Anton Paar

MCR

Temperature Devices



Ready for the greatest influence of all.

Temperature Control for MCR Rheometers



Certainty.

Now you control the greatest rheological influence of all: temperature. Choose from a vast range of temperature devices to combine with your MCR rheometer and rely on the high-precision temperature control required for truly accurate rheological results.

Safety.

All outside surfaces of Anton Paar´s MCR temperature devices are touch-proof up to highest temperatures. The exhausts are designed with cooling mechanisms to ensure safe and comfortable use anytime at any temperature.

Variety.

Anton Paar's temperature devices:

- rapidly set the temperature, without overshoots during the controlling process,
- precisely maintain and measure the temperature at all times,
- ensure uniform temperature distribution throughout the sample.

Four temperature control methods are employed to fulfill these requirements: liquid-, Peltier-, electrical and convection temperature control. Considering the specific characteristics of each method, this flexible approach ideally covers the broad spectrum of your present and future application needs.

Comfort.

Whichever choices you make, all temperature devices are swiftly and easily integrated and exchanged, and your rheometer reliably adapts to each new setup and temperature requirement.

Patented MCR features make sure of this: Toolmaster™ automatically recognizes and configures all connected devices, TruGap™ controls and adjusts the rheometer's actual measuring gap. T-Ready™ cuts short unnecessary waiting times by immediately detecting temperature equilibration.

Patented technological highlights like the truly Peltier-controlled hood (H-PTD) and the Peltier temperature device for concentric-cylinder systems (C-PTD) expand your measurement options and ensure temperature accuracy.

Modular Temperature Control …
… from -150 °C to 1000 °C

Anton Paar's temperature control portfolio is sure to contain a specific solution for your application. Here are all relevant parameters for your consideration – and the symbols with which they are presented in this brochure.



Which range of temperature do you require?

Which materials are you going to measure?

These symbols are used to give you a first impression of each temperature device's area of application.

Which measuring systems are you going to employ?

These symbols are used to point out the suitable measuring systems for each temperature device.

Find out more about Anton Paar's measuring systems on **page 17**.

Which temperature control method best serves your needs?

These symbols are used to denote the temperature control methods available from Anton Paar.

Find out more about these methods' characteristics and benefits on **pages 18-19.**

Page

6-7
I want to measure around room temperature

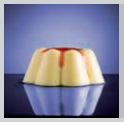
8-10
I want to measure up to 200 °C

12-13
I want to measure above 200 °C

14-16
I want full flexibility


Low-viscosity liquids


Visco-elastic liquids


Gel-like materials


Soft solids


Melts


Paste-like materials

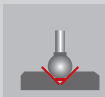

Reactive systems


Solids


Concentric Cylinder (CC)


Double Gap (DG)


Tack Systems


Tribology Systems


Cone-Plate (CP)


Parallel Plate (PP)


Stirrers


DMTA Fixtures


Extensional Fixtures


Liquid temperature control


Electrical temperature control


Peltier temperature control


Convection temperature control

I Want to Measure
Around Room Temperature

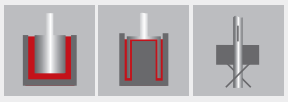
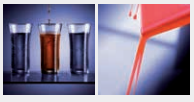


Rheology is an important factor in many application and production processes that take place around room temperature. Measurements in this field essentially rely on precise temperature setting that is independent from outside conditions.

In the following, find cost-effective temperature control solutions from Anton Paar that cover the range around room temperature.

Typical applications around room temperature

Food, coatings, paints, cosmetics, pharmaceuticals, printing inks, slurries, ceramics, building materials, paper coatings, detergents

Chamber	Temperature range	Materials	Measuring systems	Principles	Heating rate	Cooling rate
C-LTD 180, C-LTD 180/XL	-30 °C to 180 °C				Depending on fluid circulator and circulating liquid	
P-LTD 180	-30 °C to 180 °C				Depending on fluid circulator and circulating liquid	
C-PTD 180/AIR	0 °C to 180 °C				Up to 10 °C/min	Up to 9 °C/min
P-PTD 200/AIR	-5 °C to 200 °C				Up to 40 °C/min	Up to 40 °C/min

Useful accessories …

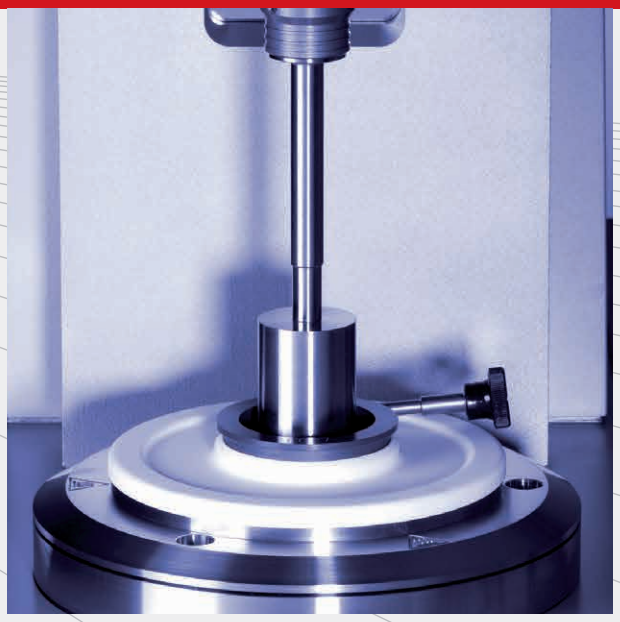
… to prevent solvent evaporation: Solvent traps or covers for concentric-cylinder, parallel-plate and cone-plate systems reduce the influence of environmental conditions and the loss of highly volatile sample components. These accessories improve temperature control and prevent sample drying or skin formation.

