abstract

Article discusses the changes in heat flows in the secondary and primary circulation ground/water heat pump to low ambient temperature environments in winter. These results are compared with various HP power parameters. At the same time it describes the changes in the thermal potential at the initial start-up HP.

Keywords: heat pump

1. Introduction

The term low-potential heat of the Earth means the heat flow from the ground in the Earth's crust with a relatively low potential. This flow can be divided into two basic groups:

- heat flux of solar radiation incident on the surface of the Earth,
- radiogenic heat flow from Earth's interior.

The heat incident on the surface of the Earth by the action of solar radiation is very unstable and affects heat flux to the surface to a depth of 10–20 meters (neutral zone). Seasonal and daily changes in the intensity of solar radiation and outside air temperatures cause temperature fluctuations of the surface layers of the Earth. Heat mode ground located at greater depth than the depth of the neutral zone is formed effect of thermal properties of the Earth's core. Heat flow from Earth's interior is stable and virtually no influence of any factor, whether seasonal or other changes in weather and temperature. The temperature of the earth increases with depth by geothermal gradient (about 3°C per 100 m). Size of radiogenic heat flow from Earth's interior for different areas is different. For Central Europe this size is approximately 0.05 to 0.12 Wm⁻².

To obtain low-potential heat from ground it is most common to use the type of heat pump ground

/water resp. water/ water, if we use for obtaining groundwater heat the ground mass. Operating conditions and performance parameters of heat pumps affect some factors related to thermophysical properties of heat transfer agents, weather conditions, ground mass structure etc. These factors can greatly affect performance of heat pumps, resp. heating water temperature on secondary side of the heat pump. In our case we have considered the influence of low ambient temperatures in winter, the heat pump itself.

1.1. COP HP

When heat is taken from the ground, it leads to cooling and reduction potential. With the gradual drawing heat from the earth ground first a significant decrease in performance due to cooling agents in the evaporator and temperature drop in circulation medium heat in an earth probe occur. Guiding performance data for the heat pump coefficient of performance COP is defined as a proportion of heat output and heat output from pumped low-potential heat source.

$$\text{COP} = \frac{\dot{Q}_v}{P_k} \quad (1)$$

where: P_k is input power,

\dot{Q}_v is heat performance, W.

The equation means that the heat pump COP proportionally affects heat output and associated power drawn from the earth, because later the power of heat pump was constant. The value of the heating power is determined by factors mentioned in the introduction. To achieve high COP values high temperatures in the evaporator, resp. low temperatures in the secondary circuit of the heat pump condenser must be achieved.

2. Experimental device for measuring HP

Measurement of the heat pump type ground/water was carried out 25 days in a forced circulation heat transfer working fluid in the primary circuit. Variables that affect performance of acquired land for the primary and secondary circuit heat pump have been observed. Temperatures were also recorded in the ground along the borehole (Fig. 1).

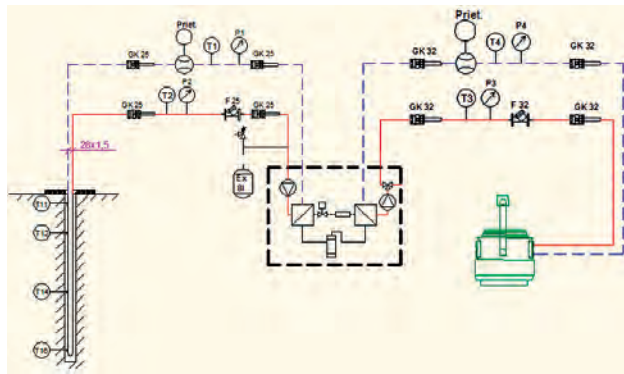


Fig. 1. Involvement of a primary and secondary circuit and measuring the heat pump components

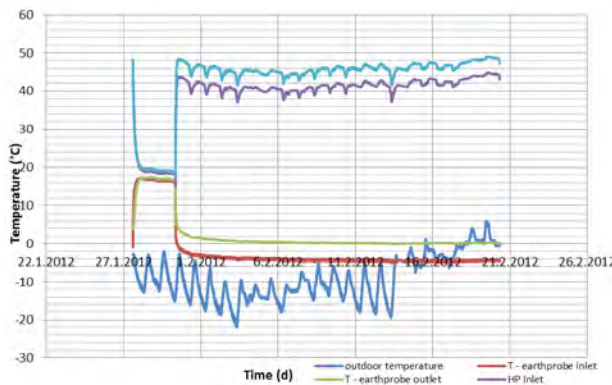


Fig. 2. The course of temperature changes working substance of the primary and secondary circuit HP

During the first two days only a circulation pump was in operation. Temperatures in the borehole slowly stabilized as temperature of the working substance. Temperature range of substances has stabilized at a value between 16.5 to 17°C. Temperatures at different depths, the well stabilized at values of 11.7°C in 150

meters depth, 10.8°C at 100 and 40 meters deep and 5.3°C at five meters.

