Anton Paar

Multiwave PRO

Microwave Reaction System for
Sample Preparation

::: Clear Solutions in Sample Preparation

Multiwave PRO

The Master of Sample Preparation Methods

The Multiwave PRO microwave reaction system delivers the sample preparation solutions you need to obtain excellent trace analysis results, even with complicated, demanding samples. Multiwave PRO masters high temperatures and provides comprehensive reaction control features. Its wide range of accessories allows digestion, leaching, oxygen combustion, solvent extraction, drying, evaporation, and UV digestion with one single system.

Advanced technology

Anton Paar has been working in the field of microwave technology for more than three decades. Using high-quality materials and innovative solutions, Anton Paar defines the standard for top-level instruments. Multiwave PRO is designed to be an extendable platform. This brochure focuses on the use of Multiwave PRO as a microwave reaction system for demanding applications in sample preparation for trace analysis professionals.

Secure investment

Once installed, Multiwave PRO keeps your costs down: its low operation costs and low costs for consumables result in a truly economical and sustainable investment. To ensure this, Anton Paar provides consumables and spare parts for many years. Anton Paar's 90 years of experience in smart engineering and consistent use of high-quality components means you can rely on Multiwave PRO for years of operation.

Close to you

For the entire working life of your Multiwave PRO, specialists from Anton Paar are at your service. With subsidiaries and sales partners worldwide, you are close to an experienced team which speaks your language and provides application support and training. Quick and efficient service reduces downtimes to a minimum.

For Your Demanding Samples

➤ Acid digestion: Quick and hot

Multiwave PRO handles complete acid digestion of samples in a fraction of the time required by conventional techniques. Routinely providing temperatures up to 300 °C, Multiwave PRO successfully digests even the most demanding materials.

➤ Digestion of high sample amounts: Robust and fast

The innovative pressure-activated venting concept provides easiest handling, routine digestions of high sample amounts (up to 2 grams) and enables the digestion of samples with different reaction behavior in the same run.

➤ Solvent extraction: Rapid

Applying high pressure allows extractions at temperatures far above the solvent's normal boiling point. Multiwave PRO drastically reduces the reaction times compared to conventional methods.

➤ Oxygen combustion: Unique and brilliant

A unique accessory allows you to burn pelletized samples in pure oxygen above 1000 °C. Analytes are absorbed in small amounts of liquid, making this procedure quick, clean and safe.

➤ UV digestion: Unrivaled

A unique accessory produces intense UV radiation inside liquid samples. Radicals destroy organic matter within minutes, almost without acid.

➤ Additional methods: Drying, acid evaporation and protein hydrolysis

Multiwave PRO supports unique additional methods around acid digestion, all in one system. This includes drying samples before digestion and evaporation of acids after digestion. It also provides acid hydrolysis of proteins for structural analysis in biotechnology.

Solutions at their Best
Flexible and Extendable

The broad range of accessories on offer for Multiwave PRO gives you maximum flexibility in your choice of configurations. The same microwave system can be used for digestion, extraction, evaporation, leaching, oxygen combustion, drying and UV digestion. You can easily add other rotors at a later date.

➤ True power

To sustain an output level of 1500 W (IEC 705) over years, Multiwave PRO is equipped with two reliable magnetrons of 850 W each. Unpulsed microwave power over the whole range ensures precise control of critical reactions.

➤ Convenient tool-free handling

Opening and sealing Multiwave PRO's rotors, vessels and sensors is quick and simple - just use your hands. This tool-free handling is unique to Anton Paar and simplifies this frequently repeated work step.

➤ Dual reaction control for closed-vessel applications

Multiwave PRO has a dual solution for reaction control: an immersing temperature probe with integrated pressure sensor is positioned in one reference vessel and infrared sensors are located underneath the rotor to simultaneously measure the temperature and pressure of each vessel. This precise control of the temperature and pressure is essential for reproducible results and ensures safe processes every time.

For convenient handling, the sensors transfer values to the Multiwave PRO wirelessly, so you do not need to connect cables before loading the rotor.

➤ Controlled overpressure release

The SMART VENT technology enables precise pressure control in each vessel. Overpressure is safely released, afterwards and the vessels are automatically resealed again, with the result of significantly increased digestion temperatures.

