Equipment for engineering education

GUNT TECHNOLOGY LIMITED

WL 110 series
Experiments on the fundamentals of heat transfer

- various heat exchangers
- practical components
- operation via touch screen

Hands-on teaching engineering – with GUNT's SMART features

By means of an integrated router, the experimental unit can also be operated and controlled via end device. The user interface can be displayed on up to 10 end devices (screen mirroring).

E-Learning from GUNT offers extensive multimedia educational material online for the laboratory experiments and thus supports technical training and engineering studies.

To follow the experiments, up to 10 external workstations can be used simultaneously via the local area network.

Measured values and screenshots are recorded and enable external evaluation, e.g. with MS Excel.

The intuitive user interface guides you through the experiments and allows the experimental units to be controlled via touch screen.

The supply unit identifies the respective accessory via RFID technology, automatically selects the appropriate software in the PLC and performs an automatic system configuration.

Table of contents

Information at www.gunt.de

Structure of the WL 110 series

WL 110
Heat exchanger supply unit

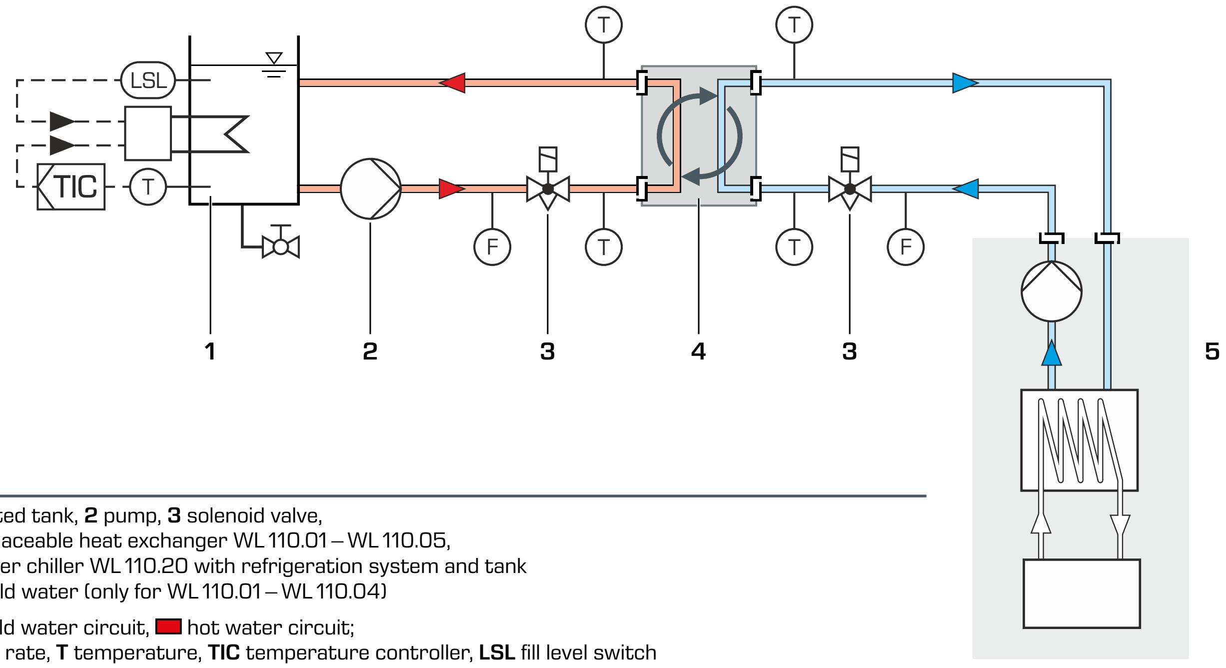
The supply unit produces hot water. All measured values are displayed on the unit's touch screen and can be transmitted via a LAN / WLAN connection.

WL 110.20
Water chiller

The water chiller can be used to operate the heat exchangers under suitable experimental conditions.

- automatic identification of accessories via RFID technology
- energy- and water-saving technology, space-saving design

RFID



1 heated tank, **2** pump, **3** solenoid valve,
4 replaceable heat exchanger WL 110.01 – WL 110.05,
5 water chiller WL 110.20 with refrigeration system and tank for cold water (only for WL 110.01 – WL 110.04)

cold water circuit, hot water circuit;
F flow rate, **T** temperature, **TIC** temperature controller, **LSL** fill level switch

About the product:

www

WL 110.01
Tubular heat exchanger

- simple design
- transparent outer tube offers visible flow space
- parallel flow and counterflow operation possible

WL 110.02
Plate heat exchanger

- compact design
- parallel flow and counterflow operation possible

WL 110.03
Shell & tube heat exchanger

- transparent jacket pipe
- media flow in cross parallel flow and cross counterflow

WL 110.04
Stirred tank with double jacket and coil

- heating using jacket or coiled tube
- stirrer for improved mixing of medium

WL 110.05
Finned tube heat exchanger

- heat transfer between water and air in cross-flow
- increase of the heat transferring surface due to fins on the pipes

Basic knowledge
Flow conditions in the heat exchanger

Heat exchangers are used for heating, cooling, evaporation or condensation of media at different temperatures. The basic function is to transfer the thermal energy of a medium with a higher temperature level to a medium with a lower temperature level.

