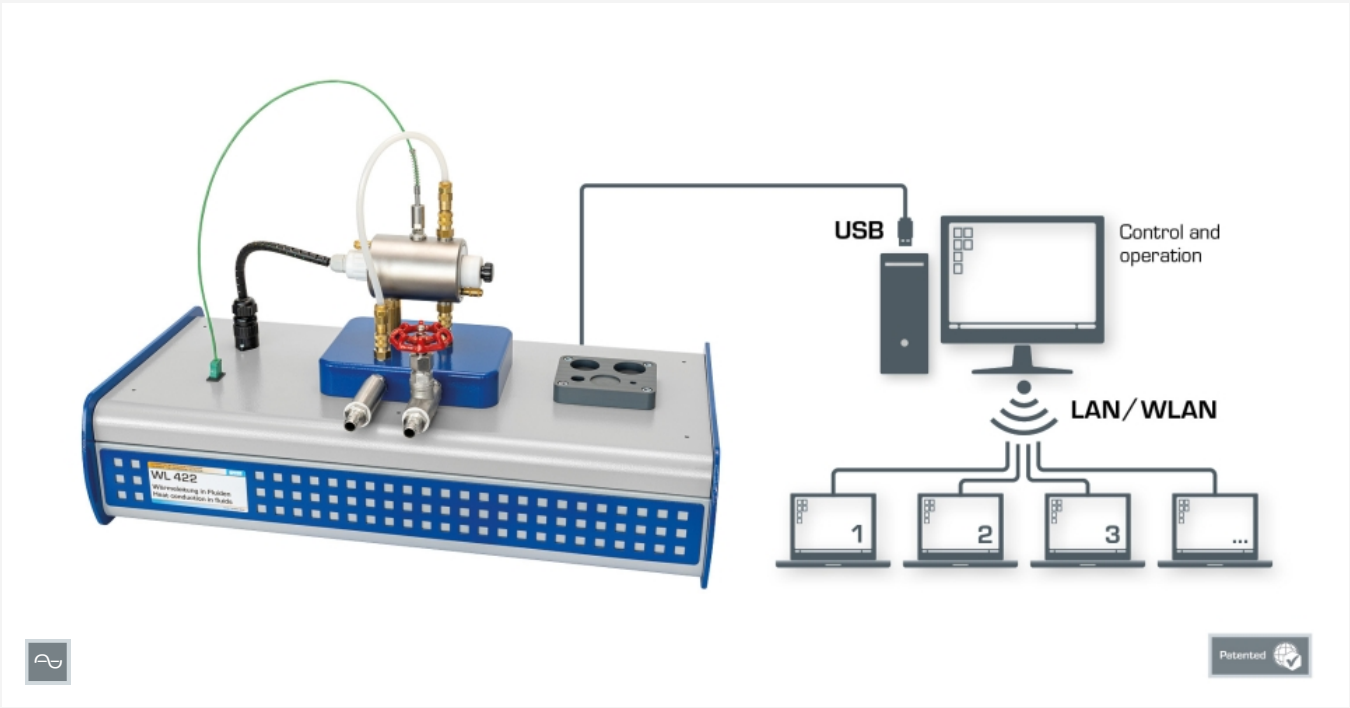
WL 422

Heat conduction in fluids



Complete experimental setup with one PC for control and operation and any number of workstations with GUNT software for observation and evaluation of the experiments.

Description

- **effect of different fluids on heat conduction**
- **network capability: network access to ongoing experiments by any number of external workstations**
- **GUNT software: operation and control of the experimental unit, data acquisition and educational software**
- **E-Learning: multi-media didactic materials accessible online**

Heat conduction is one of the three basic forms of heat transfer. According to the second law of thermodynamics, heat is always transferred from the higher energy level to the low energy level.

WL 422 offers basic experiments for targeted teaching on the topic of heat conduction in fluids. Such teaching should discuss the fundamental differences between gases and liquids.

Two cylinders form the main component of the experimental unit: an electrically heated inner cylinder situated in a water-cooled outer cylinder. There is a concentric annular gap between the two cylinders. This annular gap is filled with the fluid being studied. The heat conduction occurs from the inner cylinder, through the fluid to the outer cylinder.

The narrow annular gap prevents the formation of a convective heat flux and allows a relatively large pass-through area while at the same time providing a homogeneous temperature distribution.

The experimental unit is equipped with temperature sensors inside and outside of the annular gap. Thermal conductivities for different fluids, e.g. water, oil, air or carbon dioxide can be determined in experiments.

The microprocessor-based instrumentation is well protected in the housing. The GUNT software consists of a software for system operation and for data acquisition and an educational software. With explanatory texts and illustrations the educational software significantly aids the understanding of the theoretical principles.

The operation and control of the experimental unit is carried out via a PC (not included in the scope of delivery) connected via a USB interface. Any number of workstations with the GUNT software can be used for observation and evaluation of the experiments via LAN /WLAN connection using only one licence.