➤ Ready-to-use application library

A comprehensive library of tested methods gives you ready-to-use applications for a wide range of samples, including EPA methods. Adapting methods or creating new ones requires just minutes. Full application support for method creation is available at any time from Anton Paar.

➤ Cooling: fast and quiet

The integrated forced-air cooling system with unique air gap design cools the vessels within minutes after heating cycles. This optimized cooling results in short process times and increased working life of key components. You do not need to handle hot pressurized vessels or connect an external cooling unit.

➤ Get in touch

Multiwave PRO has a large color touchscreen for convenient operation. The remote access via VNC allows you to easily operate Multiwave PRO from your computer, notebook or mobile phone.

➤ Safety without compromise

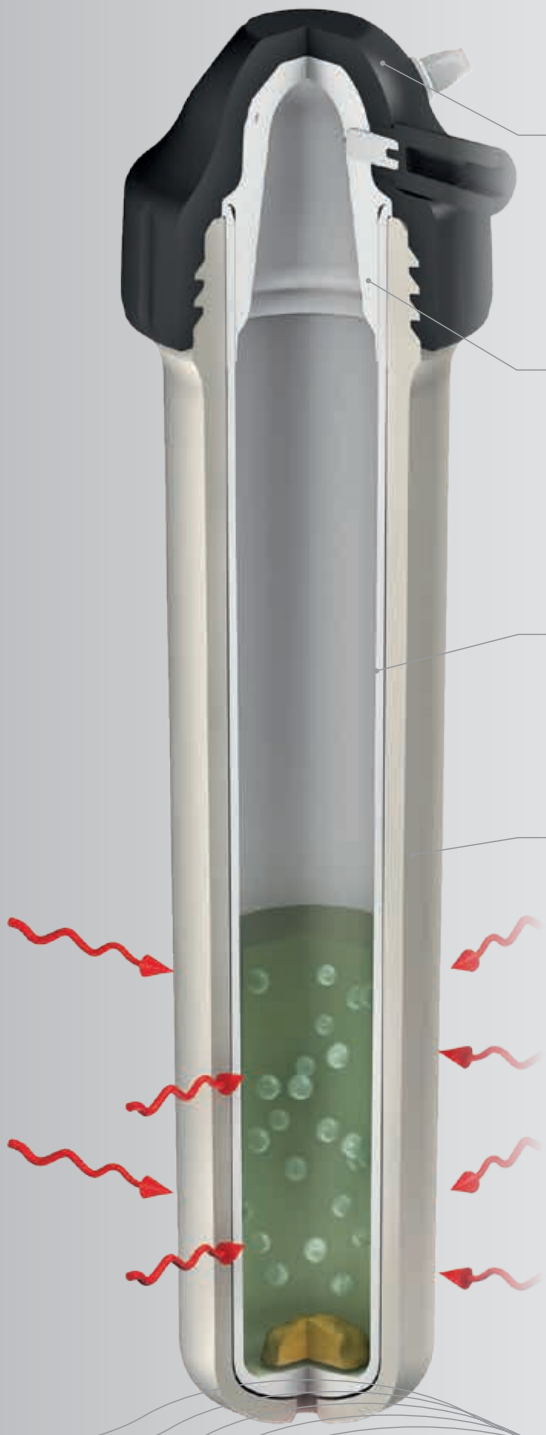
Numerous active and passive safety features protect the system, operator and surroundings in all situations. Multiwave PRO comes with built-in safety features. The pressure of each reaction vessel is measured approx. 50 times per second, which enables Multiwave PRO to also keep fast reactions within safe operating limits. The steel-reinforced door automatically reseals the cavity after a pressure release. Additional devices for releasing overpressure are built into the vessels.

Certified safety system: Only Multiwave PRO comes with ETL and GS ("approved safety") certificates.

Reaction Vessels

The reaction vessel is the heart of Multiwave PRO and the key to successful sample preparation.

Closed-vessel technology for high demands



Vessel cap

- Only 2 turns to tightness: the cap is simply screwed on by hand.
- No exposure to hazardous reaction gases: pressure release and venting of gases before you open the rotor.

Lip-type seal

- Chemically inert and clean: made of high-purity PTFE-TFM.
- Hermetically sealed within seconds: no loss of volatile analytes
- A long-life metal safety disk protects the vessel in case of overpressure.
- No risk of contamination and high overpressure tolerance.