According to the second law of thermodynamics, heat transport always goes from the medium with a higher temperature to the medium with a lower temperature.

The flow condition in the device can vary depending on the design of the heat exchanger. However, the two media flows are never mixed; there is only heat transfer between the media.

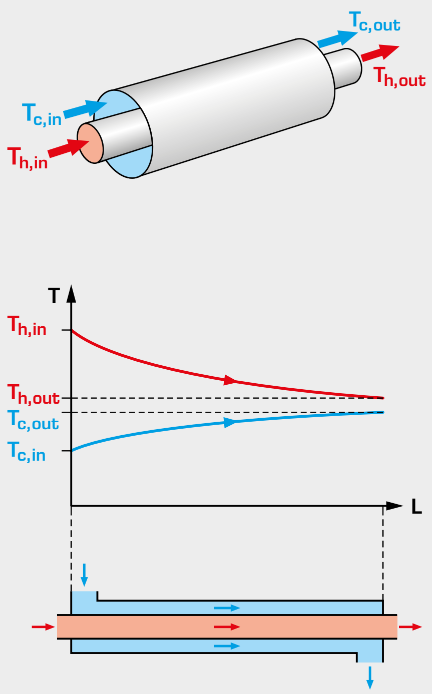
The possible flow conditions are counterflow, parallel flow, cross flow or combinations thereof.

In order to use the advantages of all flow conditions, combinations of the basic forms are common. For example, a multiple-channel shell & tube heat exchanger can be used in cross flow operation for quick and safe temperature control of large quantities of aggressive chemicals. Plate heat exchangers operated in counterflow are often used when a space-saving design is required.

Online access to the
E-Learning courses:

E learn

Parallel flow operation



Temperature profiles in **parallel flow operation** in a tubular heat exchanger

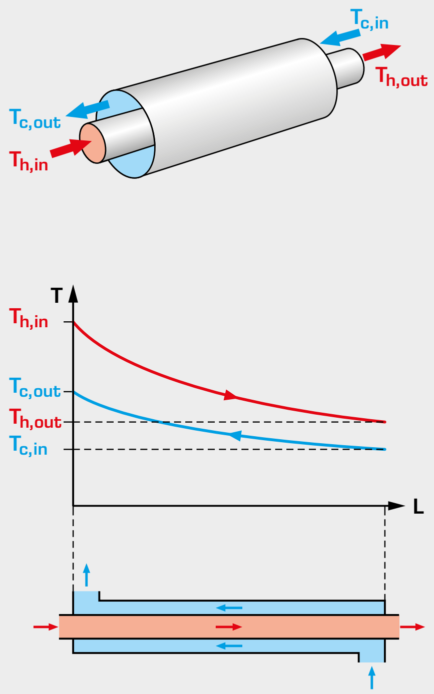
When operating a heat exchanger in **parallel flow**, both media flow in the same direction and enter the heat exchanger at the same point.

The maximum outlet temperature of the cold side can be equal to the outlet temperature of the hot side.

WL 110.01
Tubular heat exchanger

WL110.02
Plate heat exchanger

Counter flow operation



Temperature profiles in **counterflow operation** in a tubular heat exchanger

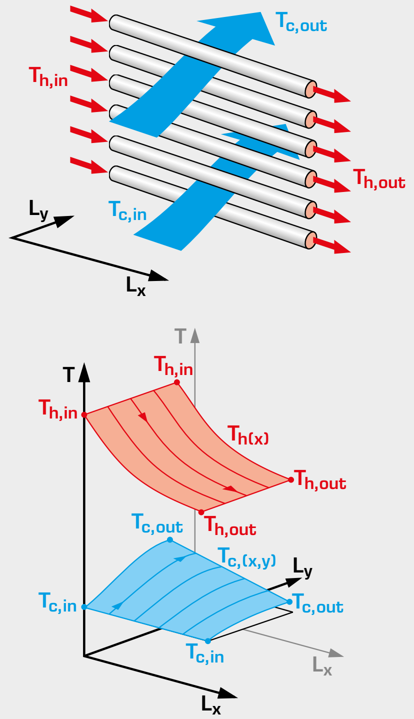
In **counterflow** operation, two media flow in the opposite direction to each other. The entry point of one medium is the exit point of the other medium running in the opposite direction.

If the heat exchanger is well designed, the outlet temperature of the cold side can even be higher than the outlet temperature of the hot side.

WL 110.01
Tubular heat exchanger

WL110.02
Plate heat exchanger

Cross-flow operation



Temperature profile for a single row of tubes with single-sided mixed **cross flow**

In **cross-flow** operation, the directions of the media intersect.

Cross flow is used in particular to accurately control the temperature of temperature-sensitive products.

WL 110.03
Shell & tube heat exchanger

WL 110.05
Finned tube heat exchanger

WL 110.01 Tubular heat exchanger

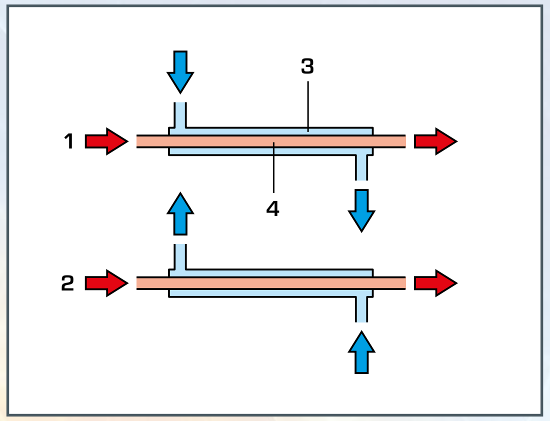
Tubular heat exchangers are the simplest type of heat exchanger design. They are preferred when heat is being transferred at high pressure differences or between highly viscous media. One advantage is that flow through the pipe space is even and free of flow dead zones.

