ET 102
Heat pump

Learning objectives/experiments

- design and operation of an air-to-water heat pump
- representation of the thermodynamic cycle in the log p-h diagram
- energy balances
- determination of important characteristic variables
  - ▸ compressor pressure ratio
  - ▸ ideal coefficient of performance
  - ▸ real coefficient of performance
- dependence of the real coefficient of performance on the temperature difference (air-to-water)
- operating behaviour under load

Description

- **utilisation of ambient heat for water heating**
- **display of all relevant values at the location of measurement**

With the air-to-water heat pump ET 102 the ambient heat of the air is used to heat water.

The heat pump circuit consists of a compressor, an evaporator with fan, a thermostatic expansion valve and a coaxial coil heat exchanger as condenser. All components are clearly arranged in the trainer.

The compressed refrigerant steam condenses in the outer pipe of the condenser and thereby discharges heat to the water in the inner pipe. The liquid refrigerant evaporates at low pressure in the finned tube evaporator and thereby absorbs heat from the ambient air.

The hot water circuit consists of a tank, a pump and the condenser as heater. For a continuous operation the generated heat is dissipated via an external cooling water connection. The cooling water flow rate is set via a valve and measured.

All relevant measured values are recorded by sensors and displayed. The simultaneous transmission of the measurements to a data recording software enables analysis and the representation of the process in the log p-h diagram. The software also displays the key characteristics variables of the process, such as the compressor pressure ratio and the coefficient of performance.

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1 expansion valve, 2 evaporator with fan, 3 pressure sensor, 4 pressure switch, 5 displays and controls, 6 compressor, 7 cooling water flow meter, 8 pump, 9 hot water tank, 10 receiver, 11 cocondenser
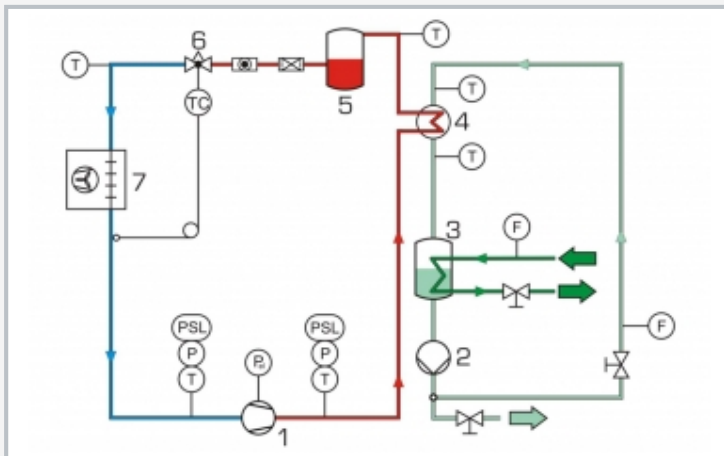
1 compressor, 2 pump, 3 hot water tank with external cooling water connection, 4 condenser, 5 receiver, 6 expansion valve, 7 evaporator with fan;
T temperature, P pressure, F flow rate, P_{el} power, PSH, PSL pressure switch;
blue/red: refrigeration circuit, light green: hot water circuit, green: cooling water
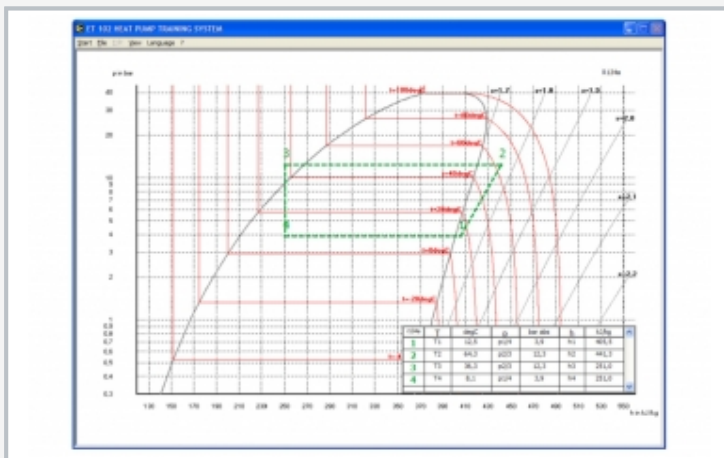
Software screenshot: log p-h diagram

Specification

[1] investigation of a heat pump with a water circuit as load
[2] refrigeration circuit with compressor, evaporator with fan, thermostatic expansion valve and coaxial coil heat exchanger as condenser
[3] hot water circuit with pump, tank and condenser as heater
[4] additional cooling via pipe coil in the hot water tank and external cooling water
[5] record and display of all relevant measured values and
[6] GUNT software for data acquisition via USB under Windows 7, 8.1, 10

Technical data

Compressor
■ capacity: 372W at 7,2/32°C

Coaxial coil heat exchanger (condenser)
■ refrigerant content: 0,55L
■ water content: 0,3L

Finned tube evaporator
■ transfer area: approx. 0,175m^2

Pump
■ max. flow rate: 1,9m^3/h
■ max. head: 1,4m

Hot water tank volume: approx. 4,5L

Measuring ranges
■ pressure: 2x -1...15bar
■ temperature: 4x 0...100°C, 2x -100...100°C
■ power: 1x 0...6000W
■ flow rate (water): 1x 0...108L/h
■ flow rate (cooling water): 1x 10...160L/h

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase
120V, 60Hz, 1 phase
LxWxH: 1620x790x1910mm
Weight: approx. 192kg

Required for operation

water connection, drain
PC with Windows recommended

Scope of delivery

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