

ET 120

Cooling using the Peltier effect



Description

- demonstration of the thermoelectric effect
- creation of energy balances

The experimental unit demonstrates cooling using the Peltier effect. Peltier elements utilise the thermoelectric effect of some semiconductors. The thermoelectric effect is the reverse of the known thermopower effect which is e.g. used when measuring temperatures using thermocouples. If current flows through a Peltier element, one end of the semiconductor becomes hot and the other cold. By a suitable connection of p- and n-doped semiconductor materials the refrigeration capacity can be increased sufficiently to be usable.

The benefits of cold production using Peltier elements are: Peltier elements are wear and maintenance-free, noiseless, independent of position and easy to adjust in their refrigeration capacity via the supply voltage. In addition, no refrigerants are required. Peltier elements are used for small capacities in thermography as beverage chillers or in medical engineering. Their low efficiency is a disadvantage.

The experimental setup is clearly arranged on the front of the experimental unit. The central component of the system is a Peltier element. The heating and refrigeration capacity of the Peltier element are dissipated via water flows. Measuring the respective flow rate and the inlet and outlet temperatures allows for the heat flows to be determined. The supplied electrical power is determined using a current and voltage measurement.

Due to the closed water circuit the experimental unit can also be operated for short periods of time without being connected to the water mains.

Learning objectives/experiments

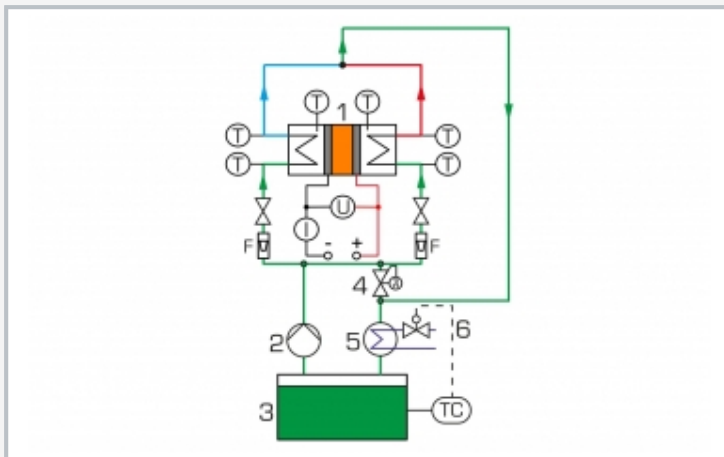
- function and operation of a Peltier element
 - ▶ for cooling
 - ▶ as heat pump
- determination of the refrigeration and heating capacity
- recording typical characteristics, such as refrigeration capacity, via temperature differences
- energy balance
- calculating the coefficient of performance

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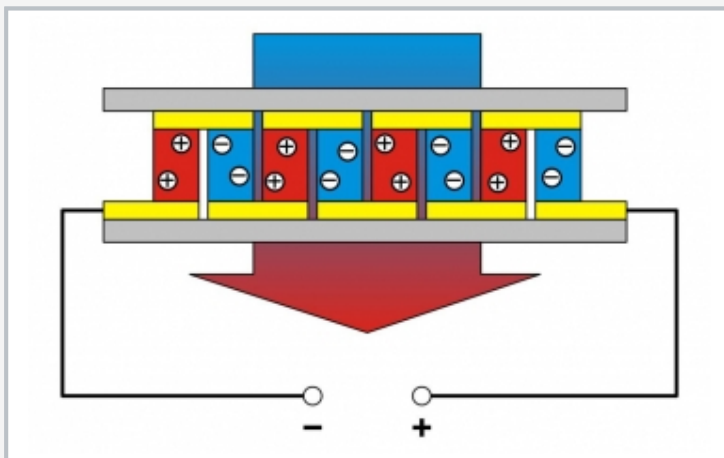
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1 cold water flow meter, 2 temperature displays cold side, 3 water tank temperature controller, 4 voltage and current displays, 5 adjustment of the electrical power, 6 Peltier element with heat exchangers, 7 hot water flow meter, 8 temperature displays hot side, 9 water tank cover



1 Peltier element, 2 pump, 3 tank, 4 pressure relief valve, 5 heat exchanger, 6 solenoid valve; T temperature, F flow rate; U, I supply voltage and current measurement; blue: water cold side, red: water hot side, green: mixed water



Principle of operation: semiconductors connected electrically in series transport the heat from the cold side (blue) to the hot side (red)

Specification

- [1] functional model of a Peltier refrigeration system
- [2] experimental unit with clear design of all components at the front
- [3] water-cooled Peltier element
- [4] shared water circuit for heating and cooling with tank, pump and flow meters
- [5] electrical power freely adjustable via potentiometer
- [6] digital displays for temperature, current and voltage
- [7] flow meter measurement of the water flows via rotameters

Technical data

Peltier element

- max. refrigeration capacity: 191,4W
- max. current: 22,6A
- max. voltage: 16,9V
- max. temperature difference: 77,8K
- hot side temperature: 50°C

Pump

- power consumption: 120W
- max. flow rate: 1000L/h
- max. head: 30m

Water tank

- content: 7L

Measuring ranges

- current: 0...20A
- voltage: 0...200V
- temperature: 2x -30...80°C, 4x 0...100°C
- flow rate: 1x 2...27L/h, 1x 15...105L/h

- 230V, 50Hz, 1 phase
- 230V, 60Hz, 1 phase
- 120V, 60Hz, 1 phase
- UL/CSA optional
- LxWxH: 1000x640x600mm
- Weight: approx. 60kg

Required for operation

- water connection
- drain

Scope of delivery

- 1 experimental unit
- 1 set of instructional material

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Optional accessories

020.30009 WP 300.09 Laboratory trolley