ET 262

Geothermal probe with heat pipe principle

Description

- **transparent components allow observing how the state of the heat transfer medium changes**
- **operation with low-boiling heat transfer medium**

In shallow geothermal energy generation the thermal energy stored under the earth's surface is used for heating purposes.

ET 262 demonstrates the operation of a geothermal probe with heat pipe principle. The transparent experimental set-up provides an insight into the closed circuit of the heat transfer: it allows a clear view on the evaporation in the heat pipe, the condensation in the probe head and the reflux of the heat transfer medium on the inside wall of the heat pipe. The set-up also allows to take a closer look at the basic methods applied for determining the thermal conductivity of the surrounding soil of the geothermal probe.

The heat pipe whose operating behaviour is examined constitutes the core element of the trainer. The heat pipe contains a low-boiling heat transfer medium. The heat input from the soil is simulated via a temperature control jacket with heating circuit. The heat from the heat transfer medium is transferred to a working medium inside the probe head. Sensors detect the temperature and flow rate of the working medium in the heat exchanger. These measured values are used to calculate the thermal power that is transferred. The GUNT software uses the measured values to simulate the energy balance of a connected heat pump.

One method to determine the thermal conductivity of the surrounding soil is the so-called thermal response test. A pump circulates constantly heated water through a U-tube geothermal probe that is sunk in sand. During this process, the inlet and outlet temperature, the flow rate and the heating power of the geothermal probe are recorded. These measured values are used to calculate the thermal conductivity.

During another experiment, a sand cylinder is heated with a cylindrical heat source. The radially dispersed thermal temperature profile within the sand sample is detected and used to calculate the thermal conductivity within the sand sample. The results of both methods will then be compared.

The measured values are transmitted directly to a PC via USB where they can be analysed using the software included.

Learning objectives/experiments

- fundamentals of geothermal energy
- operating behaviour of a geothermal probe with heat pipe principle
- determination of the amount of heat that can be dissipated in the heat pipe with variation of the thermal load
- variation of the filling level of the heat transfer medium contained
- examination of the radial temperature profile in a sand sample and determination of the thermal conductivity
- determination of the sand's thermal conductivity by means of a thermal response test
- fundamentals and energy balance of a heat pump

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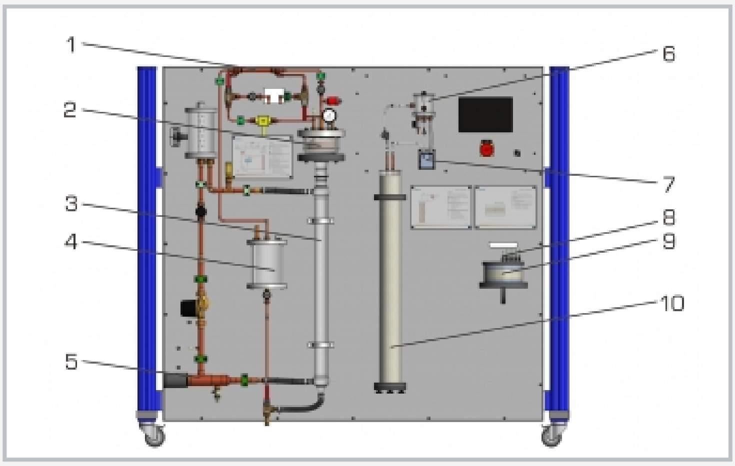
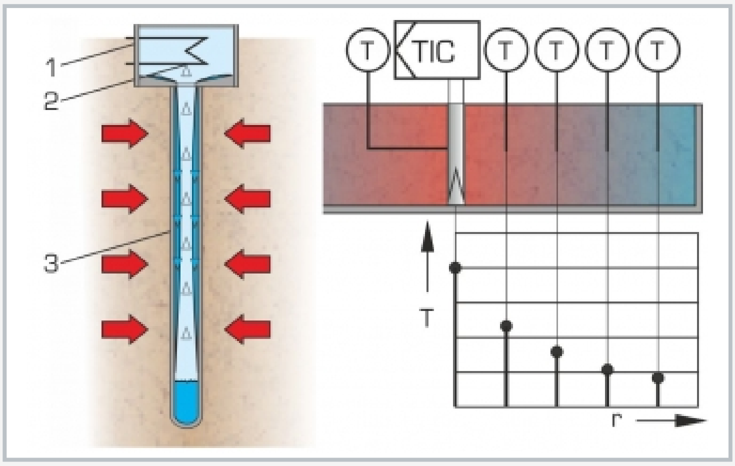
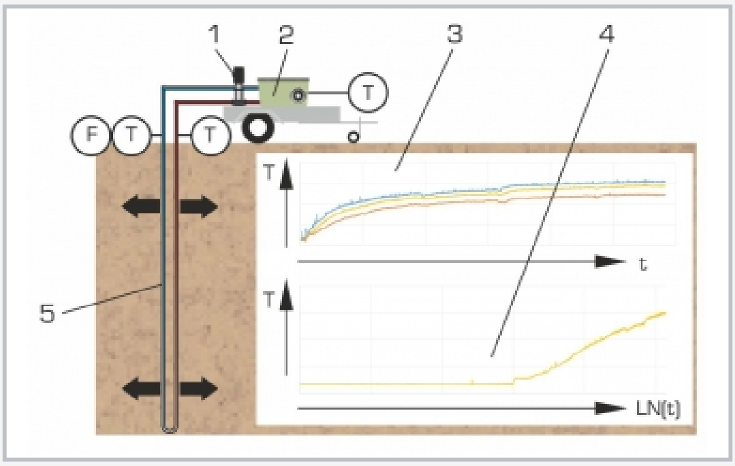


