WL 900

Steady-state and non-steady-state heat conduction

Learning objectives/experiments

- steady heat conduction
- transient heat conduction
- temperature/time profiles
- calculate thermal conductivity λ of different metals

Description

- **steady and transient heat conduction in metals**
- **12 temperature measurement points in every sample**
- **regulated temperature of the heat source**

Heat conduction is the transport of heat between the individual molecules in solid, liquid and gaseous media under the influence of a temperature difference.
Steady heat conduction is the term used when heat transport is maintained permanently and uniformly by adding heat.
In transient heat conduction, the temperature distribution in the body is dependent on location and time.

Thermal conductivity λ is a temperature-dependent property of a material that indicates how well the heat propagates from a point in the material.

WL 900 can be used to study both steady and transient heat conduction. The trainer consists of a heat source and a heat sink, between which cylindrical samples made of different metals are inserted. Each sample is fitted with 12 temperature measurement points. The temperature measurement points are designed to have as little influence on the temperature as possible and the core temperature of the sample is measured.

The heat source consists of an electrically heated hot water circuit. An electronic controller ensures the heating water is kept at a constant temperature. The heat sink is realised by means of a water cooling system. An elevated tank ensures a constant cooling water flow rate.

A temperature jump can be generated by appropriate regulation of the cooling water flow. A PC can be used to display the transient temperature distribution in the sample over time and place.

The temperatures of the sample, heating and cooling water, as well as the electrical heating power and the cooling water flow rate are displayed digitally on the switch cabinet and can be transmitted simultaneously via USB directly to a PC where they can be analysed using the software included. The thermal conductivity λ can be calculated from the measured data.

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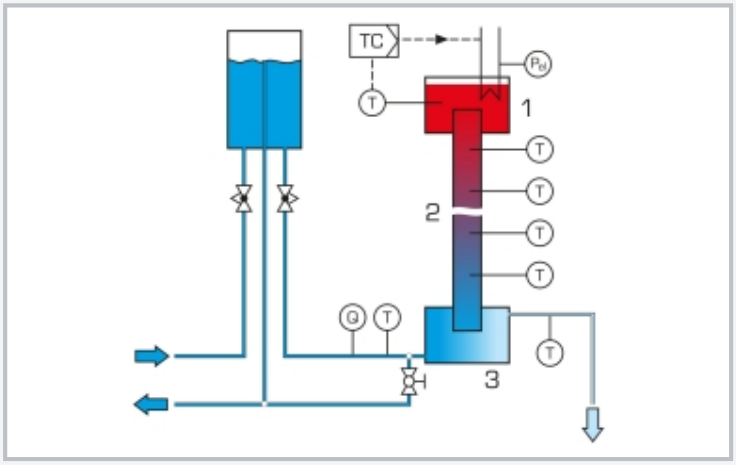
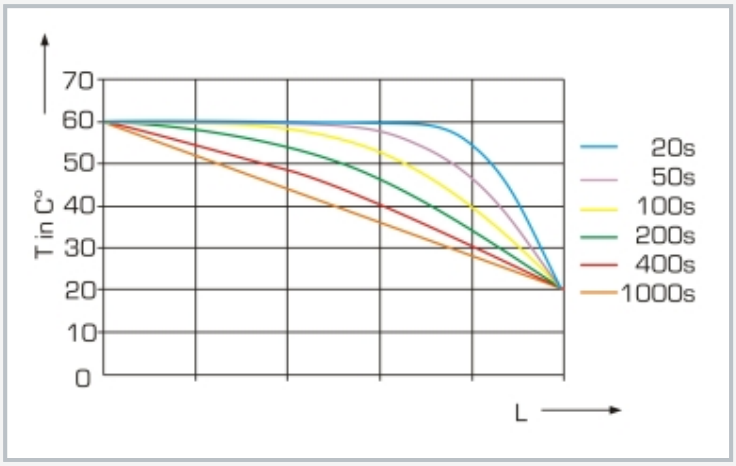
1 elevated tank for constant cooling water initial pressure, 2 heat source with heater, 3 sample, 4 water-cooled heat sink, 5 displays and controls



1 heater, 2 sample, 3 heat sink; T temperature, Q flow rate, TC heating water temperature controller, P_{el} electric heating power, blue: cooling water, red: heating water



Transient temperature profile along a rod with sudden cooling
T temperature, L length of the rod, coloured lines: temperature profile at different points in time

Specification

[1] investigation of steady and transient heat conduction in metals
[2] determining the thermal conductivity λ
[3] heating water circuit as heat source, electronically regulated
[4] electric heater with PID controller
[5] elevated tank with overflow for generating a constant cooling water flow rate
[6] samples made of 5 different metals
[7] cooling water temperature and flow rate measurement
[8] digital displays: electric heating power, temperatures, cooling water flow rate
[9] GUNT software for data acquisition via USB under Windows 11

Technical data

Heater
- output: 800W
- temperature: 20...85°C

Samples, Ø 40mm
- 3x 450mm (copper, aluminium, brass)
- 2x 300mm (steel, stainless steel)

Heating tank: ca. 2L
Cooling tank: ca. 0,5L
Elevated tank: ca. 6L

Temperature sensors
- 12x thermocouple type K, along the sample
- 2x Pt100, in the cooling water
- 1x Pt100, in the heating water

Measuring ranges
- temperature: 14x 0...100°C
- power: 0...1000W
- flow rate: 0,1...2,5L/min

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase, 120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 1240x800x1670mm
Weight: approx. 150kg

Required for operation

water connection, drain
PC with Windows recommended

Scope of delivery

1 trainer
1 GUNT software + USB cable
1 set of accessories
1 set of instructional material