Liner

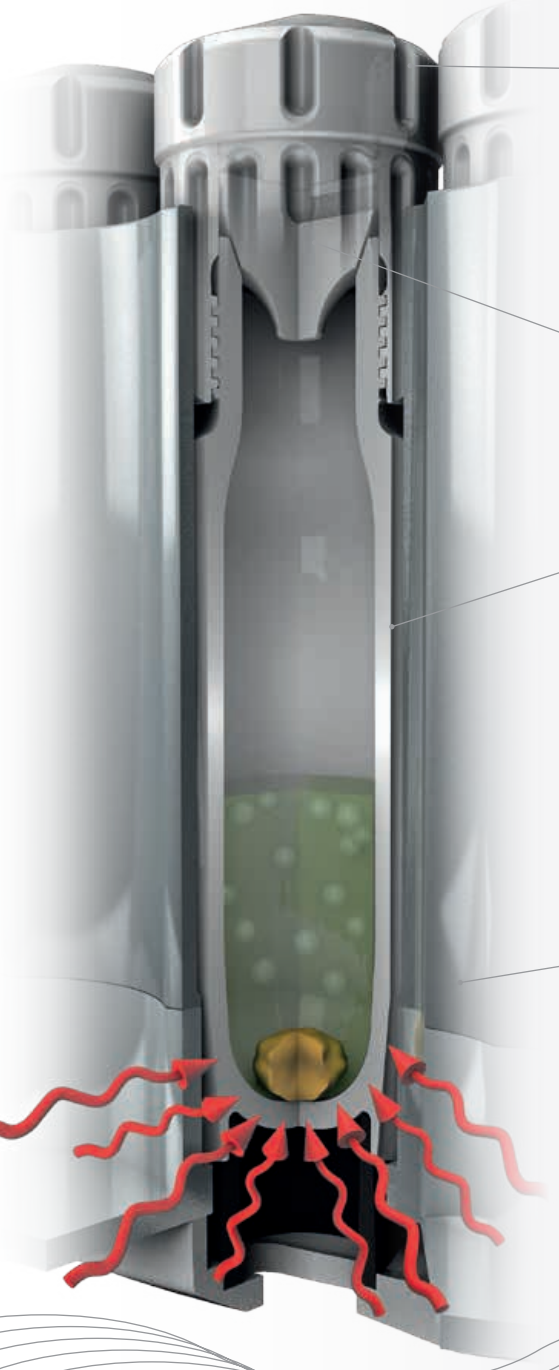
- Chemically inert and clean: made of high-purity PTFE-TFM.
- Interchangeable: suitable for most rotors and methods.

Pressure jacket

- Withstands the highest vessel pressures: made of fiber-reinforced PEEK or aluminum oxide ceramics.
- For digestions which require maximum temperature and pressure simultaneously: strong quartz glass vessels.
- Significantly reduces the overall process time: rapid cooling of the vessel through the pressure jacket.

Multiwave PRO's wide range of vessels and rotors results in a flexible platform which allows you to select the best-suited system for a wide variety of organic and inorganic sample types.

Closed-vessel digestion with SMART VENT technology for high sample amounts



Vessel cap

- Chemically inert and clean: made of high-purity PTFE-TFM.
- Reliable pressure control via.
- Safe overpressure release.
- Tool-free vessel handling: only 2 turns to tightness.

Seal

- Chemically inert and clean: made of high-purity PTFE-TFM.
- Fail-safe and robust design for highest convenience.
- Simply placed on vessel body - no additional handling required.

Vessel body

- Chemically inert and clean: made of high-purity PTFE-TFM.
- Integrated cooling fins enable fastest cooling and shortest process times.
- Flat bottom for easy weighing: vessel can be directly placed on balance.
- Internal vessel temperature can be determined and controlled via the IR sensor.

Compact aluminum rotor

- Mechanical support for vessels: increased pressure stability.
- Focuses microwave field on sample region for highly efficient heating.
- Directs air flow along vessels for shortest cooling times ever.

Acid Digestion Rotors: High Performance

Choose from these rotors for high-performance digestion:

➤ High-end

Use **Rotor 8N** to obtain the highest digestion quality. Rotor 8N masters temperatures up to 300 °C at pressures up to 80 bar. Continuous pressure monitoring of all eight sample vessels ensures safe and precise reaction control, even with critical samples.