… to avoid wall slip: In case slippage occurs with conventional measuring systems, the rough surfaces of sandblasted and profiled cap plates, inset plates or measuring systems ensure that the applied stress is transferred onto the sample.

C-LTD 180, C-LTD 180/XL

Liquid temperature control for concentric-cylinder systems

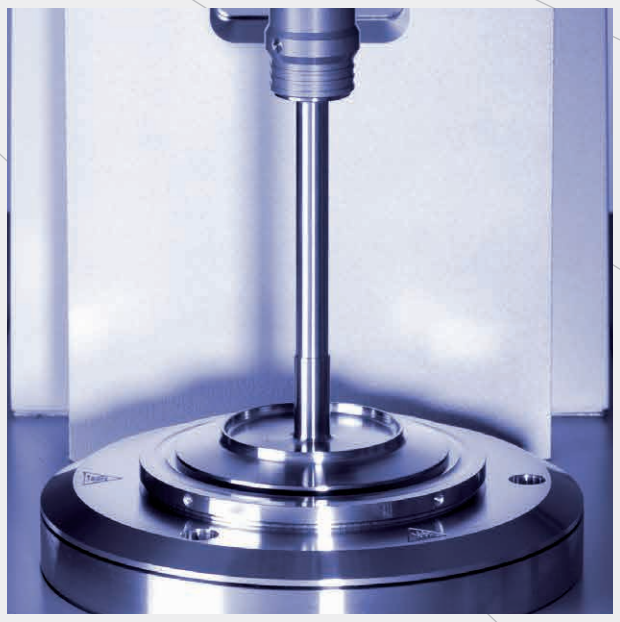
- Recommended for measurements at constant temperatures
- Temperature range depends on the used fluid circulator and circulating liquid
- Temperature measurement close to the sample
- XL version for liquids with very low viscosities
- Temperature device for pressure cells



P-LTD 180

Liquid temperature control for parallel-plate and cone-plate systems

- Recommended for measurements at constant temperatures
- Temperature range depends on the used fluid circulator and circulating liquid
- Stainless steel bottom plate



P-PTD 200/AIR

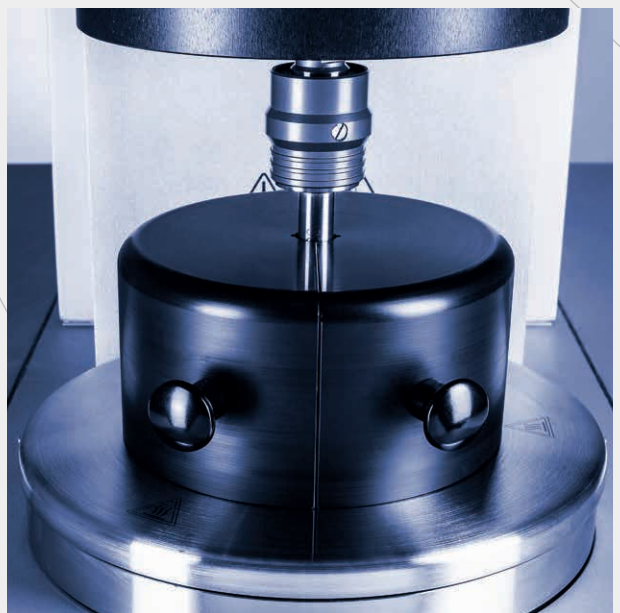
Peltier temperature control for parallel-plate and cone-plate systems

- For measurements at constant temperatures and temperature profiles
- High-precision temperature control
- Lower plate coating with high thermal conductivity for short equilibrium times
- Built-in air counter-cooling – no fluid circulator required
- Optionally used in combination with patented truly Peltier-temperature-controlled hood (US Patent 6,571,610)

