WL 377
Convection and radiation

Description

- **heat transport between heating element and vessel wall by convection and radiation**

Under real conditions, the heat transport between two objects is normally substance-bound, i.e. convection and/or heat conduction, and not substance-bound, i.e. radiation, at the same time. Determining the individual heat quantities of one type of transfer is difficult.

The WL 377 trainer enables users to match the individual heat quantities to the corresponding type of transfer. The core element is a heated metal cylinder located at the centre of the pressure vessel. The surface temperature of the heated metal cylinder is controlled. Temperature sensors measure the surface temperature of the metal cylinder and the wall temperature of the pressure vessel. In addition to the heating power of the metal cylinder, it is possible to study the heat transport from the metal cylinder to the wall of the pressure vessel.

The pressure vessel can be put under vacuum or positive gauge pressure. In the vacuum, heat is transported primarily by radiation. If the vessel is filled with gas and is under positive gauge pressure, heat is also transferred by convection. It is possible to compare the heat transfer in different gases. In addition to air, nitrogen, helium, carbon dioxide or other gases are also suitable.

Heat transport by conduction is largely suppressed by adequately suspending the metal cylinder.

A rotary vane pump generates negative pressures down to approx. 0,02mbar. Positive gauge pressures up to approx. 1bar can be realised with compressed air. Two pressure sensors with suitable measuring ranges are available for the pressure measurement: a Pirani sensor measures the negative pressure while a piezo-resistive sensor measures the positive pressure.

The measured values can be read on digital displays. At the same time, the measured values can also be transmitted directly to a PC via USB, where they can be analysed with the GUNT software.

Learning objectives/experiments

- experiments in vacuum
  - heat transfer by radiation
  - determination of the radiation coefficient
- experiments at ambient pressure or positive gauge pressure
  - heat transfer by convection and radiation
  - determination of the heat quantity transferred by convection
  - determination of the heat transfer coefficient based on measured values
  - theoretical determination of the heat transfer coefficient based on the Nusselt number
  - comparison of the heat transfer in different gases

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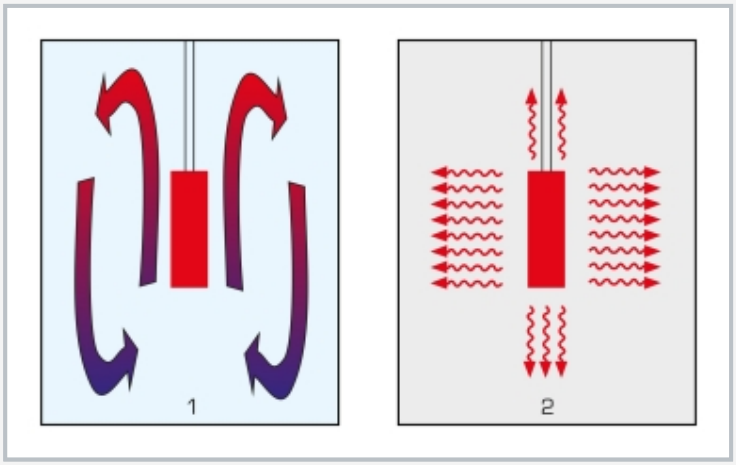
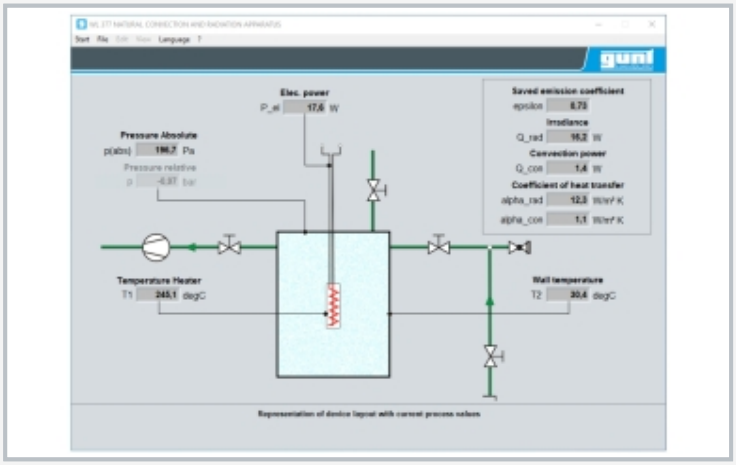
1 temperature controller with temperature display, 2 temperature display, 3 power display, 4 vacuum pump, 5 pressure vessel, 6 vessel's absolute pressure display, 7 vessel's relative pressure display



Heat transfer in the vessel:
1 convection (vessel filled with gas), 2 radiation (vessel filled with vacuum)



Software screenshot: process schematic

Specification

[1] heat transfer between heated metal cylinder and vessel wall by convection and radiation
[2] operation with various gases possible
[3] experiments in vacuum or at a slight positive gauge pressure
[4] electrically heated metal cylinder in the pressure vessel as experimental vessel
[5] temperature-controlled heating element
[6] vacuum generation with rotary vane pump
[7] instrumentation: 1 temperature sensor on the metal cylinder, 1 power sensor at the heating element, 1 Pirani pressure sensor, 1 piezo-resistive pressure sensor
[8] digital displays for temperature, pressure and heating power
[9] GUNT software for data acquisition via USB under Windows 10

Technical data

Heating element
- output: 20W
- radiation surface area: approx. 61cm^2

Pressure vessel
- pressure: -1...1,5bar
- volume: 11L

Pump for vacuum generation
- power consumption: 370W
- nominal suction capacity: 5m^3/h
- final pressure with gas ballast: 2*10^{-3}mbar
- final pressure without gas ballast: 7*10^{-2}mbar

Measuring ranges
- negative pressure: 0,5*10^{-3}...1000mbar
- pressure: -1...1,5bar rel.
- temperature: 0...250°C
- power: 0...23W

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase; 120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 1340x790x1500mm
Weight: approx. 160kg

Required for operation

compressed air: min. 1,5bar
PC with Windows recommended

Scope of delivery

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