Learning objectives/experiments

- steady heat conduction in gases and liquids:
  - determine the thermal resistance of fluids
  - determination of thermal conductivities λ for different fluids at different temperatures
- transient heat conduction in fluids:
  - interpret transient states during heating and cooling
  - introduction to transient heat conduction with the block capacity model

- GUNT E-Learning
  - multi-media online course, which enables learning independent of time and place
  - access via Internet browser
  - educational software including different learning modules
  - course in the fundamentals
  - detailed thematic courses
  - check through targeted review of the learning objectives
  - authoring system with editor that enables you to integrate your own, local content into the educational software

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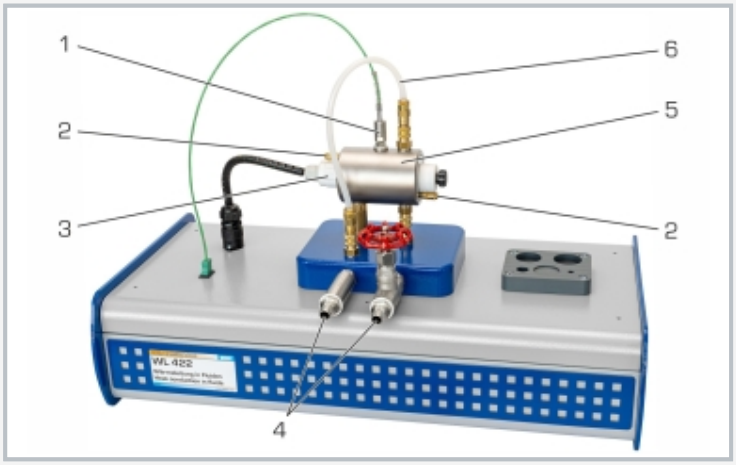
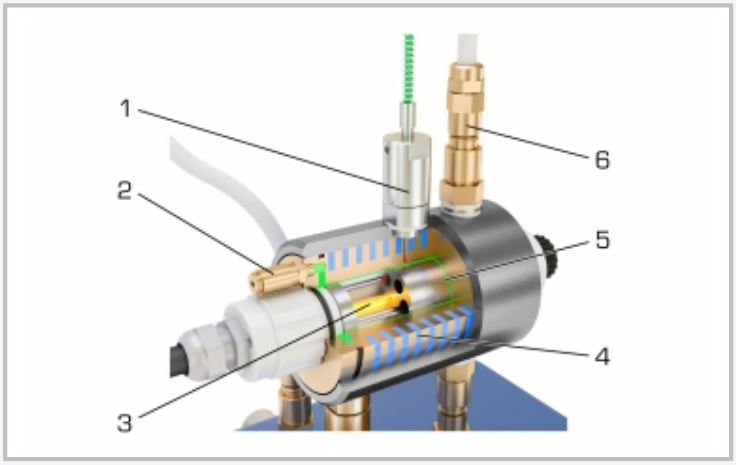
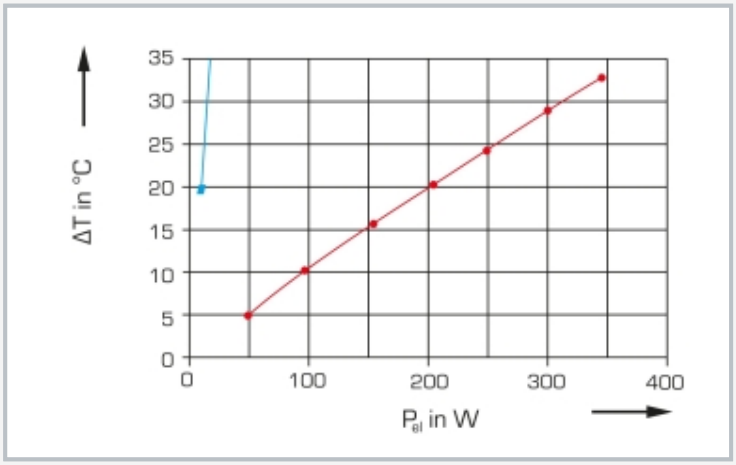


1 temperature sensor, 2 connection for fluid, 3 inner cylinder, 4 valve for cooling water, 5 outer cylinder, 6 cooling water hose



Cross-sectional view of the experimental setup: 1 temperature sensor, 2 connection for fluid, 3 inner cylinder, 4 cooling channel, 5 annular gap, 6 cooling water connection; blue: cooling water, green: fluid



Differences in calculated values for water and air
ΔT temperature difference, P_{el} electrical power; blue: air, red: water

Specification

[1] part of the GUNT-Thermoline: Fundamentals of heat transfer
[2] investigation of the thermal conductivity of common fluids, e.g. water, oil, air or carbon dioxide
[3] concentric annular gap between 2 cylinders containing the fluid being studied
[4] inner cylinder, continuously electrically heated
[5] water-cooled outer cylinder
[6] display of temperatures and heating power in the software
[7] due to integrated microprocessor-based instrumentation no additional devices with error-prone wiring are required
[8] functions of the GUNT software: system operation, data acquisition, educational software
[9] network capability: LAN/WLAN connection of any number of external workstations with GUNT software for observation and evaluation of the experiments
[10] E-Learning: multi-media didactic materials accessible online
[11] GUNT software for data acquisition via USB under Windows 10

Technical data

Heater
- heating power: 350W
- temperature limitation: 95°C

Heat transfer area: 74,39cm²
Annular gap
- height: 0,4mm
- average diameter: 29,6mm

Inner cylinder
- mass: 0,11kg
- specific heat capacity: 890J/kg*K

Measuring ranges
- temperature: 2x 0...325°C
- heating power: 0...450W

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase; 120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 670x350x480mm
Weight: approx. 18kg

Required for operation

cold water connection max. 30°C, min. 1L/h; drain; PC with Windows

Scope of delivery

1 experimental unit
1 set of hoses
1 set of hoses with quick-release couplings
1 authoring system for GUNT educational software
1 GUNT software + USB cable
1 set of instructional material