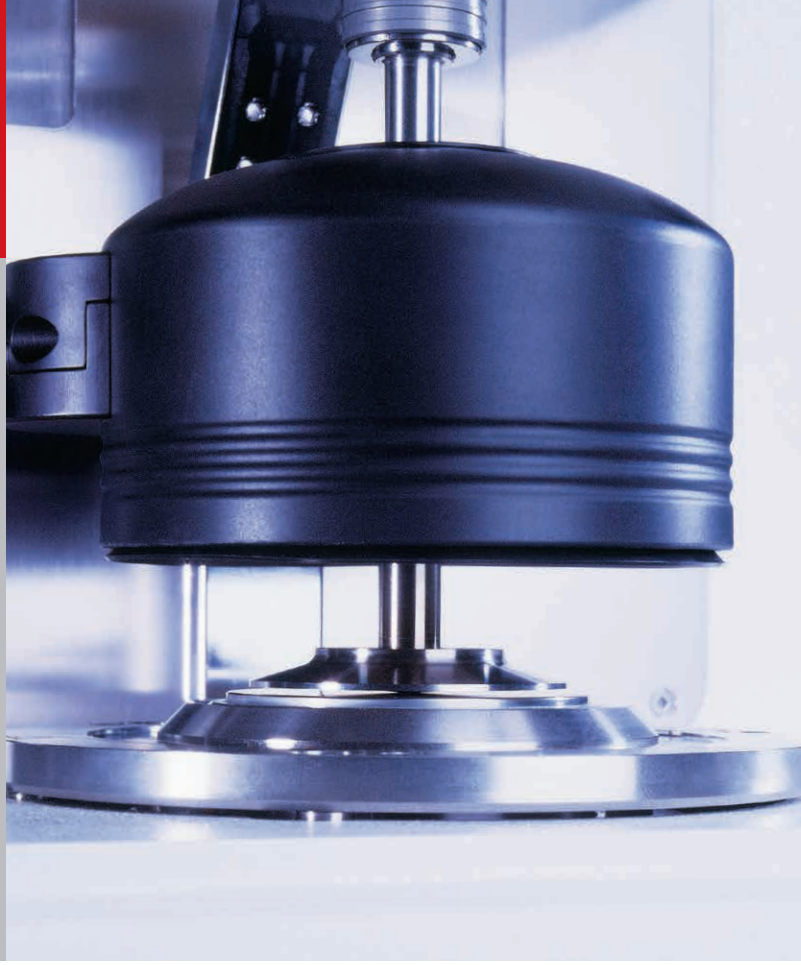
C-PTD 180/AIR

Peltier temperature control with air counter-cooling for concentric-cylinder systems

- Suitable for rheological standard applications as well as for ground tire rubber-modified asphalt (GTR)
- High heating and cooling rates
- No vertical temperature gradients in sample due to patented thermal transfer system (US Patent 6,240,770)
- No fluid circulator required



I Want to Measure
Up to 200 °C

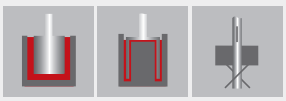
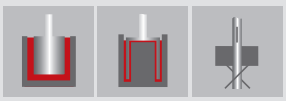


To fully investigate the rheological properties of your sample, you usually require measurements at low and high temperatures, as well as the possibility to perform temperature ramps.

These requirements are met by the following Anton Paar temperature devices, which cover a wide temperature range based on a convenient cooling option that does not require any liquid nitrogen.

Typical applications up to 200 °C

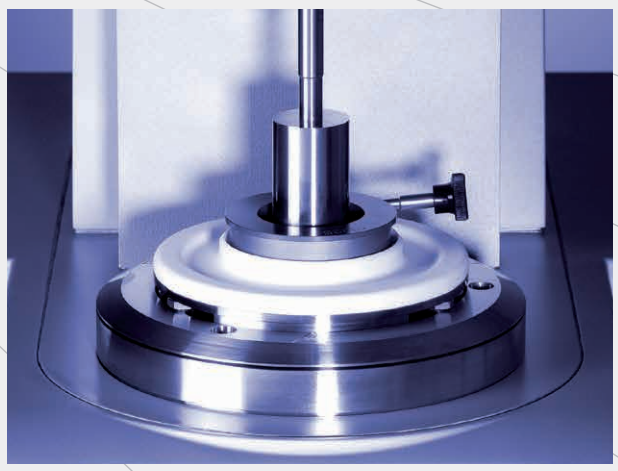
Food, coatings, paints, cosmetics, pharmaceuticals, printing inks, slurries, ceramics, building materials, paper coating, detergents, solvents, adhesives, sealants, plastisols, hotmelts, petrochemicals, asphalt, bitumen, epoxy resins, polymer solutions

Chamber	Temperature range	Materials	Measuring systems	Principles	Heating rate	Cooling rate
C-PTD 200	-30 °C to 200 °C				8 °C/min	4 °C/min
C-ETD 200/XL	Ambient temperature to 200 °C				8 °C/min	70 °C/min
P-PTD 200	-40 °C to 200 °C				Up to 60 °C/min	Up to 50 °C/min
H-PTD 200	-40 °C to 200 °C				Up to 60 °C/min	Up to 50 °C/min

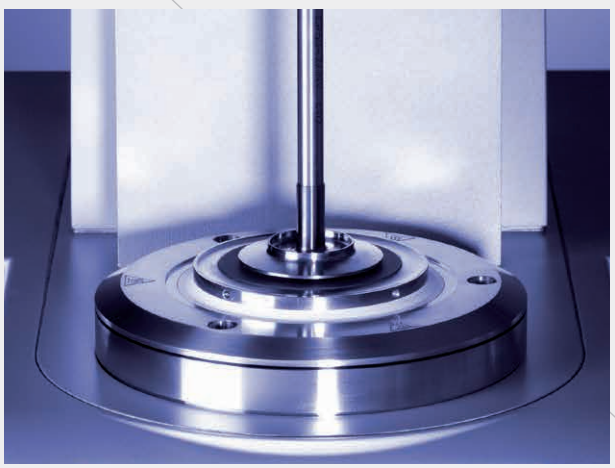
- High heating and cooling rates
- No vertical temperature gradients in sample due to patented thermal transfer system (US Patent 6,240,770)
- Fluid circulator required for counter-cooling
- Temperature device for Standard Pressure Cell (150 bar)



- Suitable for measurements at high temperatures
- Suitable for low-viscosity liquids
- High heating rates
- Cooling with air or fluid circulator
- Temperature devices for Titanium Pressure Cell (400 bar) and Pressure Cell XL (150 bar)



- High heating and cooling rates
- High-precision temperature control
- Lower plate coating with high thermal conductivity for short equilibrium times
- TruGap™ support
- T-Ready™ feature



- Used in combination with P-PTD 200 to prevent temperature gradients in sample
- Recommended for measurements performed at more than 10 °C below or above room temperature
- Fast and convenient convection heating and cooling
- Flushed with air or inert gas
- Prevents ice formation at low temperatures
- Sliding rail for easy access and sample trimming
- Evaporation Blocker
- Temperature-isolated hood (hand-warm for safe use)