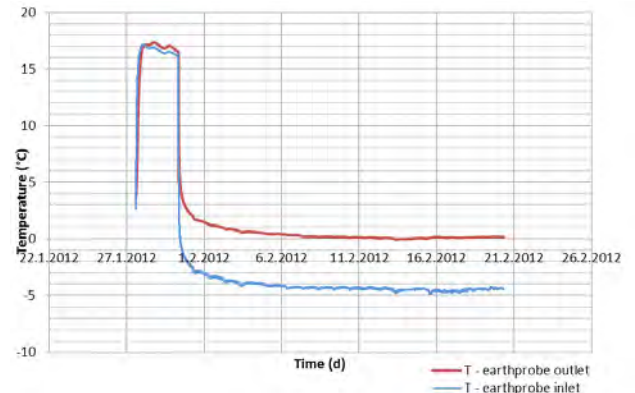


Fig. 3. Temperatures of working substance of primary circuit of entry and exit into the borehole

In the middle of the third day start heat pump and its onset can be observed for changes in temperature. After a full-on heat pump performance, we have seen increased short-term performance of heat pumps as a result of higher initial potential of accumulated heat of the earth. Over time, the pump performance measurement has stabilized at a constant value of about 8 kW, as indicated by the manufacturer. Temperatures at all depths gradually decreased and it was recorded as a reduction potential of water temperature on secondary circuit. Due to low ambient temperature overnight to reduce the temperature of heating water returns to the secondary circuit HP. There were even more marked hypothermia working substance at the inlet and the outlet of primary circuit heat pump and a slight increase in heat output obtained from the ground. Improved performance on the primary side just caused for the low temperature heat pump condenser (due to low night temperatures dropping and the temperature in the heated room, and thus to an increase in heat loss of the building). The refrigerant in condenser is cooled to a lower temperature than usual, which resulted in an increase in heat flow evaporation of refrigerant in evaporator heat pump.

On the other days there were significant variations in temperature. These fluctuations cause changes in temperatures of working substance in the primary and secondary side (Fig. 2). In the last phase of measurements there was a significant warming in weather which resulted in a slight stabilization of working substance of primary circuit and rise of working substance secondary circuit HP. During the measurement there was a slight descent working temperatures of substances on the primary and

secondary circuits. This was caused by pumping heat from the ground and reducing potential temperature in the immediate vicinity of borehole. On subsequent days, the low-potential heat flow stabilized at a constant value or value with minimum decrease output.

Measurement of the secondary (heating circuit) measurement was carried out similarly to primary side. They recorded temperature and heat transfer fluid flow rate (Fig. 4). The generated output (as presented in Fig. 5) is used to heat hall areas ŽU through heating unit FLOWAIR LEO FB 15 kW.

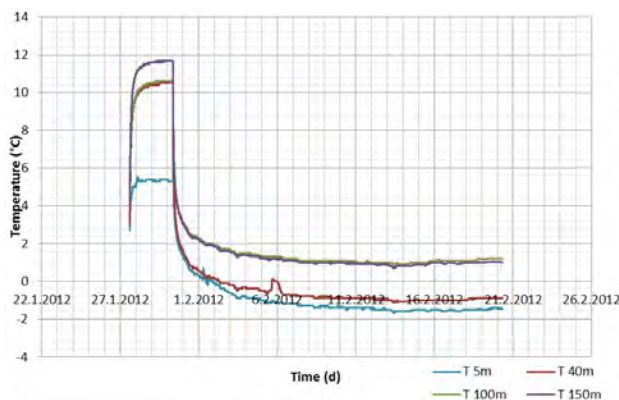


Fig. 4. Decrease in temperature in different depths of the ground

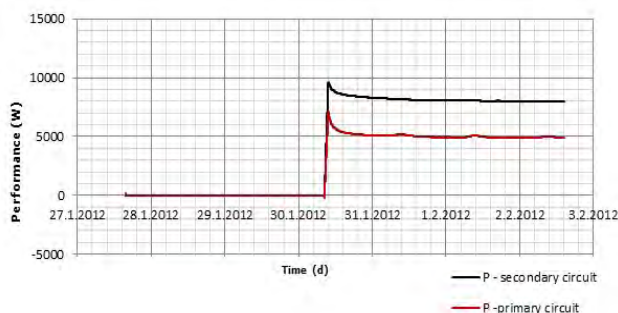


Fig. 5. Changes performance of primary circuit and overall performance of heat pump

3. Conclusions

As mentioned, the temperature of working substance in borehole affects the thermal parameters of secondary circuit HP. Due to low outdoor temperatures to reduce water temperature in secondary circulation (increased heat loss to the building). The primary circuit is increased and performance has been re-rising water temperature. The current outside temperature climb to procedure day to compensate for heating water in the system and gradually there was a leveling off of the original value of 48/42°C. On subsequent days, the process is repeated with decreasing night temperature,

while a slight drop in overall temperature reduction due to potential well on the primary side. Due to changes in ambient temperature there is an increase in heat output obtained from a borehole and a slight increase in the overall performance of heat pumps. At low temperatures there was therefore an increase in coefficient of performance COP. This change was very small and can not be considered significant. As confirmed by experiments, changes in external ambient temperature affect performance of HP at least. But more important is the decline performance in long-term performance of HP maximum power influence reduce of potential the ground (Fig. 4). Over time, operating temperature bore potential ground falls, resulting in reduction potential temperature of heating water in the system. This change is noticeable and significant only at very low ambient temperatures during the winter months.

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