The high-end rotors can withstand the highest temperatures for extended periods of time. This makes even the toughest materials soluble.

➤ Workhorse

Take advantage of the **16-position rotors** to increase your productivity in high-performance routine applications.

A selection of interchangeable pressure jackets, liners and seals make it possible to digest a wide range of sample types, ranging from environmental samples to biological material, food to metals, alloys to geological materials. Even solvent extraction is covered.

➤ Large sample amounts

The Rotor 24HVT50 with vessels using SMART VENT technology offers you precise pressure control and the possibility to routinely digest large amounts of your samples. The 24 positions in combination with fastest cooling and heating times ensure outstanding sample throughput. The robust and fail-safe three-part vessel system was designed for your utmost convenience.

➤ High throughput

The **48-position rotor** meets the demand for high sample throughput and eliminates your bottlenecks in sample preparation.

Convenient and quick tool-free handling is ensured by the ready-assembled screw cap with cone-type seal.

➤ Microsamples

Requiring up to 20 mg of sample and approx. 1 mL of acid, the **64-position rotor** is unique for the large-scale digestion of microsamples, e.g. for biological materials.

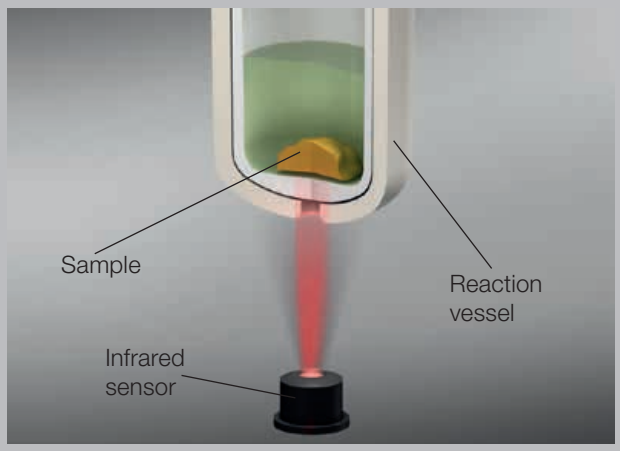
Technical Data

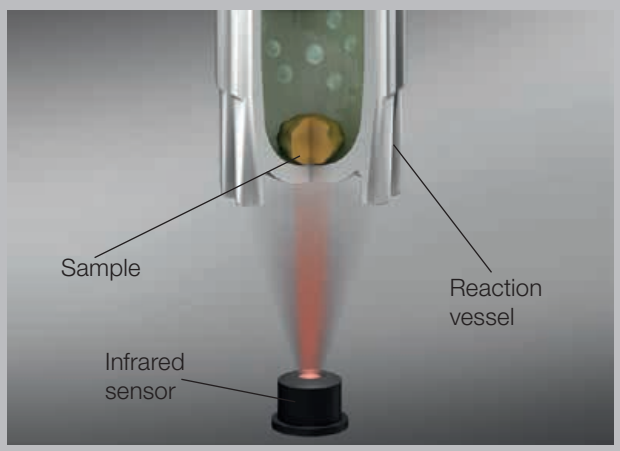
Rotor	64MG5	48MF50	24HVT50	16MF100	16HF100	8NXF100	8NXQ80
No. of vessels	64	48	24	16	16	8	8
Reaction control	Temperature control in 16 positions		Temperature control in all positions			▸ Temperature and pressure control in all positions	
Reaction control in a reference vessel	n.a.	Temperature and/or pressure control	n.a.	Temperature and/or pressure control		Temperature control	
Vessels	MG5	MF50	HVT50	MF100	HF100	XF100	XQ80
Liner material	Glass (PTFE seal)	PFA or PTFE-TFM	PTFE-TFM	PTFE-TFM	PTFE-TFM	PTFE-TFM	n/a
Pressure jacket	n.a.	PEEK-GF	n.a.	PEEK-GF	Ceramic	Ceramic	Quartz
Volume	5 mL	50 mL	50 mL	100 mL	100 mL	100 mL	80 mL
HF resistant	No	Yes	Yes	Yes	Yes	Yes	No
Typical applications	Biological material	Various kinds of samples, including water, effluents, sewage sludge, plant material, soil, sediment, US-EPA procedures, biological material, food samples			Various kinds of samples, including contaminated soil, metals, alloys, glass, quartz	All kinds of samples, including ceramics, semiconductors, refractories, ores, slags and ashes	All kinds of samples, including plastics, oil, grease and coal. No samples which require HF usage