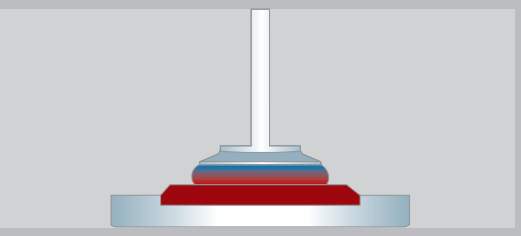


I Want to Measure
Up to 200 °C

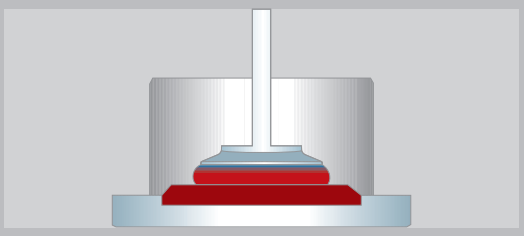
Avoiding temperature gradients

The figures below show the temperature distribution between the upper and lower surface of a sample temperature-controlled without a cover, with a passive cover and with an actively heated hood.

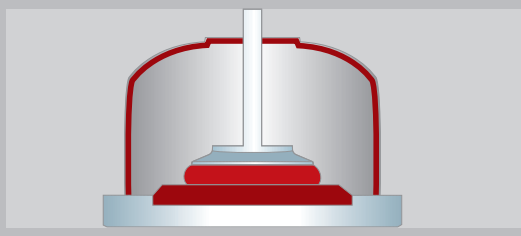
The temperature differences were measured in a thermoplast sample at a measuring temperature of 100 °C. The tests clearly show that only a hood with temperature control can provide the temperature accuracy required for successful rheological measurements.



Open system ΔT = 14.5 °C in the sample



System with passive insulating hood ΔT = 12.1 °C in the sample



Advanced Peltier System PTD 200 with temperature-controlled hood ΔT = 0.1 °C in the sample

Useful accessories …

… to prevent solvent evaporation:

The Evaporation Blocker, used in combination with H-PTD 200, is the most effective tool for minimizing evaporation during parallel-plate or cone-plate measurements at room and elevated temperatures. The saturated atmosphere produced by a reservoir ensures reproducible measurements of highly volatile samples.

In addition, solvent traps or covers for concentric-cylinder and parallel-plate systems are available, which reduce the influence of environmental conditions and the loss of highly volatile components. These accessories improve temperature control and prevent sample drying and skin formation.

… to avoid wall slip:

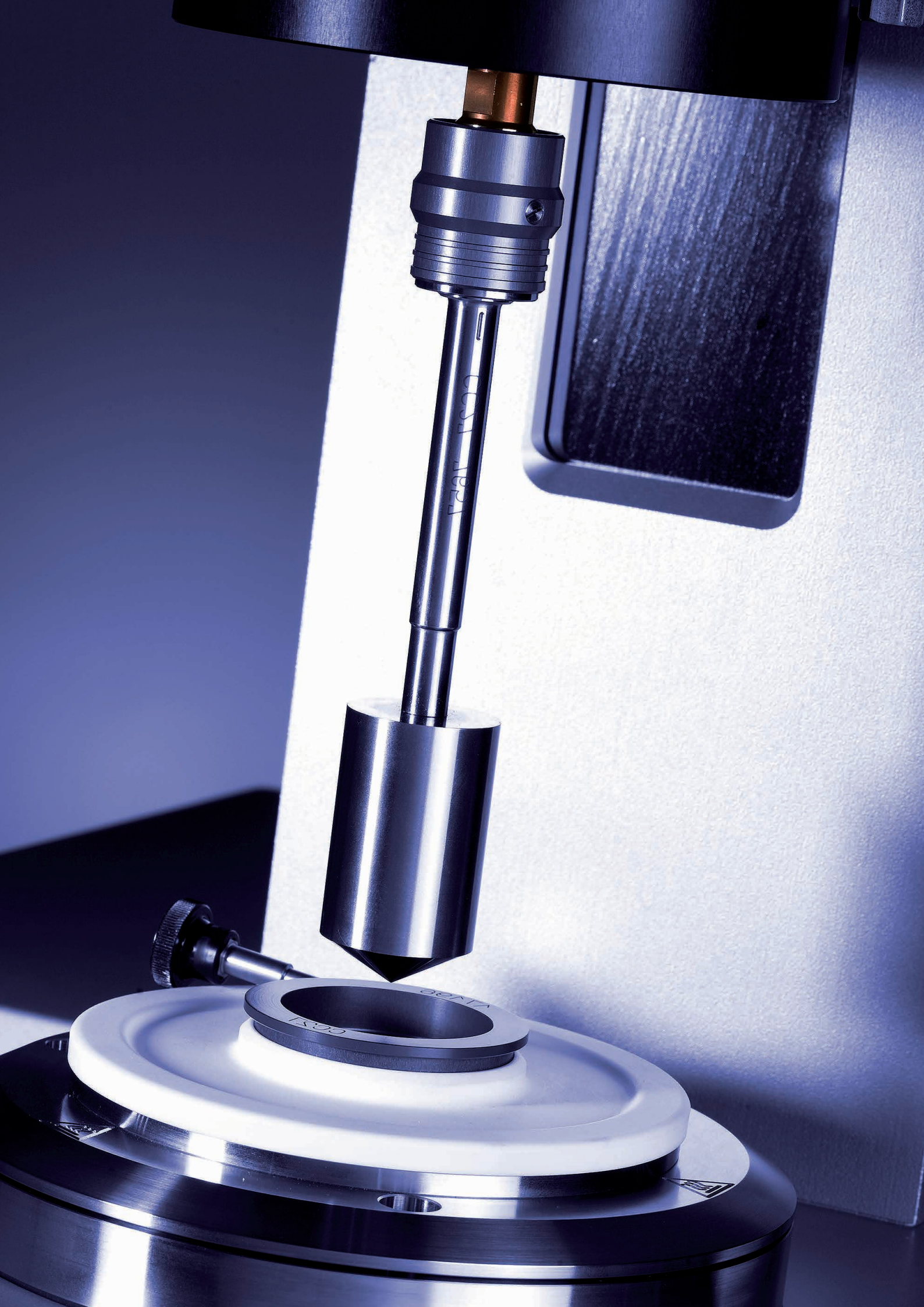
In case slippage occurs with conventional measuring systems, the rough surfaces of sandblasted and profiled cap plates, inset plates or measuring systems ensure that the applied stress is transferred onto the sample.

