ET 352

Vapour jet compressor in refrigeration

screen mirroring is possible on up to 10 end devices

Description

- **refrigeration system with vapour jet compressor**
- **cold production using heat**
- **log p-h diagram in real time**
- **together with ET 352.01 and HL 313: using solar heat as drive energy for the vapour jet compressor**

Unlike standard compression refrigeration systems, vapour jet refrigeration machines do not have a mechanical but a vapour jet compressor. This makes it possible to use different heat sources, such as solar energy or process waste heat, for cold production.

The system includes two refrigerant circuits: one circuit is used for cold production (refrigeration cycle), the other circuit is used for the generation of motive vapour (vapour cycle). The vapour jet compressor compresses the refrigerant vapour and transports it to the condenser. A transparent tank with a water-cooled pipe coil serves as condenser.

In the refrigeration cycle some of the condensed refrigerant flows into the transparent evaporator connected to the intake side of the vapour jet compressor. The evaporator is a so-called flooded evaporator where a float valve keeps the filling level constant. The refrigerant absorbs the ambient heat or the heat from the heater and evaporates.

The refrigerant vapour is aspirated by the vapour jet compressor and compressed again.

In the vapour cycle, the other part of the condensate is transported to a vapour generator. An electrically heated tank with water jacket evaporates the refrigerant. The generated refrigerant vapour drives the vapour jet compressor. Alternatively to the electric heater, solar heat can be used as drive energy by using ET 352.01 and the solar thermal collector HL 313.

The heater power at the evaporator is adjustable. The cooling water flow rate at the condenser is adjusted using a valve.

The trainer is controlled by a PLC via touch screen. All relevant measured values are captured by sensors. The simultaneous transmission of the measured values to a 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.

Learning objectives/experiments

- understanding compression refrigeration systems based on the vapour jet method
- clockwise and anticlockwise Rankine cycle
- energy balances
- calculation of the coefficient of performance of the refrigeration circuit
- represent and understand the refrigeration cycle in the log p-h diagram
- operating behaviour under load
- solar thermal vapour jet refrigeration

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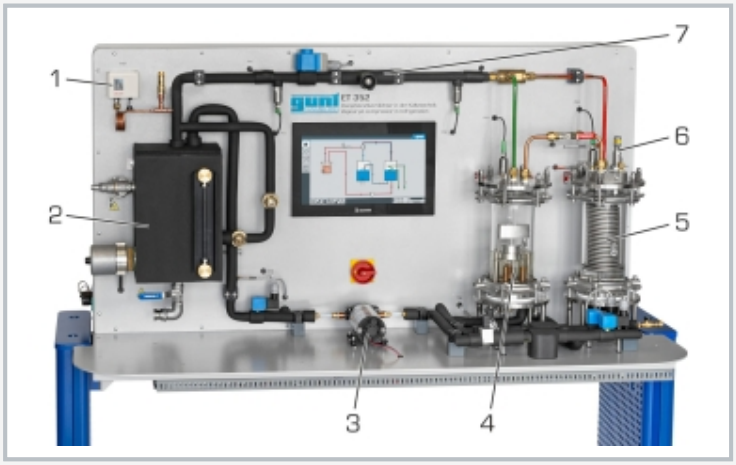
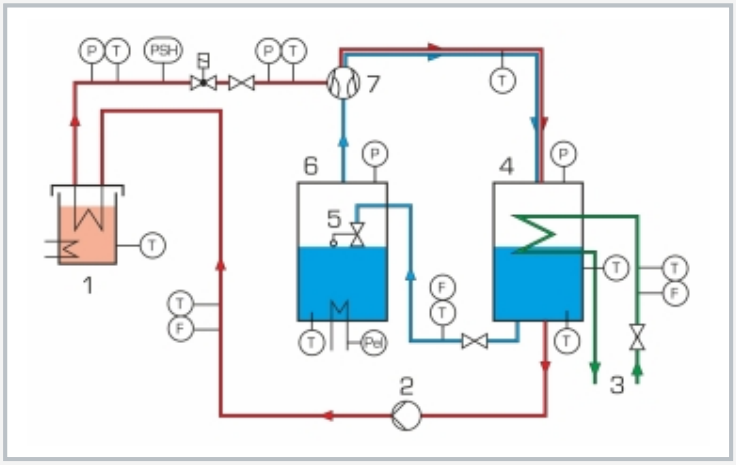
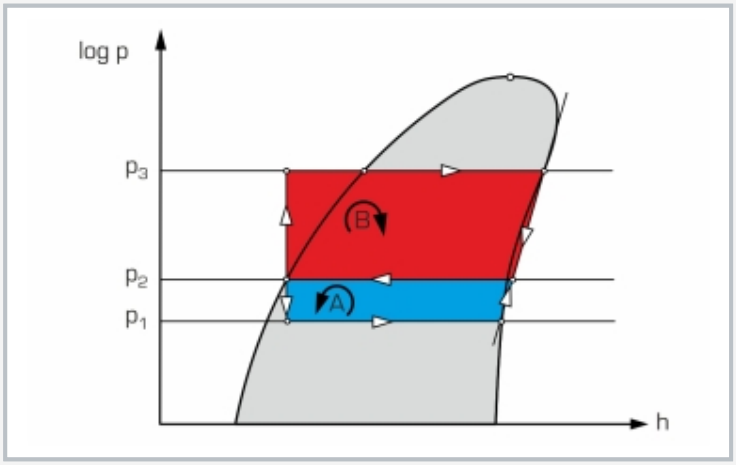


