

Quality inspection: In a vehicle, media-carrying components must withstand extreme strains at temperatures ranging from  $-40^{\circ}\text{C}$  to  $+140^{\circ}\text{C}$ . Poppe + Potthoff Maschinenbau develops testing systems to check and optimize them efficiently.

## Pressure Test Systems: Thermal Management & Cooling Circuit for E-Mobility

# Cooling and heating tests

**Comprehensive testing of cooling and heating system components used in electric vehicles must be conducted under different pressure levels and temperatures**



The compact pressure cycling test bench from Poppe + Potthoff Maschinenbau tests climate components at  $-40$  to  $+140$  degrees Celsius. Temperature, volume flow and pressure changes can be freely programmed in sinusoidal and trapezoidal form and enable fast and economical testing.

## KEYWORDS

Testing Technology | A/C Components | Thermal Management | Energy Efficiency | Environmental Simulation

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## Pressure change at $-40$ to $+140$ degrees Celsius

In a typical test, the component is inserted into the test chamber of the pressure cycling test bench. This can be an auxiliary heater for an electric car or valves, hoses and other hollow bodies that need to withstand

more than 100,000 load changes over the lifetime of the vehicle (up to 15 years). The test medium is a water-glycol mixture or pure glycol (for example Glysantin G40, G44, G48). The cooling circuit is tested at  $-40^{\circ}\text{C}$  to  $+20^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $+68^{\circ}\text{F}$ ) while a heating circuit is tested in temperatures from  $+20^{\circ}\text{C}$  to  $+140^{\circ}\text{C}$  ( $68^{\circ}\text{F}$  to  $284^{\circ}\text{F}$ ).

A specially developed closed test media circuit uses pressure to prevent the formation of alcoholic vapours (which create a risk of explosion). A system can also be analysed in a climate chamber.



Traction battery: It not only drives the engine, but also supplies the vehicle's entire electrical system with power. In Poppe + Potthoff Maschinenbau's function test stand, the energy efficiency of heating and cooling units can be tested and optimised to increase the accumulator's performance.

**Climate control systems must be able to withstand extreme load changes. Instead of testing the load-bearing capacity in proprietary test setups or in real operation, manufacturers can now analyse their products in pressure cycling and function test benches from Poppe + Potthoff Maschinenbau.**