… for measuring materials that are reactive or hard to clean:

With some materials, cleaning is difficult, e.g. because of an irreversible hardening process. For measurements of such samples, disposable parallel-plate and concentric-cylinder measuring systems are available.

… to measure UV-reactive samples:

UV-reactive samples can be measured with a Peltier temperature device and a glass bottom plate with a UV light guide fixed underneath. Find more details on this UV Curing System in the brochure “MCR Application-specific Accessories for Additional Parameter Setting”.



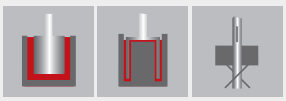
I Want to Measure
Above 200 °C



Materials like typical polymer melts are usually measured in a temperature range from 170 °C to 280 °C. In case the glass transition of the material is of interest, temperatures below room might be required as well.

Benefit from specific Anton Paar solutions for these applications and use one single temperature device to operate in a range from -150 °C to 400 °C.

Typical applications above 200 °C
Polymer melts, epoxy resins

Chamber	Temperature range	Materials	Measuring systems	Principles	Heating rate	Cooling rate
C-ETD 300	Room temperature to 300 °C				30 °C/min	3 °C/min
P-ETD 400	-150 °C to 400 °C				Up to 50 °C/min	Up to 100 °C/min
H-ETD 400	-150 °C to 400 °C				Up to 50 °C/min	Up to 100 °C/min

Useful accessories…

... to avoid wall slip: In case slippage occurs with conventional measuring systems, the rough surfaces of sandblasted and profiled cap plates, inset plates or measuring systems ensure that the applied stress is transferred onto the sample.

… for measuring materials that are reactive or hard to clean: Some materials are difficult to clean, e.g. because of irreversible hardening. For measurements of such samples, disposable parallel-plate and concentric-cylinder measuring systems are available.

… to ensure accurate sample trimming: Residual sample at the edge of the measuring system may influence the rheological results. Inset plates allow optimal sample trimming.

C-ETD 300

Electrical temperature control for concentric-cylinder systems

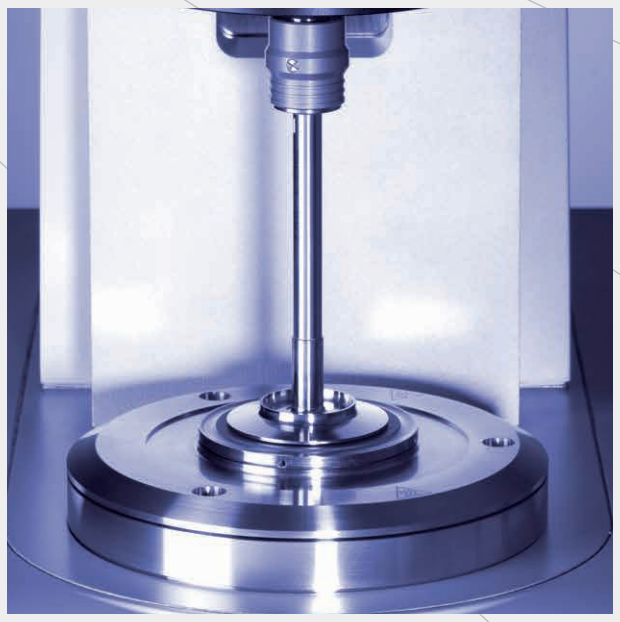
- Temperature device for Standard Pressure Cell when measuring at high temperatures
- High heating rates
- Cooling with compressed air



P-ETD 400

Lower plate system with electrical temperature control

- Especially suitable for measurements at high temperatures
- High heating rates
- Ideal for measurements of tablets, granules and powders
- Three cooling options: compressed air, water or liquid nitrogen
- Low-temperature measurements (down to -150 °C) with Evaporation Unit and liquid nitrogen



H-ETD 400

Hood with electrical temperature control

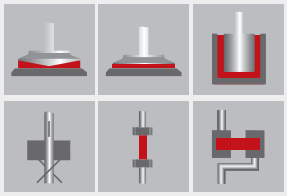
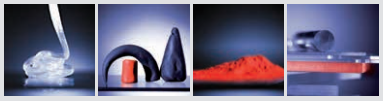
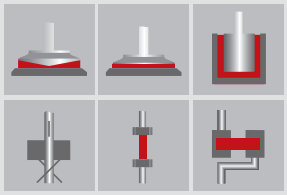
- Used in combination with P-ETD 400 to avoid temperature gradients in sample
- Fast and convenient heating or cooling by convection and radiation
- Sample area optionally flushed with inert gas to avoid sample degradation
- Cooling with compressed air or liquid nitrogen
- Sliding rail for easy access and sample trimming
- Temperature-isolated hood (hand-warm for safe use)



I Want Full Flexibility

Rheological characterizations are performed on all kinds of materials, from low-viscosity liquids up to solids. To measure different kinds of samples, you require a variety of different measuring systems, and in addition you might also be interested in performing DMTA tests in torsion or extension as well as extensional rheological measurements. This wide range of applications calls for temperature control solutions that give you full flexibility regarding temperature, measuring systems and testing possibilities: The convection temperature devices from Anton Paar incorporate these requirements with large-volume ovens and a wide range of temperatures.