The hot water is fed through the core tube (inner) and the cold water fed through the jacket tube (outer). In doing so, the hot water continuously emits some of its thermal energy to the cold water.

Two additional temperature sensors are located on the tubular heat exchanger to measure the temperature after one half of the transfer section.

About the product:

www



1 parallel flow operation, **2** counterflow operation,
3 outer tube with cold water,
4 inner tube with hot water

cold water side, hot water side

Learning objectives / experiments

- function and behaviour of a tubular heat exchanger during operation
- recording temperature curves
  - in parallel flow operation
  - in counterflow operation
- calculation of mean heat transfer coefficient
- comparison with other heat exchanger types

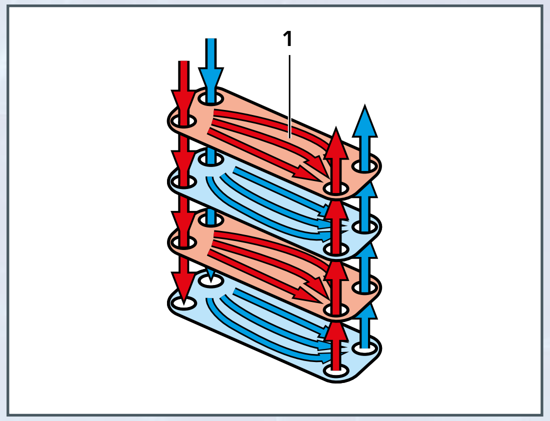
WL 110.02 Plate heat exchanger

Plate heat exchangers are mainly characterised by their compact structural shape, in which the entire medium is used for heat transfer. One advantage is the low space requirement, relative to the heat transfer area.

The plate heat exchanger consists of several profiled plates. Connecting the plates to each other results in two hermetically separated tube channels. A cold tube channel and a hot tube channel alternate in the arrangement. The profiled plates ensure mixing of the water and improve heat transfer.

About the product:

www



1 plate with pressed profile

cold water side, hot water side

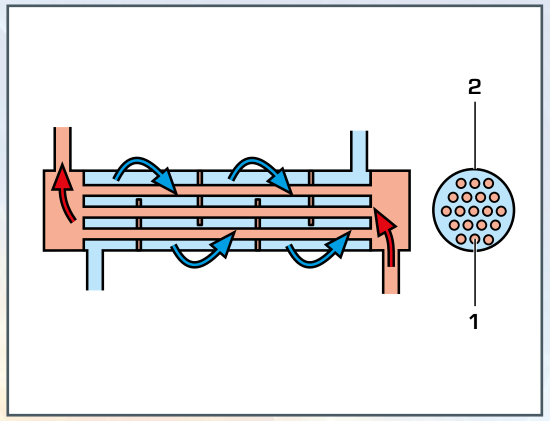
Learning objectives / experiments

- function and behaviour of a plate heat exchanger during operation
- plotting temperature curves
  - in parallel flow operation
  - in counterflow operation
- calculation of mean heat transfer coefficient
- comparison with other heat exchanger types

WL 110.03 Shell & tube heat exchanger

Shell and tube heat exchangers are characterised by the large heat transfer area and the compact structural shape.

The shell and tube heat exchanger consists of seven core tubes, surrounded by a transparent jacket tube. The hot water flows through the core tubes and the cold water flows through the jacket tube. In doing so, the hot water emits some of its thermal energy to the cold water. Using baffle plates, the flow in the inside of the shell is diverted in order to produce stronger turbulence and more intensive convective heat transfer. The media flow continuously in cross parallel flow and cross counterflow.



1 core tube, **2** jacket tube

cold water side, hot water side

About the product:

www

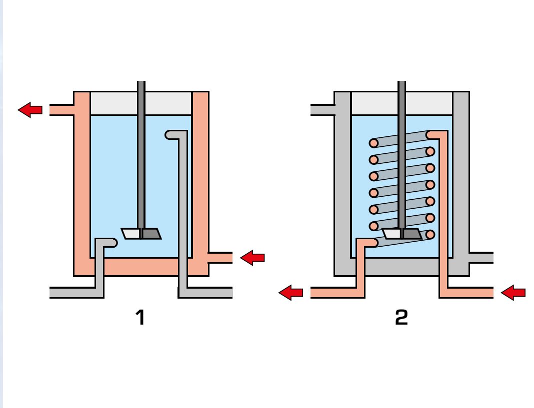
Learning objectives / experiments

- function and behaviour of a shell and tube heat exchanger during operation
- plotting temperature curves
  - in cross parallel flow operation
  - in cross counterflow operation
- calculation of mean heat transfer coefficient
- comparison with other heat exchanger types

WL 110.04 Stirred tank with double jacket and coil

Many engineering processes use simple stirrer tanks. These are often fitted with a double jacket or a coiled tube for cooling or heating. Stirring machines are used for better mixing of the tank contents and for an even temperature distribution.