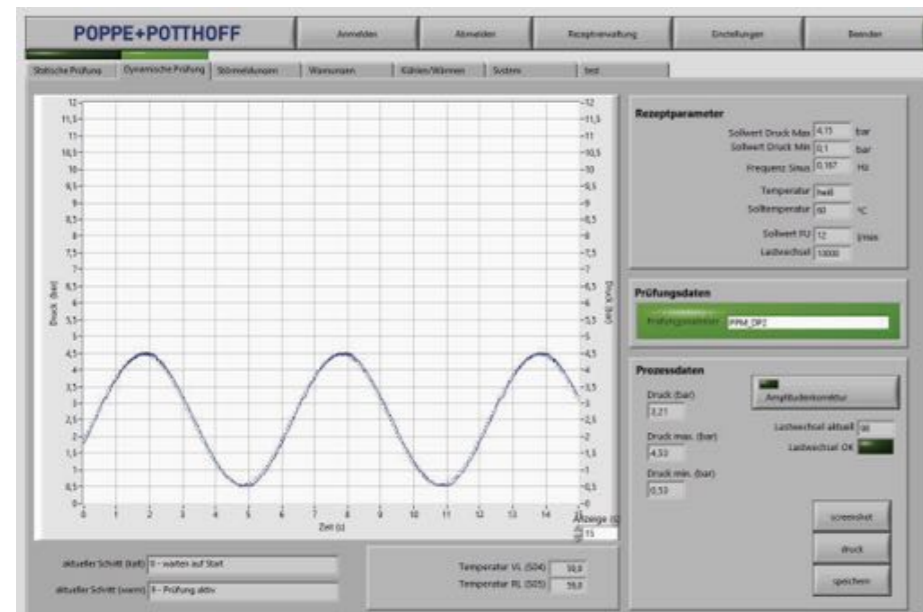
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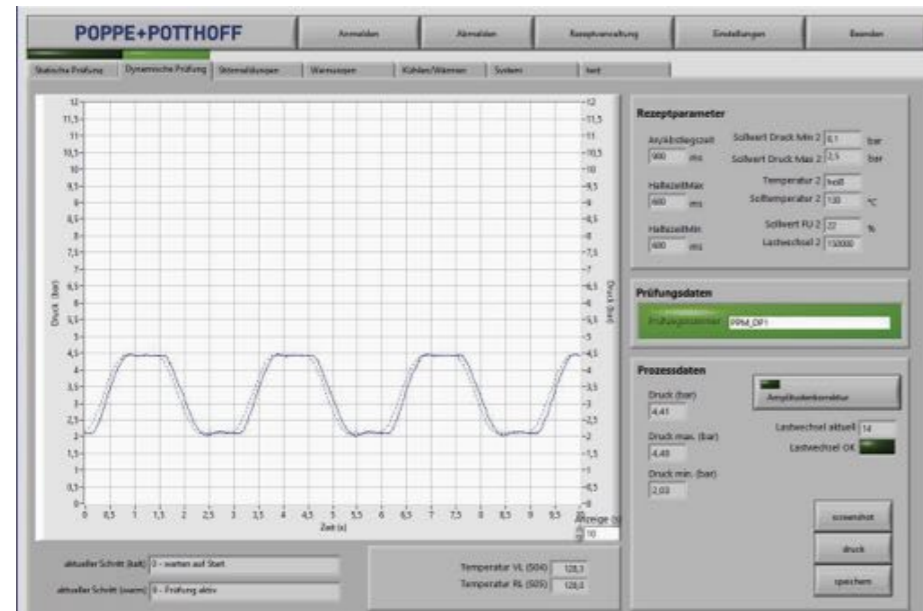
The flow rate of the test medium can vary from 1-50 l/min at a pressure of 0.2-12 bar or higher. The load changes are freely programmable with sinusoidal or trapezoidal rise at a test frequency of 0.2-2 Hz or faster.

The test stand can be used for complete systems, assemblies and components made of various plastics, metals and sealants.

Weak points in the material combination – for example around a weld seam – can be sounded out and optimized early in the development process as well as during production.



The pressure cycling test bench from Poppe + Potthoff Maschinenbau tests climate-control components at -40 to +140 degrees Celsius. Temperature, volume flow and pressure changes can be freely programmed in sinusoidal and trapezoidal form at a test frequency of e.g. 0.2 to 2 Hz and enable fast and economical testing.



## Time lapse for long-term tests Safe and easy to use

A long-term test usually takes 20-30 days, depending on the frequency of the load changes. The temperature and volume flow of the test medium as well as the ambient temperature (if the test takes place in the climatic chamber) vary according to the test specification.

Poppe + Potthoff Maschinenbau test systems are easy to operate and extremely safe. The test chamber consists of welded stainless steel and a high-strength polycarbonate safety window. Any test sequences created on the PC can simply be called up manually via coded recipe management or by a handheld scanner.

The temperature at the inlet and outlet of the test object is measured continuously, as well as the flow rate, pressure and pressure drop, and current and voltage (both in the high and low range). The focus is on the thermal and electrical performance of the heating and cooling unit under varying environmental conditions. Thermal sensors can be mounted on the product to indicate during the test when energy is lost (thermal bridges) or when the component becomes very hot (and thus presents a fire hazard).

The integrated LabView software from National Instruments enables efficient data acquisition and visualization. Test procedures and data are automatically stored on the system and can be exported to the network for evaluation. The open software structure makes it possible to integrate additional sensors and data during testing. Poppe + Potthoff Group can provide numerous testing services, remote maintenance and on-site technicians, if necessary.



Pressure cycling test stand with climate chamber

- Temperature ambient: -40°C to +160°C with rate of change 1,5 K/min
- Temperature fluid: -40°C to +135°C
- Test chamber: with Ex protection for pressure test with coolant (ATEX)
- Size of test chamber: 1,500 x 900 x 900 mm (W x H x D)
- Flow rate coolant: 0,5 l/min up to 30 l/min adjustable
- Test pressure: dynamic 0,2 to 6 bar with sinus- and trapezoidal curve
- Frequenzy: up to 2 Hz (further frequencies upon request)
- Pressure drop test: up to 1,000 mbar
- Static pressure test: up to 20 bar with compressed air and adjustable pressure increase
- Leak rate test: 0,5 cm<sup>3</sup>/min
- Vacuum testing: Pressure variation between atmosphere and 18 mbar abs.