Chamber	Temperature range	Materials	Measuring systems	Principles	Heating rate	Cooling rate
CTD 180	-20 °C to 180 °C				18 °C/min	10 °C/min
CTD 450 TDR	-150 °C to 450 °C				50 °C/min	35 °C/min
CTD 1000	-100 °C to 1000 °C				60 °C/min	30 °C/min

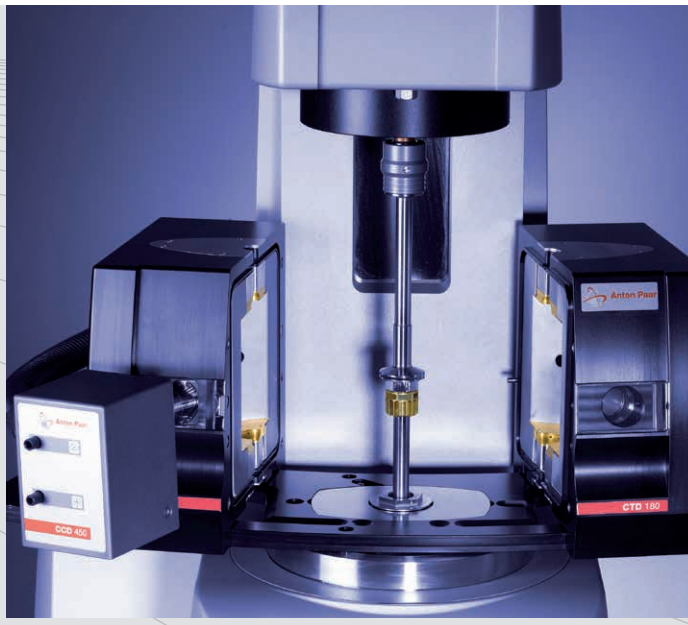
Convection temperature devices: General features

- Virtually gradient-free temperature control with high accuracy due to symmetrical design
- Expanded temperature range with high heating and cooling rates
- Pt 100 signal reflects true sample temperature
- Temperature-isolated jacket (hand-warm for safe use)
- Modular configuration with parallel plate, cone-plate (standard, disposable), concentric cylinder, DMTA torsional or extensional fixtures, UV curing option
- Low temperature option: Measurements with optimized liquid nitrogen consumption depending on temperature range
- Evaporation Unit actively controls continuous flow of liquid nitrogen
- No fluctuations due to continuous evaporation

CTD 180

Peltier-based convection temperature control

- Suitable for DMTA in torsion, DMTA in extension, Photo DMTA (UV curing), extensional rheology (SER)
- Digital Eye CCD camera option for capturing images and videos during the measurement
- TruGap™ support
- T-Ready™ feature
- Gas consumption heating: 17 L/min
- Total air consumption: 57 L/min
- Humidity option
- Typical applications: food, coatings, paints, cosmetics, pharmaceuticals, printing inks, slurries, ceramics, building materials, paper coating, detergents, solvents, adhesives, sealants, plastisols, hotmelts, petrochemicals, asphalt, bitumen, epoxy resins, polymer solutions



CTD 450 TDR

Temperature control based on combined convection and radiation

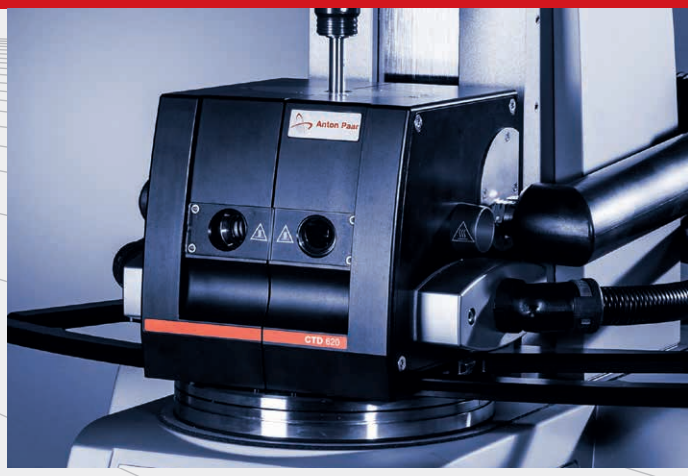
- Suitable for DMTA in torsion, DMTA in extension, Photo DMTA (UV curing), extensional rheology (SER)
- Digital Eye CCD camera option for capturing images and videos during the measurement
- TruGap™ support
- T-Ready™ feature
- Gas consumption heating: 25 L/min
- Total gas consumption: 48 L/min
- Liquid nitrogen consumption: 3 to 6 L/h
- Gas Chiller Option for cooling with fluid circulator instead of liquid nitrogen
- Typical applications: polymer melts, reinforced materials, films and fibers, epoxy resins, aluminum, metals and alloys, low-temperature glasses