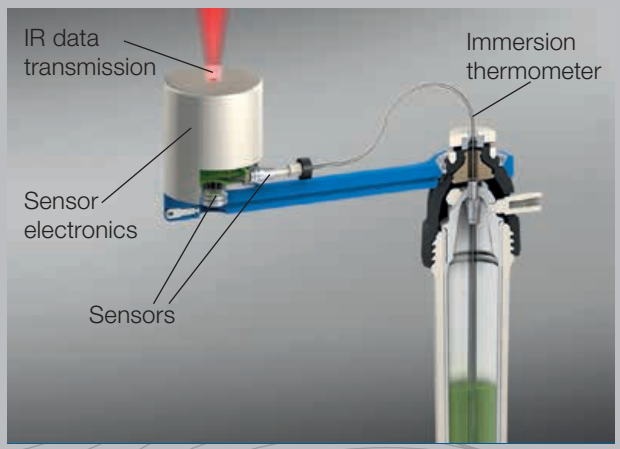
Outstanding Sensor Technology and Reaction Control

To obtain high-quality solutions and ensure safe operation, Multiwave PRO keeps pressure and temperature under control. See here how it works.

Temperature measurement and control







➤ By monitoring the temperature of each vessel with an IR sensor

The result: safe and reliable digestion processes.

An infrared sensor measures the temperature at the base of each reaction vessel. If the temperature rises too high, Multiwave PRO reduces microwave power so that the temperature does not exceed a preset limit.

➤ By controlling the internal temperature of each vessel with an IR sensor

The result: precise control of digestion processes in each vessel.

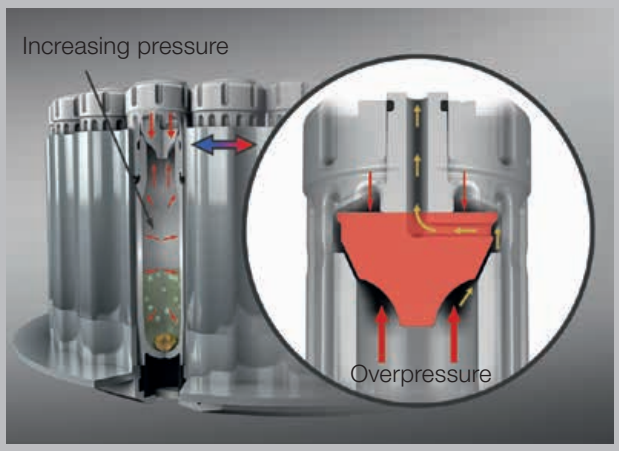
A robust temperature model for the HVT50 vessels provides the internal temperature in each vessel without the need for an optional sensor. The digestion runs can be controlled based on different temperature control strategies. The hottest vessel, the coldest vessel or the average temperature of all vessels can be used as references.

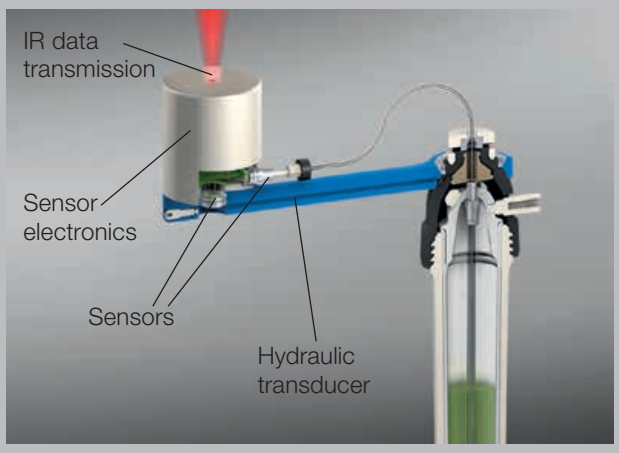
➤ By measuring the temperature in a reference vessel