## Energy efficiency in battery operation

In addition, Poppe + Potthoff Maschinenbau offers a function test bench for electrical appliances such as cooling and heating units, control valves and pumps. Power consumption and performance are typically tested at alternating temperatures – optionally with a low- or high-voltage power supply to simulate operation via onboard battery and generator or the traction accumulator.

In many EVs, the heating and cooling systems drain the battery and negatively affect the vehicle's range. Comparison of test results before and after a load test on the pressure cycling test bench can show how power consumption and performance change over the vehicle's service life. The test object is connected to the power supply (low voltage 0-20VDC/5A) or high voltage (0-600VDC/150A) and the test media circuit. The test medium is circulated at a temperature of between -35°C to +100°C (-31°F to +212°F) and a flow rate of 1-50 l/min. The test can also be carried out in a climatic chamber at -40°C to +140°C (-40°F to +284°F) simulating changing ambient temperatures.



The Poppe + Potthoff Maschinenbau function test bench measures the consumption and performance data of heating and cooling units under changing temperature conditions so that their efficiency can be optimized.

## Performance data

Exemplary systems from Poppe + Potthoff Maschinenbau

### Pressure cycling test stand

Testing media:

- Water-glycol mixture
- Pure glycol

Media temperature control:

- Cooling circuit: 5 kW to -30°C, 2 kW to -40°C
- Heating circuit: 12 kW +20°C to +140°C

Volume flow control:

- 1 to 50 l/min

Ambient temperature control:

- -40°C to +140°C (optional with appropriate climatic chamber)

Dynamic pressure cycling:

- 0,2 to 12 bar or higher
- Frequency: 0,2 Hz-2 Hz or higher

Ramp form:

- Trapezoidal & sinusoidal, static pressure drop test: up to 12 bar or higher

Measured data:

- Temperature of medium
- Ambient temperature
- Flow rate
- Pressure
- Pressure drop

### Function test bench

Testing media:

- Water-glycol mixture
- Pure glycol

Media temperature control:

- Cooling circuit: 15 kW to -35°C
- Heating circuit: 25 kW to +100°C

Volume flow control:

- 1 to 50 l/min

Ambient temperature control:

- -40°C to +140°C (optional with appropriate climatic chamber)

Battery simulation:

- High Voltage: 0 to 600V<sub>DC</sub> / 150A
- Low Voltage: 0 to 20V<sub>DC</sub> / 5A

Measured data:

- Temperature of medium at the inlet and outlet of the test specimen
- Ambient temperature
- Flow rate
- Pressure
- Pressure drop
- Electrical output
- Thermal performance
- Voltage HV and LV
- Current HV und LV
- Maximum value current HV

**Poppe + Potthoff Maschinenbau GmbH** designs and manufactures test stands for measuring the strength and durability of components in automotive engineering and shipbuilding as well as other industries. The precise and high-performant special machines by the expert for high-pressure and test technology are used in research, development and production. This includes test stands for measuring bursting pressure and tightness, impulse testing, autofrettage as well as automated testing. In addition, comprehensive component tests are offered as a service. The company based in Nordhausen (Germany) is a member of the Poppe + Potthoff Group.



**Poppe + Potthoff** stands for precision. The group develops and manufactures customer-specific steel tubes, common rail subsystems, high pressure tubes, precision components, line shafts, couplings as well as specialized test stands and other machines. Poppe + Potthoff enables highly sophisticated solutions in automotive engineering and shipbuilding, machine tool building and mechanical engineering as well as other industries. The family-owned enterprise with its headquarters and technology center in Werther (Germany) was founded in 1928 and has more than 1,500 employees. Poppe + Potthoff is active in more than 50 countries with its subsidiaries and long-term partners – always in close contact with its customers.

## THE PRECISION-MAKERS



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