

# ET 411C

## Compression refrigeration system



### Description

- **compression refrigeration system with transparent evaporator and transparent condenser**
- **comparison of different expansion elements**
- **effect of under/overfilling of the system with refrigerant**
- **dynamic recording of the refrigerant mass flow rate**

The setup of ET 411C represents a typical refrigeration circuit consisting of a hermetic compressor, condenser, evaporator and expansion element. Evaporator and condenser are designed as finned tube heat exchangers. The pipes of both heat exchangers are partially transparent to visualise the process of the phase transition during evaporation and condensing. Three capillary tubes of different lengths and a thermostatic expansion valve can be compared as expansion elements.

The trainer is equipped with a receiver for refrigerant. Using the receiver, refrigerant can be added to or removed from the refrigeration circuit. This allows for the effects of overfilling or underfilling of the system to be examined.

The flow rate of the refrigerant is read from a flow meter. Temperature and pressure in the refrigeration circuit and the electrical power consumption of the compressor are recorded by sensors. 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.

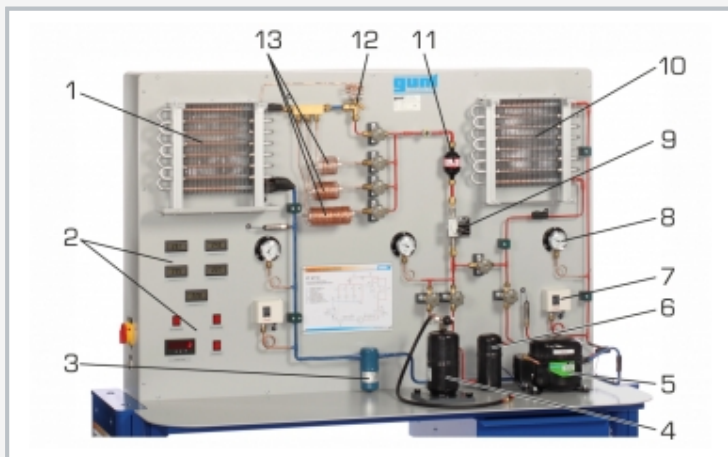
The data acquisition software is included. Parameter changes in the refrigeration circuit can be viewed dynamically in the software's log p-h diagram.

### Learning objectives/experiments

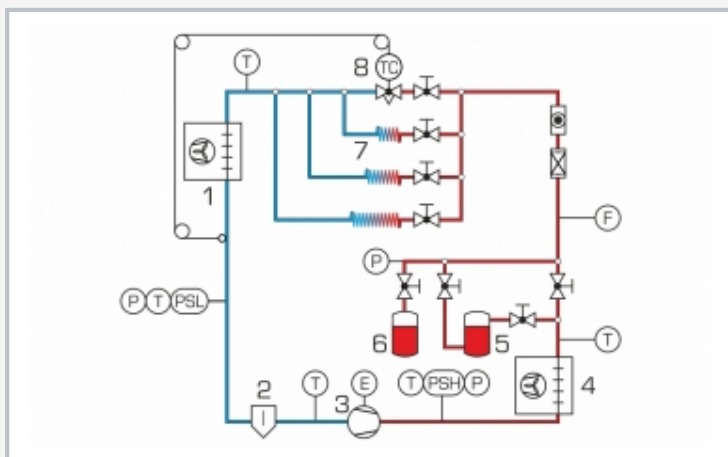
- function and operational behaviour of the refrigeration circuit components
- operation with expansion valve or with capillary tubes of different lengths
- underfilling or overfilling with refrigerant
- thermodynamic cycle in the log p-h diagram
- from the log p-h diagram and in comparison with the measured values
  - ▶ determination of the refrigeration capacity
  - ▶ determination of the coefficient of performance
  - ▶ determination of the efficiency of the compressor

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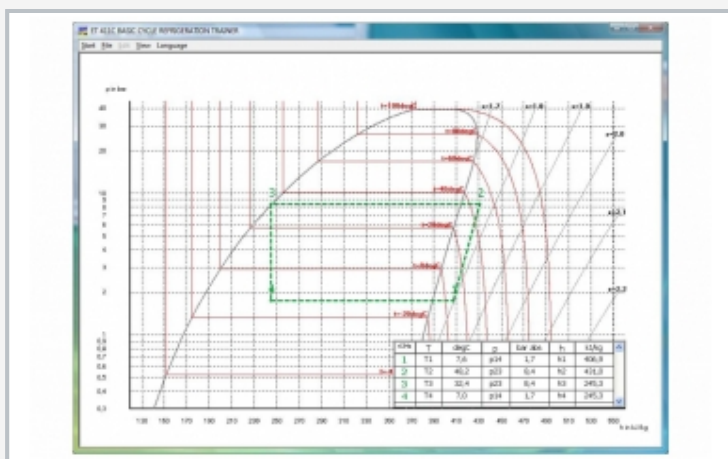
## Compression refrigeration system



1 evaporator, 2 displays and controls, 3 liquid separator, 4 reservoir, 5 compressor, 6 receiver, 7 compressor pressure switch, 8 manometer, 9 refrigerant flow meter, 10 condenser, 11 filter/drier, 12 expansion valve, 13 capillary tube



1 evaporator, 2 liquid separator, 3 compressor, 4 condenser, 5 receiver, 6 reservoir, 7 capillary tube, 8 expansion valve; T temperature, F flow rate, P pressure, E power consumption, PSH, PSL pressure switch



Software screenshot: log p-h diagram

### Specification

- [1] investigation of a refrigeration system with different expansion elements
- [2] refrigeration circuit consisting of a hermetic compressor, condenser, evaporator and expansion element
- [3] transparent finned tube heat exchangers as condenser and evaporator to observe the phase transitions of the refrigerant
- [4] expansion valve and capillary tubes of different lengths as expansion elements
- [5] receiver for underfilling/overfilling the system with refrigerant
- [6] sensors record pressure, temperature and flow rate
- [7] compressor equipped with two pressure switches
- [8] GUNT software for data acquisition via USB under Windows 8.1, 10
- [9] refrigerant R513A, GWP: 631

### Technical data

#### Compressor

- power consumption: 288W at 7,2°/54,4°C
- refrigeration capacity: 463W at 7,2°/54,4°C

#### Condenser and evaporator with fan

- max. volumetric air flow rate condenser: 300m<sup>3</sup>/h
- max. volumetric air flow rate evaporator: 180m<sup>3</sup>/h

Capillary tubes: 1,5m, 3m, 6m

Receiver for refrigerant: 1,3L

#### Refrigerant

- R513A
- GWP: 631
- filling volume: 2,5kg
- CO<sub>2</sub>-equivalent: 1,6t

#### Measuring ranges

- pressure: -1...9bar / -1...24bar
- temperature: 4x -40...150°C, 1x -100...100°C
- flow rate: 2...19kg/h [refrigerant]
- power consumption: 0...1000W

230V, 50Hz, 1 phase

230V, 60Hz, 1 phase

120V, 60Hz, 1 phase

UL/CSA optional

LxWxH: 1740x800x1780mm

Weight: approx. 190kg

### Required for operation

PC with Windows recommended

### Scope of delivery

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