The jacketed vessel with stirrer and coil consists of a tank surrounded by a jacket. In the tank is a coiled tube. In the “heating with jacket” operating mode, the hot water flows through the jacket and emits some of its thermal energy to the cold water in the tank. In the “heating with coiled tube” operating mode, the hot water flows through the coiled tube and heats the cold water in the tank. A stirring machine can be used in all operating modes.



1 heating via the jacket, **2** heating via the coiled tube

cold water side, hot water side

About the product:

www

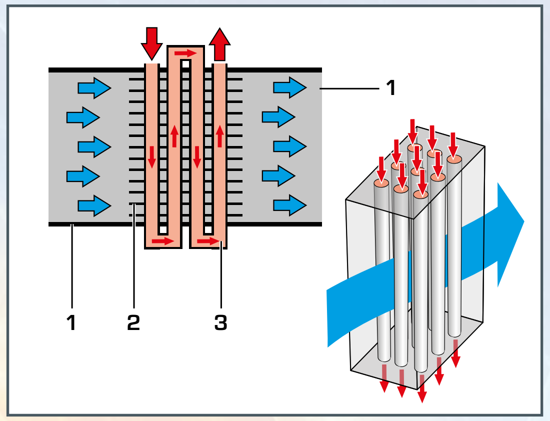
Learning objectives / experiments

- function and behaviour of a jacketed vessel heat exchanger
- plotting time dependencies:
  - heating mode with jacket
  - heating mode with coiled tube
  - influence of a stirring machine
- comparison with other heat exchanger types

WL 110.05 Finned tube heat exchanger

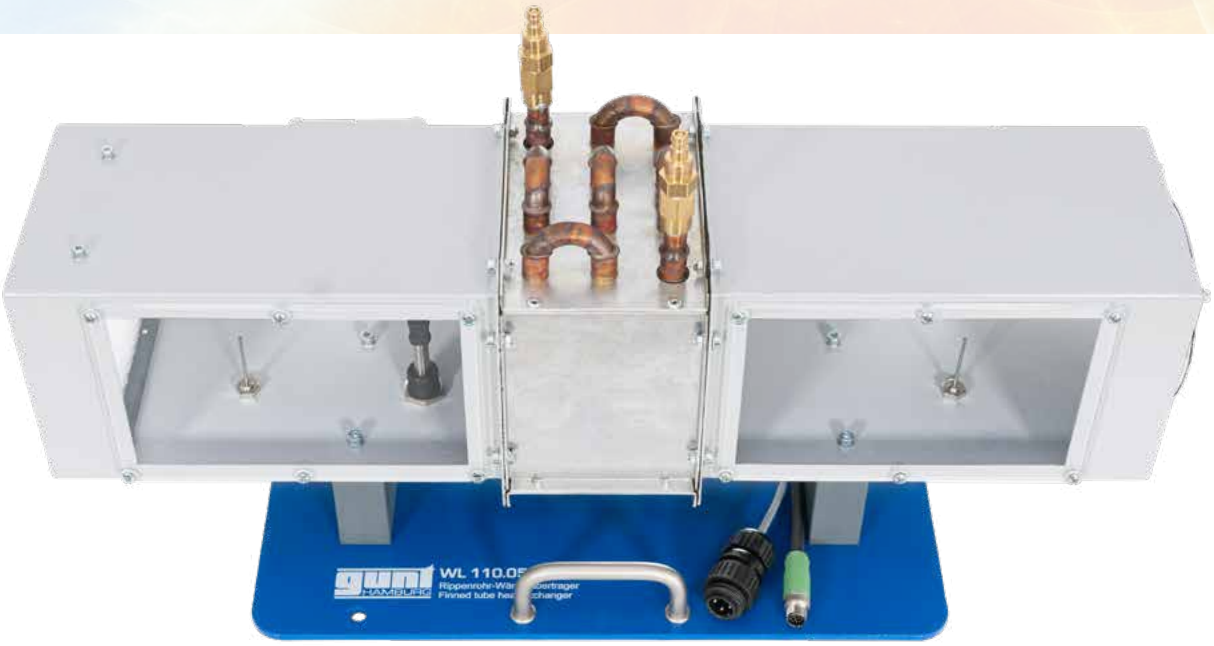
The heat transfer surface of a heat exchanger can be effectively increased by attaching fins. This principle is used in the finned tube heat exchanger primarily to cool or heat a closed circuit using the ambient air.

The finned tube heat exchanger consists of a box shaped profile through which air flows and which is traversed several times by the pipe section carrying hot water. This creates a cross-flow of the heat-transferring media. The hot water emits part of its thermal energy to the air. Fins are applied to the pipe section to increase the heat-transferring surface.



1 air duct, **2** fins, **3** water pipe section,
cold air, pipe section with hot water

About the product:



Learning objectives / experiments

- function and behaviour of a finned tube heat exchanger
- heat transfer between water and air in cross-flow
- plotting temperature curves
- determine the mean heat transfer coefficient
- compare with other heat exchanger types

Simple exchange of accessories – automatic accessory recognition

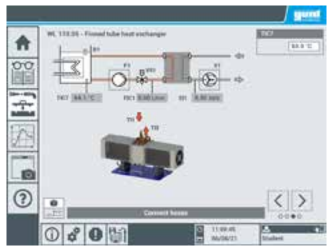
1. Remove the hose connections on the shell and tube heat exchanger.