I Want Full Flexibility

Gas Chiller Option for CTD

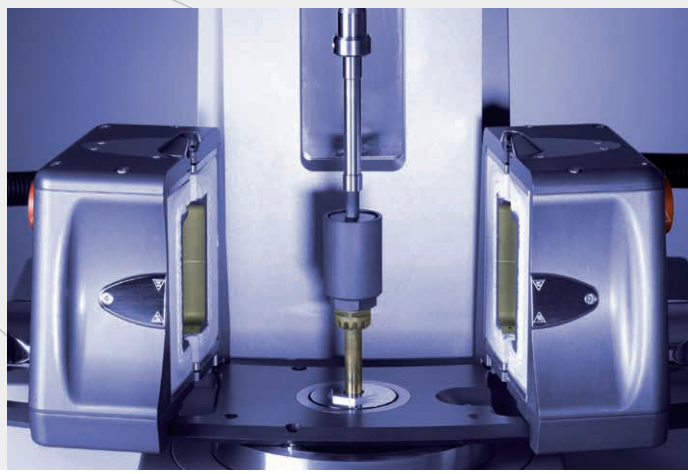
The Gas Chiller Option (GCO) for CTD 450 TDR allows to cool the convection oven devices for MCR rheometers far below room temperature without the use of liquid nitrogen. The GCO features a heat exchanger which can be cooled with a high capacity fluid circulator (Julabo FP89) so that temperatures down to -45 °C can be achieved. All fixtures for the CTD 450 TDR such as DMTA, Extensional and parallel plate systems can also be used in combination with the Gas Chiller option as the same inlets and can be used as for liquid nitrogen.

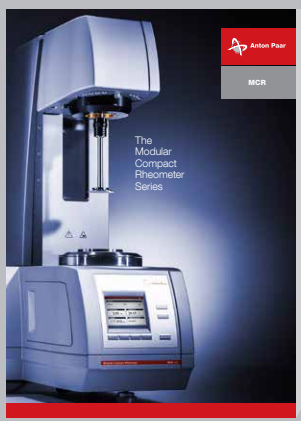


CTD 1000

Temperature control based on combined convection and radiation

- Optionally operated with special measuring systems for glass melts and aluminum
- Gas consumption heating: 10 to 20 L/min
- Total gas consumption: 53 L/min
- Liquid nitrogen consumption: 3 to 6 L/h
- Typical applications: aluminum, metals and alloys, low-temperature glasses





Find more details on MCR measuring systems in the "MCR Rheometer Series" brochure.

Measuring Systems

Anton Paar's MCR measuring systems can be used with all temperature devices and are interchangeable within their category of accessories. For example, a PP25 parallel-plate geometry can be used in all non-cylindrical LTD, PTD, ETD or CTD systems.

All geometry dimensions, safety limitations and calibration constants are saved in the Toolmaster™ chip located in the coupling of every measuring system. Made from diverse materials and featuring different surfaces and dimensions, all measuring systems are optimized regarding compliance, thermal expansion and thermal conductivity.

With hundreds and hundreds of measuring systems, and their efficient combination with a wide range of environmental systems, there is barely any application that cannot be covered by an Anton Paar MCR rheometer.

Patented Features for Comfort and Efficiency

Toolmaster™

Automatic tool recognition and configuration

Toolmaster™ (US Patent 7,275,419), the first fully automatic tool recognition and configuration system for rheology, detects all temperature devices and accessories as soon as they are connected to the rheometer.

- Fast exchange of measuring systems, environmental systems and accessories
- No more errors due to the insertion of unsuitable systems or wrong software selections
- Unique identification of individual measuring system by transfer of serial numbers
- Intelligent auto-configuration for customized rheometer packages
- Calculation of exact geometry factors using real system data, e.g. truncation, diameter and cone angle

TruGap™

Permanent control of the actual measuring gap

The patented TruGap™ system (US Patent 6,499,336) monitors and controls the real measuring gap in cone-plate and parallel-plate measurements. TruGap™ can be employed with Peltier-, electrical and convection temperature devices. According special measuring systems and lower plates are available for each environmental system.

- Enables temperature-dependent cone-plate measurements on polymers
- Full functionality over an extended temperature range and for temperature sweeps with all available heating rates
- Online determination of the measuring gap independently of the rheological test

