

Heat capacity of vertical ground heat exchangers with single U-tube installation in the function of time

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Abstract: - One of the major problems of ensuring optimal working of ground source heat pump systems is a heat transfer around vertical ground heat exchanger. The working of vertical U-tube can be understood as a heat exchanger between the ground and the heat carrying medium. In our case this heat carrying medium is fluid, which transfers the extracted heat from the ground to the heat pump. In winter we extract heat from the ground and in summer we transfer heat to the ground. In our paper we propose a simple calculation model to calculate the temperature change and the thermal resistance in vertical ground heat exchangers with single U-tube installation. We made calculations to obtain the amount of extractable heat from the U-tube in the function of different mass flow. We did these calculations for several periods of time, 1 day, 1 year, 10 years. We found that the amount of extractable heat in winter and in summer is between 10 – 80 % in the function of mass flow, and with elapsing time its values decline.

Key-words: - heat pump, U-tube, heat transfer, heat flow, thermal resistance, system theory.

1 Introduction

In recent years, a large number of residential and commercial buildings have been installed with ground coupled heat pump systems for space cooling, heating and even hot water supply because of their higher efficient, low maintenance cost and environmental friendliness. Most of the ground coupled heat pumps use vertical ground heat exchangers which usually offer higher energy performance than the horizontal ground heat exchangers due to the less temperature fluctuation in the ground.

In the Carpathian basin, but mainly on the territory of Hungary the crust of the earth is thinner than the average; therefore its geothermal features are very good. Under the ground surface in the earth core levels from the decomposition of radioactive isotopes heat is produced. Its flow directed towards the surface is geothermal energy. The global average of the geothermal gradient is 33 m/°C, while in Hungary it is only 18-22 m/°C. The average value of the heat flow from the inner core of the ground is 80-100 mW/m² according to the heat flow map of Hungary, which is almost the double of the average value measured on the mainland [1].

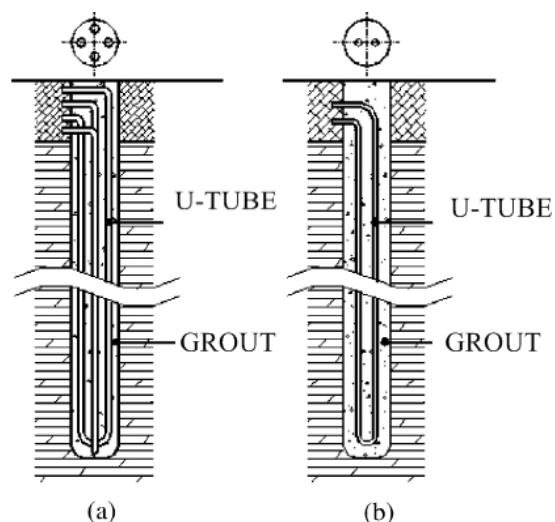


Fig. 1: Location of double (a) and single (b) U-tubes in boreholes

The primary side heat sources of heat pumps operating with water-water sources are the following: underground waters and heat of the earth (geothermal energy). The geothermal energy is extracted from the ground by ground heat exchangers with U-tubes. The installation of U-tubes can be vertical and horizontal. In

