

# ET 508

## Simulation of a two-stage air compressor



### Description

#### ■ simulated compressor plant with intermediate and aftercooling

When operating real compressor plants in industry, the specified process parameters must be adhered to. Certain operating conditions must be avoided in order to prevent damage to the plant.

The ET 508 experimental unit is a simulation device which students can use to safely familiarise themselves with the different operating states of a two-stage compressor plant. Boundary conditions and their consequences can be simulated. The significance of clearance volume and re-expansion are demonstrated. The plant's response can be tested by deliberately changing the process parameters.

Nine different process parameters can be set via potentiometers on the control unit of the experimental unit. The process parameters control the software. The process parameters include, among other things, cubic capacity, clearance volume, speed or intake state of the air.

The software offers a wide range of display options. The consequences of changes in the settings on the potentiometers can be observed directly in the software displays. For example, the compression process can be displayed in the p-V diagram. The thermodynamic conditions can be displayed in the T-s diagram. Single-stage and multi-stage compression can be compared. Intake air volume, compressor stroke and pressure ratio of the respective stage, convective heat transfer during condensation and air flow rate are calculated in the software.

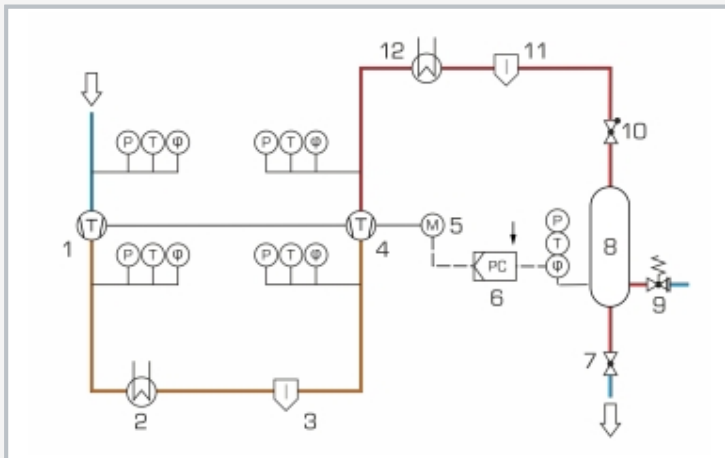
The experimental unit is connected to a PC via USB. The power supply is provided by the PC.

### Learning objectives/experiments

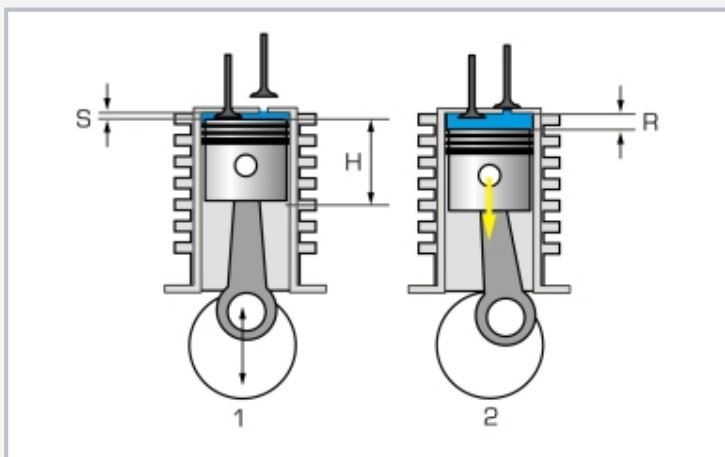
- fundamentals of the multi-stage compression process
- characteristics of a multi-stage compressor
- thermodynamic state variables
- representation of the compression process in the T-s diagram and in the p-V diagram
- condensation in the intercooler and aftercooler
- 2-point pressure control with hysteresis

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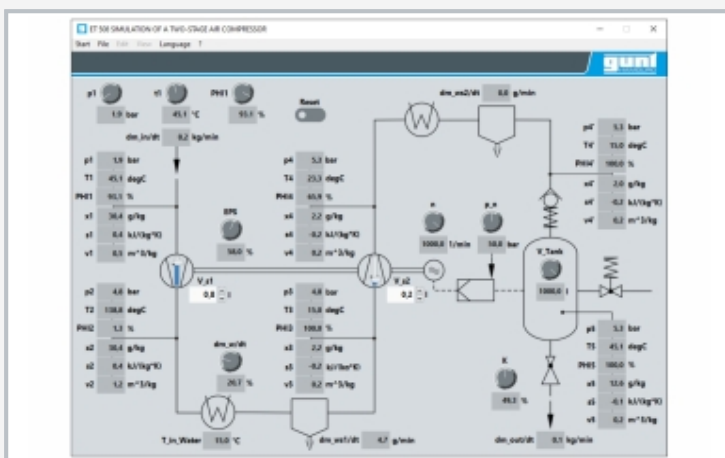
## Simulation of a two-stage air compressor



1 compressor, 2 heat exchanger for intercooling, 3 separator, 4 compressor, 5 motor, 6 pressure controller, 7 expansion valve, 8 pressure vessel, 9 safety valve, 10 non-return valve, 11 separator, 12 heat exchanger for aftercooling;  
P pressure, T temperature, φ humidity; blue: low pressure, orange: average pressure, red: high pressure



Principle of re-expansion;  
1 top dead centre: residual air remains in the clearance volume, 2 start of downward movement: this air expands to the atmospheric pressure before the suction valve opens; S clearance volume, H displacement, R re-expansion



Software screenshot

### Specification

- [1] simulated operation of a two-stage compressor plant with intermediate and aftercooling
- [2] change 9 system parameters via potentiometers
- [3] software calculates: intake air volume, temperatures, pressures, pressure ratio stage 1+2, convective heat transfer during condensation, delivered air volume
- [4] GUNT software for data acquisition via USB under Windows 10

### Technical data

- 9 potentiometers for setting
- intake pressure: 0...2bar abs.
  - intake temperature: 0...100°C
  - relative air humidity: 0...100%
  - coolant mass flow: 0...100kg/h at 15°C
  - flow control valve position: 0...100%
  - tank nominal pressure: 0...50bar
  - motor speed: 0...1000min<sup>-1</sup>
  - tank volume: 0...1000L
  - relative clearance volume: 0...100%

### Inputs and outputs

- 16x analogue in, 1x analogue out
- each 4x digital in/out

LxWxH: 600x350x480mm

Weight: approx. 15kg

### Required for operation

PC with Windows

### Scope of delivery

- 1 experimental unit
- 1 GUNT software + USB cable
- 1 manual

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Optional accessories

WP 300.09      Laboratory trolley