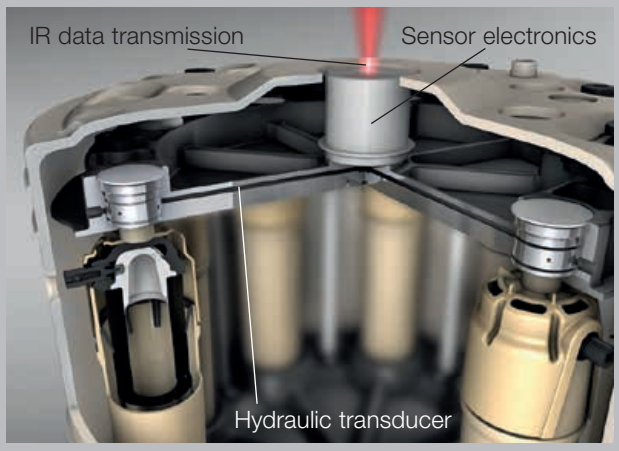
The result: quick and precise control, even of fast and spontaneous reactions.

A temperature sensor is integrated into one of the reaction vessels. With Multiwave PRO you can define temperature ramps, making it a valuable tool for digestion of unknown samples and method development.

Pressure measurement and control







➤ By controlled overpressure release

The result: precise pressure control in each vessel and significantly increased digestion temperatures.

Based on the SMART VENT technology used in the HVT50 vessels the overpressure is safely and reliably released. This concept permits the digestion of extremely large sample quantities.

➤ By measuring the pressure in a reference vessel

The result: quick and precise control, even of fast and spontaneous reactions.

A hydraulic pressure sensor with or without temperature sensor is integrated into one of the reaction vessels. It measures the pressure and the pressure increase rate every 20 milliseconds. If one of the preset limits is exceeded, the microwave power is immediately reduced and, if required, the cooling effort is increased.

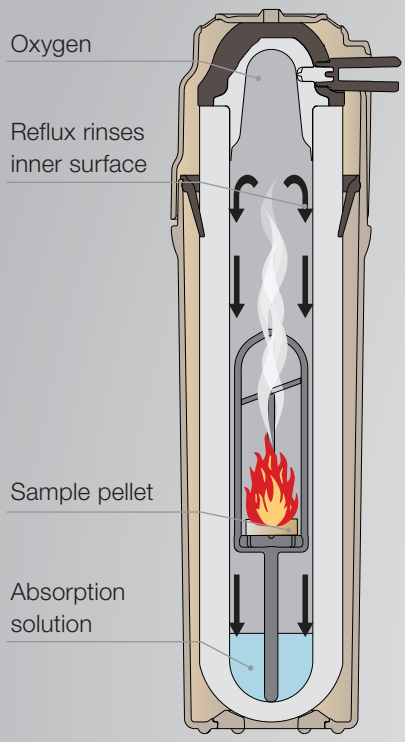
➤ By measuring the pressure in all vessels every 20 milliseconds

The result: An extremely quick and simultaneous pressure measurement allows you to apply the highest possible temperatures for acid digestion.

Critical situations emerging from spontaneous reactions, for example. are intercepted due to the high frequency of pressure measurements. Multiwave PRO immediately reduces microwave power and the unwanted reaction is stopped before it leads to pressure release.

Special Solutions

Some samples require special treatment. Multiwave PRO provides unique methods which are efficient alternatives to digestion.



You want to digest combustible solids quickly and cleanly?

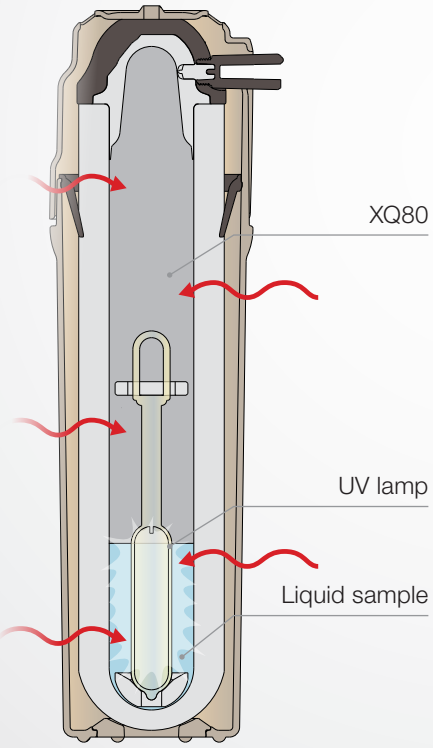
Microwave-induced oxygen combustion (MIC)