2. Remove the accessory and replace it, no tools needed. Position the finned tube heat exchanger on the work surface of the supply unit.

RFID

The accessories are identified automatically using RFID technology. The appropriate GUNT software is then loaded and the system is configured automatically.

3. Attach the hose connection to the finned tube heat exchanger.



Once the system has been configured, the user interface is ready for experiment preparation.

Laboratory trolley WP 300.09

The laboratory trolley enables to easily store experimental units and, when needed, moving it comfortably to another place. Accessories such as hoses, valves for ventilation and water drainage as well as instructions, can be stored in three drawers. Three retractable sockets are available for power supply.

Real experiments – digital media

The digital teaching-learning concept offers an interaction between real experiments and digital teaching with:

1. **preparation**
2. **execution**
3. **evaluation**

of the experiments.

The WL 110 supply unit provides the basic supply in each case. Measurement and control systems as well as the interfaces are also provided by the supply unit.

Connection to max. 10 mobile end devices via integrated WLAN router

Data transfer via LAN / WLAN for versatile external use of measured values and screenshots e.g. evaluation in Excel

- **intuitive** execution of experiments via **touch screen** (HMI)
- device control with **PLC**, operation via touch screen or an end device
- integrated WLAN router for operation and control via an end device and for **screen mirroring** on up to 10 end devices: PC, tablet, smartphone
- automatic system configuration
- data acquisition in the PLC
- access to stored measured values is possible from end devices via WLAN with integrated router / LAN connection to the customer's own network is possible

1. Preparation

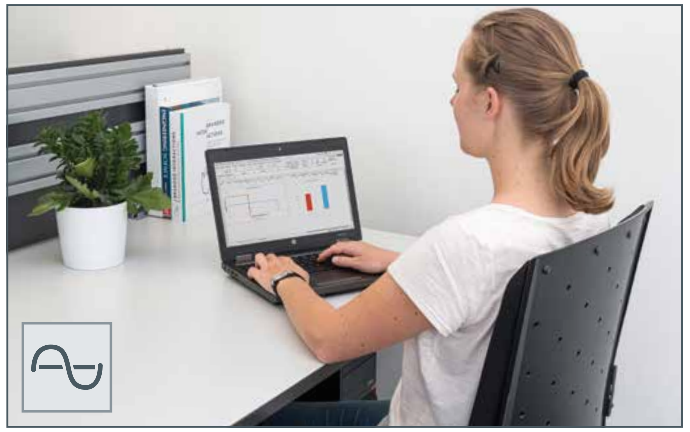
Location-independent experiment preparation with GUNT E-Learning courses or directly at the experimental unit with the basic knowledge pages in the PLC.

2. Execution

Investigation and comparison of different heat exchangers, intuitive guidance through the experiments via touch screen.

3. Evaluation

Directly at the experimental unit and via data transfer of measured values and screenshots also possible independent of location.



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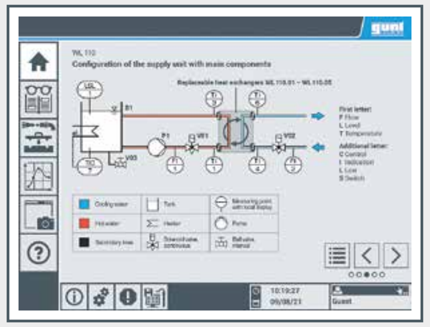
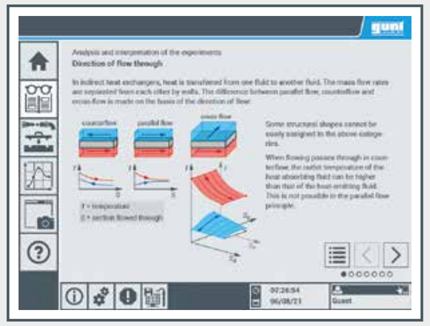
Integrated PLC with touch screen

The operation and control of the WL 110 supply unit and of the heat exchangers WL 110.01 – WL 110.05 is done via the integrated PLC with touch screen. Alternatively, an end device takes over the operation via the integrated WLAN function. Up to 10 end devices (PC, tablet, smartphone) can perform the experiments via screen mirroring.



