ET 350

Changes of state in the refrigeration circuit

screen mirroring is possible on up to 10 end devices

Description

- **visualisation of the refrigeration circuit components: transparent components, augmented reality interface**
- **real time log p-h diagram**
- **Game-Based Learning: learn complex theory easily and playfully**

In a compression refrigeration system, a refrigerant flows through the refrigeration circuit and is subject to different changes of state. Here, the physical effect is used that during the transition of the refrigerant from a liquid to a gaseous state energy is required which is removed from the environment (evaporation enthalpy).

The experimental unit ET 350 represents a refrigeration circuit consisting of a hermetic piston compressor, condenser, expansion valve and evaporator. The evaporator and condenser are transparent to provide good monitoring of the phase transition process during evaporation and condensation. The operation of the float valve as expansion valve is also easy to observe. Before the entry into the evaporator the aggregate state of the refrigerant can be monitored at a sight glass. A water circuit cools the condenser or supplies the cooling load for the evaporator. Cold and hot water flows are adjustable.

All relevant measured values are recorded by sensors. The simultaneous transmission of the measured values to the PLC enables easy analysis and the representation of the process in the log p-h diagram. Complex processes, such as changes of state, are visualised by real-time representation of the cycle, e.g. in the log p-h diagram. Intuitive operation of the PLC makes it easy to adjust all elements of the cycle. The effect of the modifications is immediately visible on the touch screen. An augmented reality interface (Vuforia View) for mobile devices is available for visualising the refrigeration circuit components.

The experimental unit is controlled by a PLC via touch screen. The PLC provides exact data on the condition of the refrigerant, which is used to calculate the refrigerant mass flow rate accurately. The calculation therefore gives a much more accurate result than measurement using conventional methods.

Digital multimedia teaching material is available at the GUNT Media Center. In addition to real-time representation directly on the unit, Game-Based Learning is made possible with these online media, e.g. worksheets, e-learning, quizzes, videos, etc.

Learning objectives/experiments

- design and operation of a compression refrigeration system
- observe the evaporation and condensation of the refrigerant
- representation of the thermodynamic cycle in the log p-h diagram
- energy balances
- determination of important characteristic variables
  - ▸ coefficient of performance
  - ▸ refrigeration capacity
  - ▸ compressor work

- GUNT Media Center, develop digital skills
  - ▸ retrieve information from digital networks
  - ▸ use digital learning media, e. g. Web Based Training (WBT)
  - ▸ augmented reality for the visualisation of the components in the refrigeration circuit

ET 350

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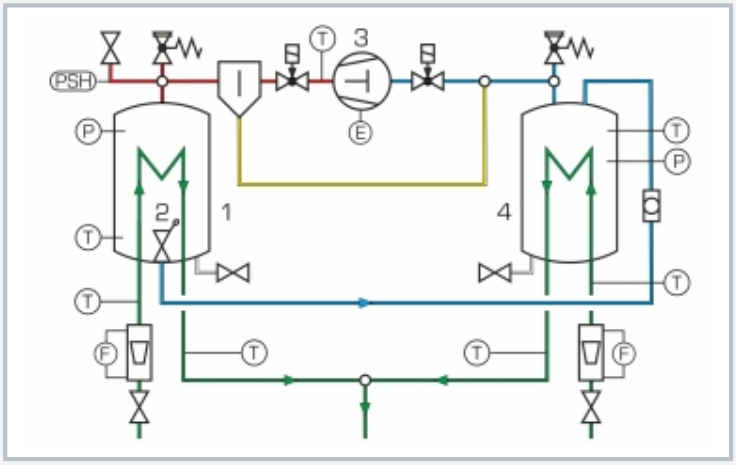
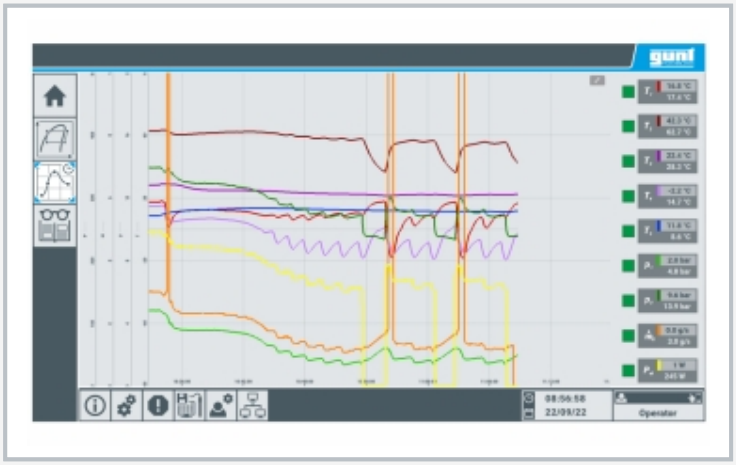
1 pressure switch, 2 flow meter, 3 condenser, 4 expansion valve, 5 compressor, 6 evaporator, 7 sight glass



1 condenser, 2 expansion valve, 3 compressor, 4 evaporator; T temperature, P pressure, E electrical power, F flow rate, PSH pressure switch; blue: low pressure, red: high pressure, green: water, yellow: oil



control of the experimental plant using a PLC, operated by touch screen

Specification

[1] demonstration of the processes in a refrigeration circuit
[2] augmented reality: visualisation of the refrigeration circuit components
[3] for better process monitoring the evaporator and condenser are of transparent design
[4] evaporator and condenser with pipe coil
[5] expansion valve in the shape of a float valve
[6] pressure switch to protect the condenser
[7] temperature sensor, power meter, manometer in refrigeration circuit, flow meter for hot and cold water
[8] safety valves at the evaporator and condenser
[9] refrigerant R1233zd, GWP: 1
[10] WL 110.20 and ET 350.01 provide the cold and hot water supply for optimum experiment conditions
[11] data acquisition via PLC on internal USB memory, access to stored measured values via WLAN/LAN with integrated router/LAN connection to customer's own network or direct LAN connection without customer network
[12] digital multimedia teaching material online in the GUNT Media Center: E-Learning course, worksheets, videos

Technical data

PLC: Weintek cMT3162X

Hermetic piston compressor, capacity: 18,3cm^3

Evaporator capacity: approx. 2450mL

Condenser capacity: approx. 2450mL

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

Measuring ranges
- temperature: 8x -20...200°C
- pressure: 2x -1...1,5bar
- flow rate: 2x 0...1620cm^3/min (water)
- power: 0...1200W

230V, 50Hz, 1 phase; 230V, 60Hz, 1 phase
120V, 60Hz, 1 phase; UL/CSA optional
LxWxH: 1100x470x670mm
Weight: approx. 50kg

Required for operation

water connection cold max. 16°C or WL 110.20; water connection warm min. 20°C or ET 350.01; drain

Scope of delivery

experimental unit, 1 set of hoses, online access to the GUNT Media Center, set of instructional material

ET 350

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Optional accessories

ET 350.01	Hot water generator
WL 110.20	Water chiller
WP 300.09	Laboratory trolley