WL 210
Evaporation process

Learning objectives/experiments

- observation of typical forms of evaporation
  - single phase liquid flow
  - sub-cooled boiling
  - slug flow
  - annular flow
  - film boiling
  - dispersed flow
  - single phase vapour flow
  - wet steam
- effect on the evaporation process by
  - flow rate
  - temperature
  - pressure

Description

- **demonstration of evaporation in a double-wall pipe evaporator made of glass**
- **operation with harmless, special low boiling point liquid**

During the generation of vapour, the medium that is to evaporate runs through different flow forms dependent on the heat transfer area. The medium flows into a tube evaporator as a fluid and exits the tube evaporator as superheated vapour.

In practice, the water vapour generated in big systems is used e.g. for heating plants or machine drives. To design steam generators, it is important to have knowledge of the evaporation process with the boiling crises in order to ensure reliable operation. Boiling crises are caused by a sudden deterioration of the heat transfer, whereby the high heat flux density leads to a dangerous increase in the wall temperature.

The WL 210 experimental unit can be used to examine and visualise the evaporation process in its various flow forms. This is done by heating evaporating liquid, R1233zd, in a tube evaporator made of glass.

Compared with water, this liquid has the advantage that its boiling point is at approx. 18°C (1013hPa), whereby the entire evaporation process takes place at much lower temperatures and a lower heating power. The pressure can be varied via the cooling circuit. A water jet pump evacuates the evaporation circuit.

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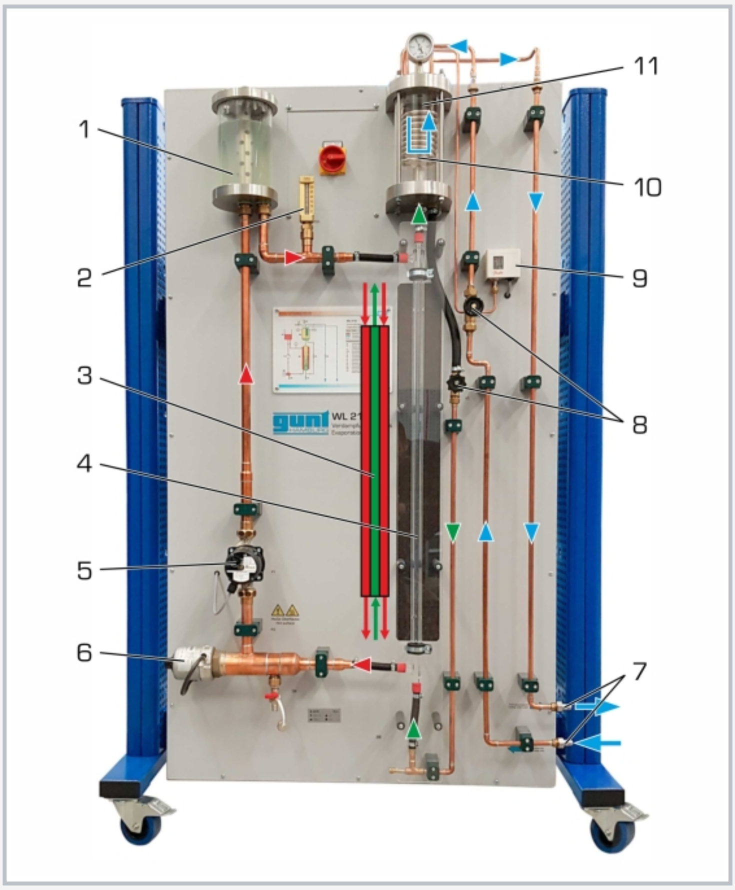
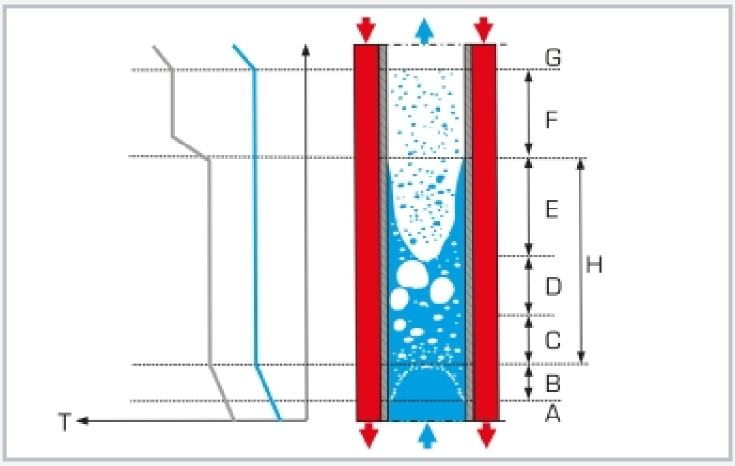


1 heating circuit tank, 2 thermometer, 3 tube evaporator, schematic drawing, 4 tube evaporator, 5 pump, 6 heater, 7 cooling water connection, 8 valves, 9 pressure switch, 10 tube coil, 11 collector with manometer and safety valve;
red: heating circuit, green: evaporation circuit, blue: cooling circuit



Evaporation in a tube evaporator:
A subcooled fluid, B initial boiling point, C bubbly flow, D slug flow, E annular flow, F dispersed flow, G superheated vapour, H boiling range; blue: fluid temperature, grey: heating surface temperature

Specification

[1] visualisation of evaporation in a tube evaporator
[2] heating and cooling medium: water
[3] water supply via the lab network or via WL 110.20 Water chiller to ensure a maximum water temperature of 16°C
[4] tube evaporator made of double-wall glass
[5] heating circuit with heater, pump and expansion vessel
[6] safety valve protects against overpressure in the system
[7] water jet pump to evacuate the evaporation circuit
[8] refrigerant R1233zd, GWP: 1

Technical data

Heater
- power rating: 2kW
- temperature range: 5...80°C

Heating and cooling medium: water

Pump
- 3 stages
- max. flow rate: 1,9m^3/h
- max. head: 1,5m
- power consumption: 58W

Tube evaporator
- length: 1050mm
- inner diameter: 16mm
- outer diameter: 24mm

Condenser: coiled tube made of copper

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

Measuring ranges
- pressure: -1...1,5bar rel.
- temperature: 0...100°C

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
120V, 60Hz, 1 phase
UL/CSA optional
LxWxH: 1250x800x1970mm
Weight: approx. 170kg

Required for operation

water connection (min. 320L/h, water temperature max. 16°C), drain or WL 110.20

Scope of delivery

1 trainer
1 set of hoses
1 set of instructional material

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Optional accessories

WL 110.20	Water chiller