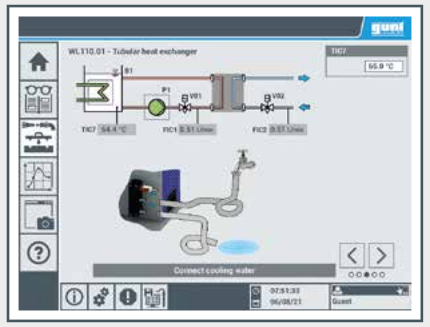
Overview

supply unit WL 110 and available heat exchangers WL 110.01 – WL 110.05 with detailed description and information on the setup



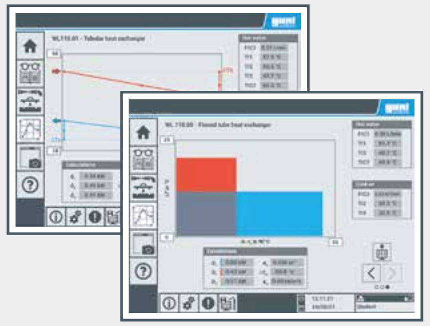
Basic knowledge

- extensive theoretical basics on heat transfer and heat fluxes
- analysis and interpretation of the experiments
- dependencies of heat transfer
- design of heat exchangers



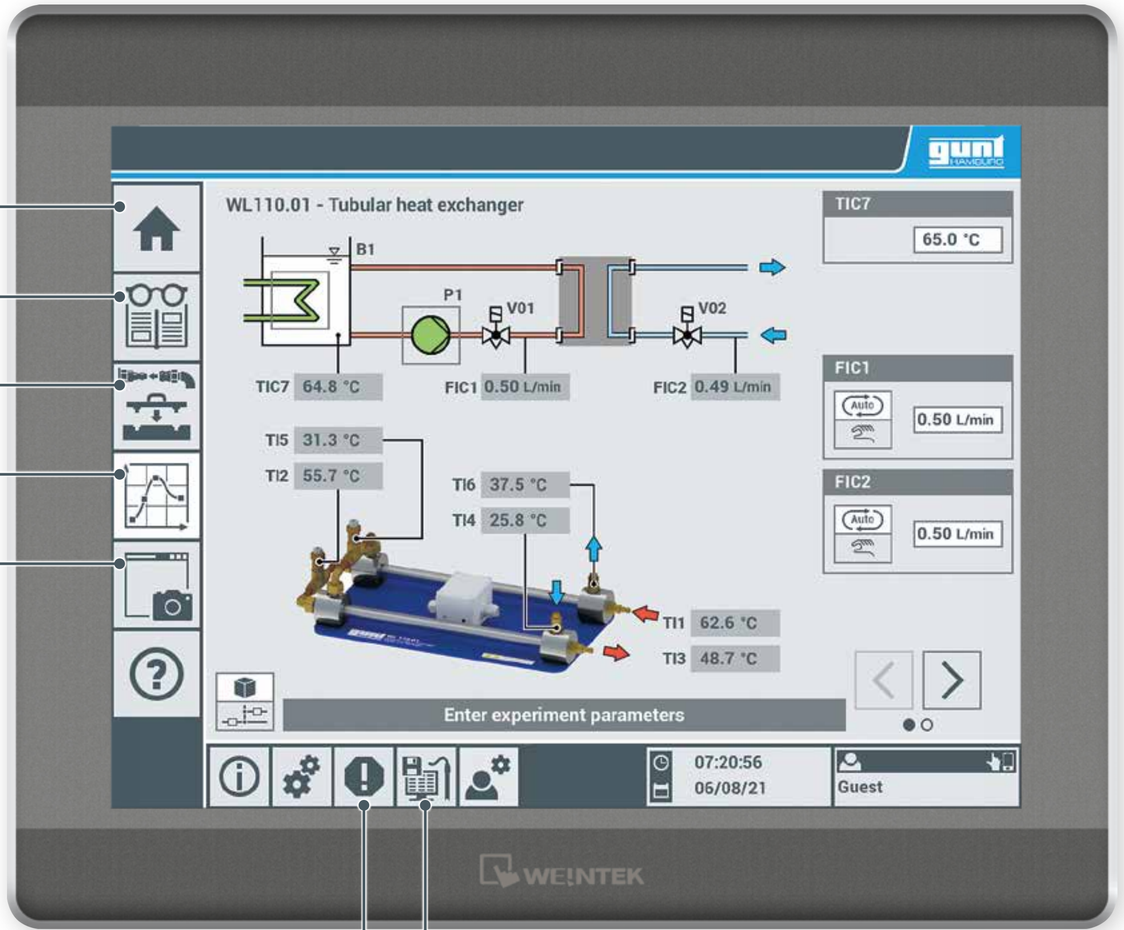
Experiment preparation

- step-by-step guide visualizes connection of the individual elements
- draining process with ventilation and emptying



Experiment overview

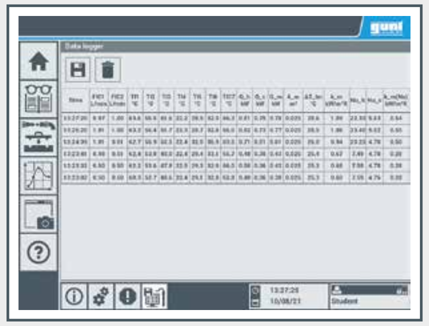
- digital data acquisition
- graphical representation of the measured values, e.g. temperature curve
- comparison of the heat fluxes shown as an area, WL 110.05



Display of error messages

Screenshot

Screenshot of current view and storage of the image file on an external device, connection via WLAN with integrated router / LAN connection to the customer's own network