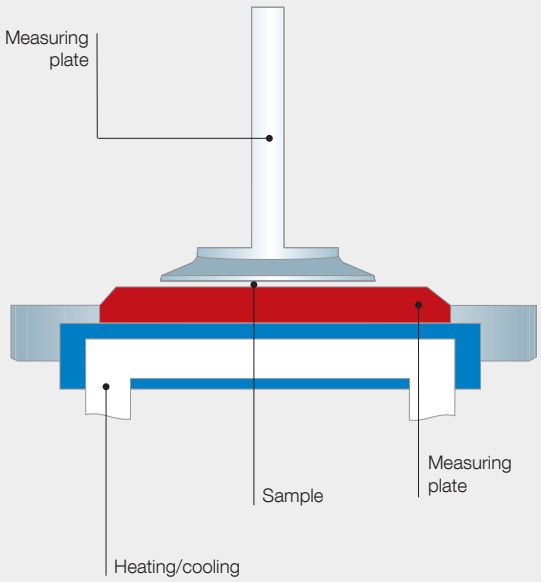
T-Ready™

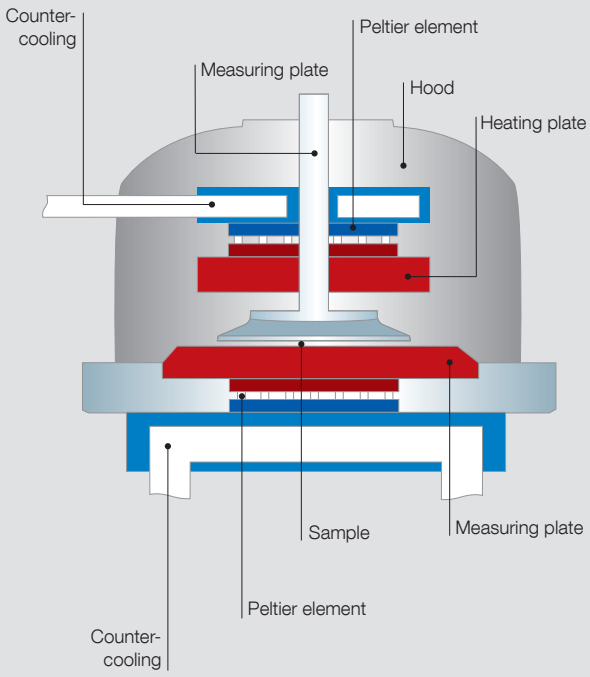
Time-saving temperature certainty

In addition to accurate temperature control, knowledge of the sample temperature equilibration is essential. The new T-Ready™ feature employs TruGap™ functionality to give a green light at the precise moment the desired sample temperature has been reached. Unnecessarily extended waiting times before tests are eliminated.



Four Principles Working for You





Liquid temperature control

Fluid circulators are an established solution for accurate temperature control of the lower measuring plate at a low purchasing cost.

Since the inertia of the large volume of liquid does not allow for rapid temperature changes, liquid temperature control is best suited for measurements at a constant temperature.

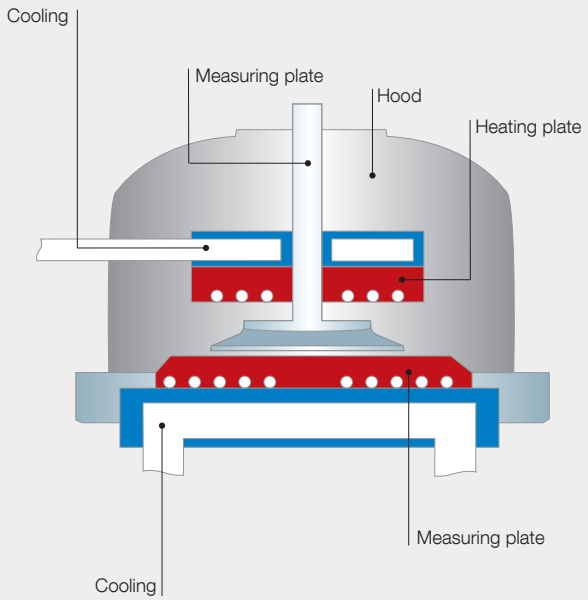
Depending on the fluid circulator and circulating liquid you use, available temperatures range from -30 °C to 180 °C. The MCR series' application software controls various circulators from different manufacturers for running temperature programs.

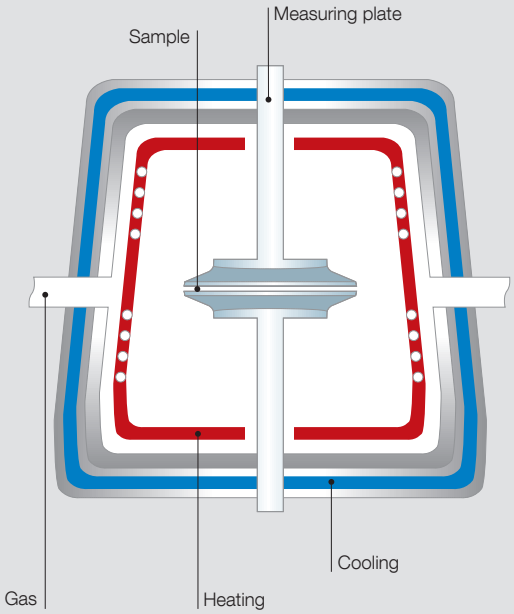
Peltier temperature control

Peltier systems have a number of advantages over other temperature control methods: They are compact, easily installed and do not require any additional controller.

Peltier temperature devices can be used for both heating and cooling, since they employ a thermo-electrical effect. The devices' extraordinarily high heating and cooling rates (up to 60 °C/min) allow rapid and precise temperature control.

To eliminate temperature gradients in the sample, Anton Paar provides patented Peltier-controlled hoods (US Patent 6,571,610). Minimized gas flow in the sample chamber further improves temperature distribution and reduces temperature gradients in the sample to a minimum. Peltier temperature devices are suitable for the majority of rheological measurements.





Electrical temperature control

Electrical temperature control is mainly used for higher temperatures and offers high heating rates. Due to its optimized temperature control methodology, this system is ideal for the investigation of temperature-dependent rheological properties.

Electrical temperature devices are also used for material characterization at constant high temperatures. To prevent considerable gradients in the sample due to the large temperature difference from the ambient temperature, an additional heated hood should be used. Minimized gas flow in the sample chamber further improves temperature distribution and reduces the temperature gradients in the sample to a minimum.

The temperature range of these systems spans from ambient temperature up to 400 °C. Liquid nitrogen cooling in combination with the Evaporation Unit extends the temperature range down to -150 °C.

Convection temperature control

The high-performance convection temperature devices are an ingenious combination of the advantages of electrical and convection temperature control: high temperatures, rapid heating and uniform temperature distribution within a large sample volume.

The devices consist of two half-shells in which a convection gas is heated. The gas flow in the sample chamber is completely symmetric, ensuring perfect temperature distribution in the sample across the entire temperature range.

The operating temperature of the CTD systems goes up to 1000 °C, depending on the device you use. Cooling options are liquid nitrogen evaporation down to –150 °C or built-in Peltier systems.

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