1 pressure switch, 2 vapour generator, 3 pump, 4 evaporator, 5 condenser, 6 flow meter, 7 vapour jet compressor



1 vapour generator, 2 pump, 3 cooling water connections, 4 condenser, 5 float valve, 6 evaporator, 7 vapour jet compressor; T temperature, P pressure, PSH pressure switch, F flow rate, P_{el} power; red: vapour cycle, blue: refrigeration cycle, green: cooling water



log p-h diagram: A refrigeration cycle, B vapour cycle, p_1 pressure in the evaporator, p_2 pressure in the condenser, p_3 pressure in the vapour generator

Specification

[1] refrigeration circuit with condenser, evaporator and vapour jet compressor for refrigerant
[2] vapour circuit with pump and vapour generator for operating the vapour jet compressor
[3] transparent tank with water-cooled pipe coil as condenser
[4] transparent tank with adjustable heater as evaporator
[5] water supply via the lab network or via WL 110.20 Water chiller to ensure a maximum water temperature of 14°C
[6] flooded evap. with float valve as expansion element
[7] vapour generator with heated water jacket (electrically or solar thermally using ET 352.01, HL 313)
[8] refrigerant R1233zd, GWP: 4
[9] receiver for refrigerant with individual filling option for each process tank
[10] control of the experimental plant using a PLC, operated by touch screen
[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

Technical data

PLC: Weintek cMT3162X
Vapour jet compressor
- d_{min} convergent-divergent nozzle: approx. 1,7mm
- d_{min} mixing jet: approx. 7mm

Condenser, tank: approx. 3,5L
- pipe coil area: approx. 0,17m²

Evaporator, tank: approx. 3,5L
- heater power: 3x 175W

Vapour generator
- refrigerant tank: approx. 0,75L
- water jacket: approx. 9L
- heater power: 2kW

Pump
- max. flow rate: approx. 1,7L/min
- max. head: approx. 70mWS

Refrigerant: R1233zd, GWP: 4, filling volume: 2kg, CO_2-equivalent: 0t

Measuring ranges
- temperature: 12x -20...100°C
- pressure: 2x 0...10bar; 2x -1...9bar
- flow rate: 2x 0...1,5L/min, 1x 30...320L/h
- power: 1x 0...750W, 1x 0...3kW

230V, 50Hz, 1 phase
230V, 60Hz, 1 phase, 230V, 60Hz, 3 phases
UL/CSA optional
LxWxH: 1708x790x1524mm; Weight: approx. 225kg

Required for operation

water connection (min. 320L/h, water temperature max. 14°C), drain or WL 110.20
PC with Windows recommended

Scope of delivery

trainer, 1 set of accessories, 1 set of instructional material

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Optional accessories

ET 352.01	Solar heat for refrigeration
HL 313	Domestic water heating with flat collector
HL 313.01	Artificial light source
WL 110.20	Water chiller