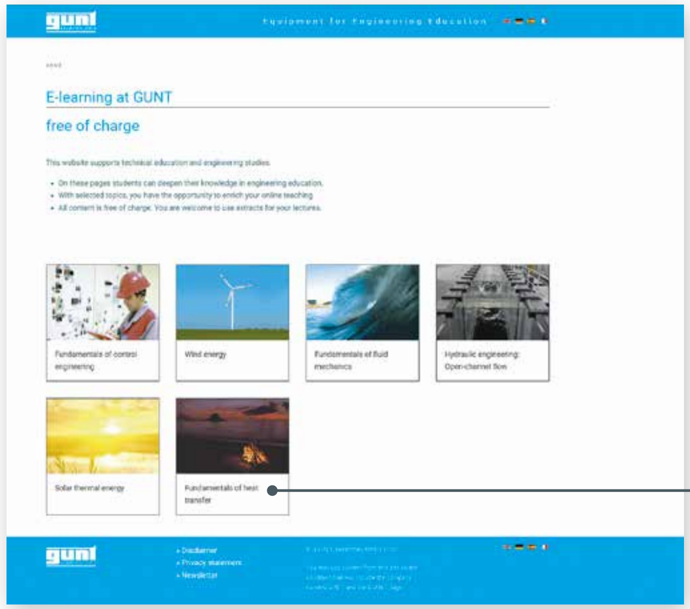


Data logger

- data transfer of measured values to an external device, connection via WLAN with integrated router / LAN connection to the customer's own network
- later evaluation e.g. in Excel

E-Learning:
Theoretical basics of heat transfer

Extensive multimedia educational material from GUNT on the laboratory experiments is available free of charge online. This enables students to prepare specifically for the laboratory experiments at their external workplace.

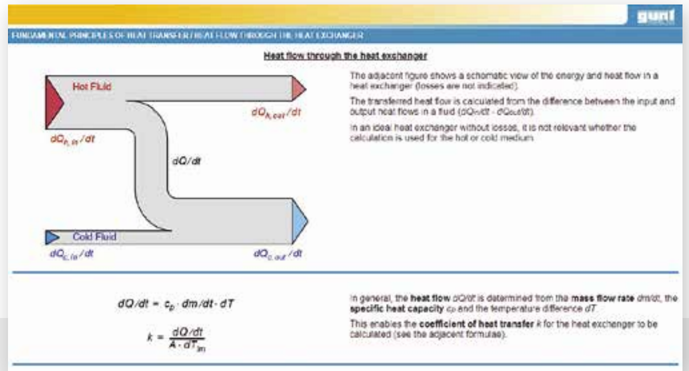


Online access to the E-Learning courses:

- Fundamentals of Heat Transfer I
- Fundamentals of Heat Transfer II

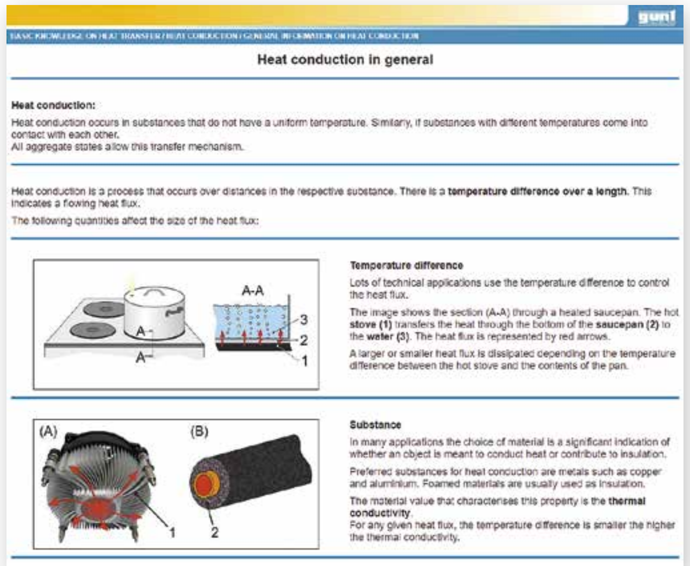
Benefits at a glance

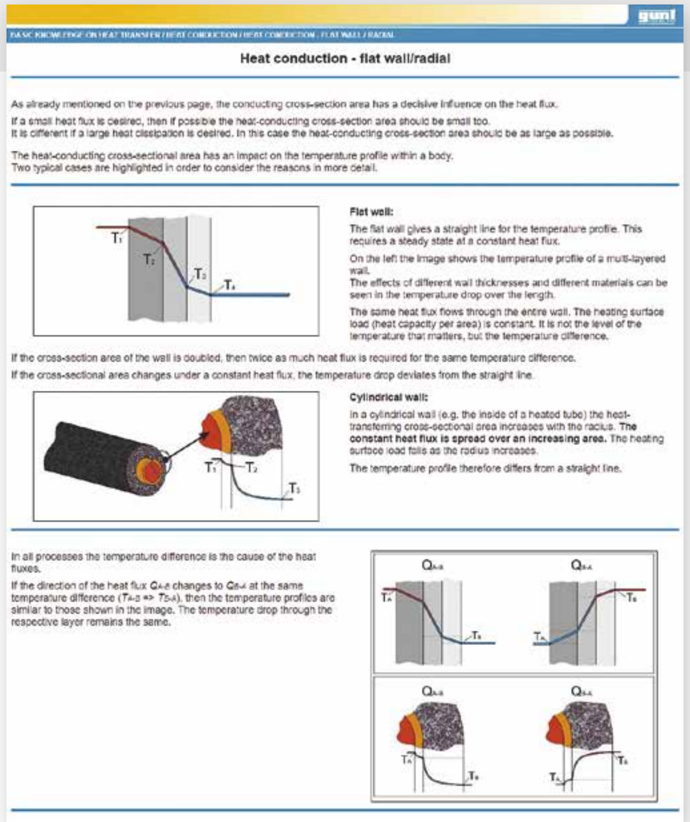
- flexibility due to self-determination of the time, duration and location of the learning unit
- allows learning progress to be checked discreetly and automatically
- focus points can be repeated as often as required
- improves the workstation capacity of colleges
- motivation enhancement through originality and playful access to the learning material
- integration of multimedia learning methodology in your students' routine