1 condensate separator, 2 heat exchanger, 3 heat pipe with temperature control jacket, 4 storage tank for heat transfer medium, 5 heater in the heating circuit, 6 water tank with heating element, 7 pump, 8 heating element, 9 sand cylinder, 10 U-tube geothermal probe



Left: geothermal probe with heat pipe principle: 1 sensor head, 2 heat exchanger, 3 heat pipe, blue: liquid heat transfer medium, light blue: gaseous heat transfer medium, red arrow: geothermal heat;
right: radial heat conduction in a sand sample: T temperature, TIC temperature controller of the heater, r radius



Thermal response test: 1 pump, 2 water tank with heating element, 3 time dependency of the measured temperatures, 4 logarithmic time dependency of the central water temperature, 5 U-tube geothermal probe; T temperature, F flow rate, t time, LN(t) natural logarithm of time

Specification

[1] demonstration of the operation of a geothermal probe with heat pipe principle
[2] heat pipe made of glass with transparent temperature control jacket
[3] water as a working medium for heat dissipation in the heat exchanger
[4] supply of the working medium via the lab network or via water chiller WL 110.20
[5] simulation of the energy balance of a heat pump in the GUNT software
[6] refrigerant R1233zd, GWP: 1
[7] GUNT software for data acquisition via USB under Windows 7, 8.1, 10

Technical data

Heat pipe
- length: approx. 1000mm
- Ø external, heat pipe: approx. 56mm
- Ø external, temperature control jacket: approx. 80mm

Heater in the heating circuit
- output: 2kW

Pump in the heating circuit
- max. flow rate: 1,9m^3/h
- power consumption: 58W

U-tube geothermal probe made of copper
- length: approx. 1000mm

Pump in the thermal response test
- flow rate: 4,8...28,2L/h
- power consumption: max. 60W

Heating element in the water tank
- output: 100W

Heating element in the sand container
- output: 50W

Refrigerant: R1233zd, GWP: 1
- filling volume: 2,3kg
- CO_2-equivalent: 0t

Measuring ranges
- temperature of the heating element in the sand sample: 0...250°C
- flow rate: 0,4...6L/min

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase; 120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 2170x790x1900mm
Weight: approx. 250kg

Required for operation

water connection, drain or WL 110.20
PC with Windows

Scope of delivery

1 trainer
1 packing unit of sand (25kg; 1...2mm grain size)
1 GUNT software CD + USB cable
1 set of instructional material

ET 262

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Optional accessories

060.11020	WL 110.20	Water chiller