WL 220
Boiling process

Description

■ visualisation of boiling and evaporation

Heating a liquid over a heating surface produces different modes of boiling dependent on the heat flux density. They can accelerate the evaporation process (nucleate boiling) or impair it (film boiling). In practice, a limitation of the heat flux density must be assured in order to prevent damage to the heating surface. This knowledge is applied in practice e.g. when designing steam boilers for steam-powered drives.

The WL 220 experimental unit can be used to demonstrate boiling and evaporation processes in a straightforward manner. The processes take place in a transparent tank. A condenser in the form of a water-cooled tube coil ensures a closed circuit within the tank.

R1233zd is used as evaporating liquid. Compared with water, this liquid has the advantage that its boiling point is at approx. 18°C (1013hPa), whereby the evaporation process takes place at much lower temperatures and a lower heating power.

Sensors record the flow rate of the cooling water, the heating power, pressure and temperatures at all relevant points. 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. The data acquisition software is included.

Learning objectives/experiments

- visualisation of different forms of evaporation
  - ▶ free convection boiling
  - ▶ nucleate boiling
  - ▶ film boiling
- heat transfer
- effect of temperature and pressure on the evaporation process

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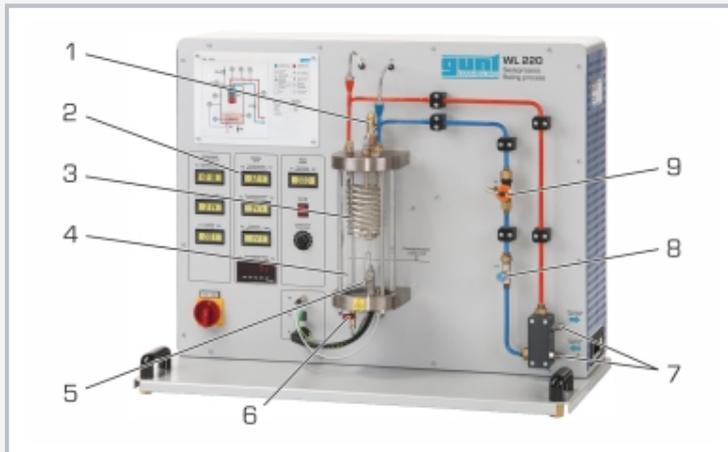
1 safety valve, 2 displays for temperature, flow rate and pressure, 3 condenser, 4 pressure vessel, 5 heater, 6 drain valve for the evaporating liquid, 7 cooling water connection, 8 valve for adjusting the cooling water, 9 cooling water flow rate sensor
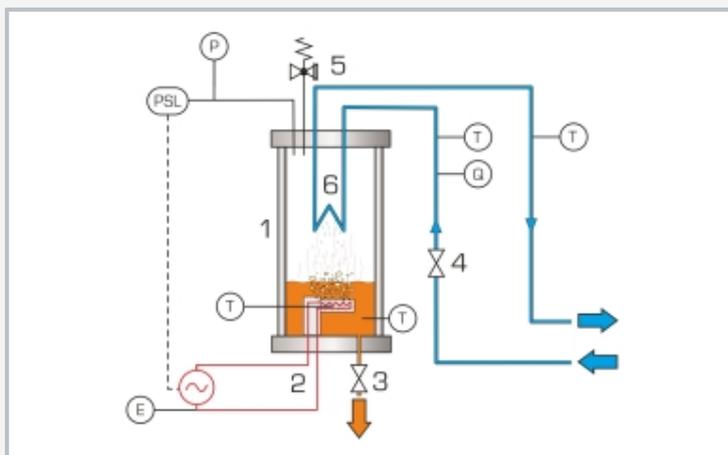
1 pressure vessel, 2 heater, 3 drain valve, 4 cooling water valve, 5 safety valve, 6 condenser; orange: evaporating liquid, red: heater, blue: cooling circuit; PSL pressure switch, E output, T temperature, Q flow rate, P pressure
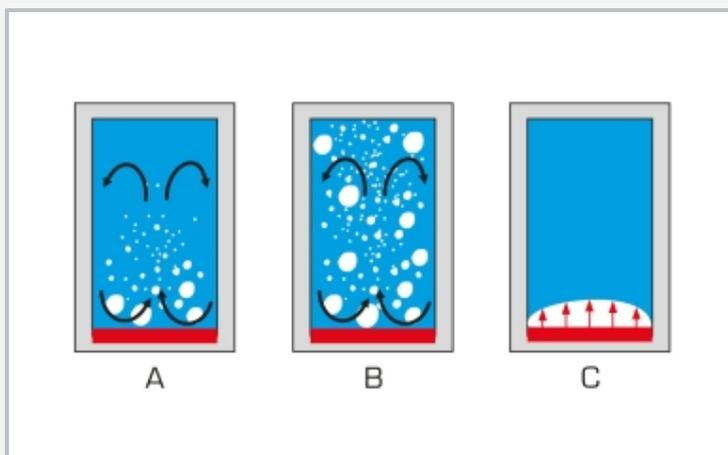
Different modes of boiling: A free convection boiling, B nucleate boiling, C film boiling; red: heater, blue: evaporating liquid, white: steam, black: convection flow

Specification

[1] visualisation of boiling and evaporation in a transparent pressure vessel
[2] evaporation with heating element
[3] condensation with tube coil
[4] water supply via the lab network or via WL 110.20 Water chiller to ensure a maximum water temperature of 16°C
[5] safety valve protects against overpressure in the system
[6] pressure switch for additional protection of the pressure vessel, adjustable
[7] sensors for pressure, flow rate and temperature with digital display
[8] GUNT software for data acquisition via USB under Windows 10
[9] refrigerant R1233zd, GWP: 1

Technical data

Heater
■ power: 315W, continuously adjustable

Safety valve: 4bar abs.
Pressure vessel: 2850mL
Condenser: coiled tube made of copper

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

Measuring ranges
■ pressure: 0...4bar abs. (tank)
■ power: 0...300W (heater)
■ flow rate: 0,05...1,8L/min (cooling water)
■ temperature: 4x 0...100°C

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 1000x550x800mm
Weight: approx. 65kg

Required for operation

water connection (min. 120L/h, water temperature max. 16°C), drain or WL 110.20
PC with Windows recommended

Scope of delivery

1 experimental unit
1 GUNT software + USB cable
1 set of hoses
1 set of instructional material

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Optional accessories

for Remote Learning
GU 100   Web Access Box
with
WL 220W   Web Access Software

Other accessories
WP 300.09   Laboratory trolley
WL 110.20   Water chiller