Fundamentals of Heat Transfer I

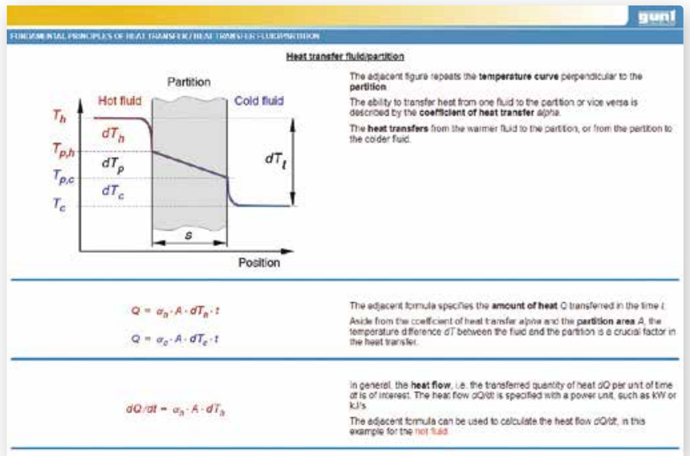
didactically well designed and medially prepared learning content of heat transfer

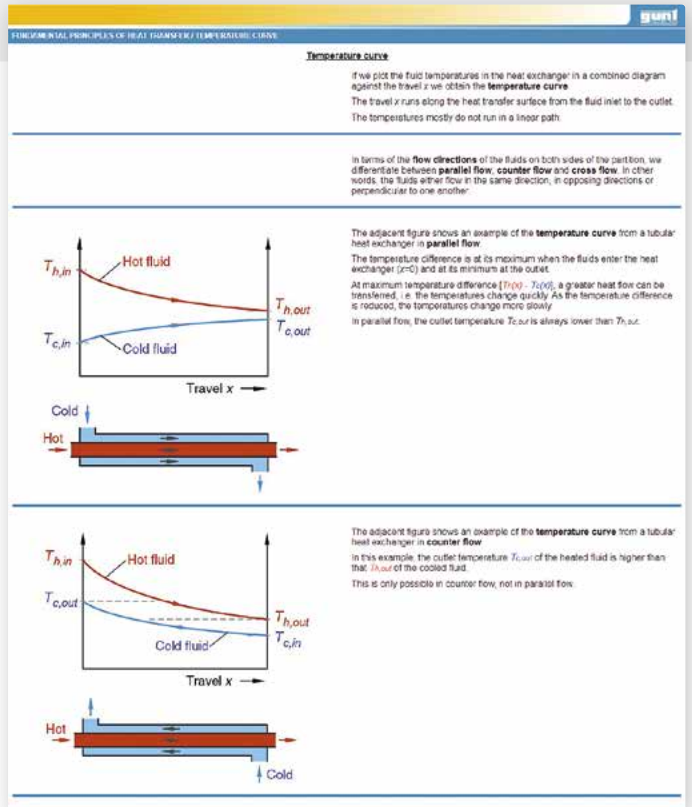




Fundamentals of Heat Transfer II

further description of the heat transfer between fluid and partition wall with formulas for in-depth study

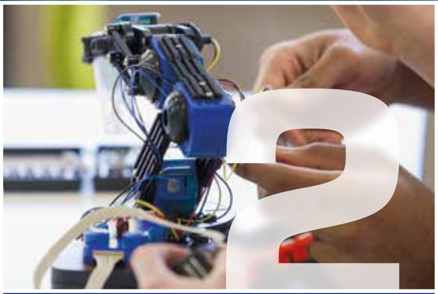




The complete GUNT programme

Engineering mechanics and engineering design

- statics
- strength of materials
- dynamics
- machine dynamics
- engineering design
- materials testing



Mechatronics

- engineering drawing
- cutaway models
- dimensional metrology
- fasteners and machine parts
- manufacturing engineering
- assembly projects
- maintenance
- machinery diagnosis
- automation and process control engineering

Thermal engineering

- fundamentals of thermodynamics
- heat exchangers
- thermal fluid energy machines
- internal combustion engines
- refrigeration
- HVAC

Fluid mechanics

- steady flow
- transient flow
- flow around bodies
- components in piping systems and plant design
- turbomachines
- positive displacement machines
- hydraulic engineering

Process engineering

- mechanical process engineering
- thermal process engineering
- chemical process engineering
- biological process engineering
- water treatment

2E Energy & Environment

Energy

- solar energy
- hydropower and ocean energy
- wind power
- biomass
- geothermal energy
- energy systems
- energy efficiency in buildings

Environment

- water
- air
- soil
- waste

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