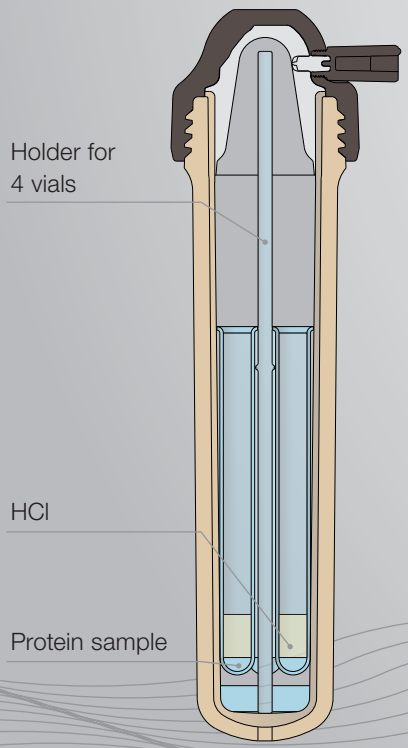
- Unique, clean and quick method.
- Halogens or metals are trapped in a low-concentration absorption solution which can be measured without dilution.
- Suitable for all combustible solids such as wood, paper, coal, food or polymers.
- Parallel combustion of up to 8 samples in highly resistant quartz vessels.
- It replaces steel combustion bombs.

You need to digest liquid samples containing organic compounds?

UV digestion

- Unique microwave-powered UV lamps produce radicals which digest the sample.
- The resulting low-concentration solution can be measured without dilution.
- For ultra-trace analysis of e.g. seawater, effluents, sewage, body fluids or beverages.
- Low analytical blanks.





You want to run protein hydrolysis in a fraction of the time?

Microwave-assisted protein hydrolysis

- Reduction of the overall process time to less than one hour, compared to several hours with classical thermal methods.
- Precise temperature measurement ensures accurate reaction control.
- For milligram to gram amounts.
- Use of disposable glass inserts.
- No cross-contamination between vessels.
- Inert gas atmosphere can be applied.

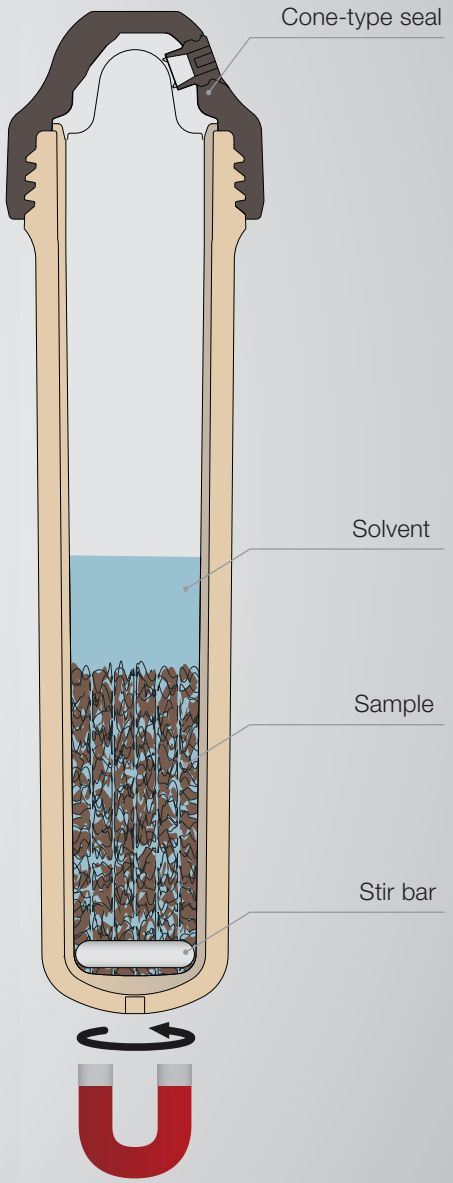
Extraction

Multiwave PRO supports more than just digestion procedures. Microwave-Assisted Extraction (MAE) improves both the performance and throughput of HPLC- or GC-based analysis.

➤ You want to extract organic trace compounds?

Microwave-assisted extraction

- Microwave-assisted extraction with Rotor 16SOLV replaces slow and tedious classical solvent extraction methods.
- It significantly reduces extraction times from hours to minutes.
- For extractions of PCBs, PAHs and hydrocarbons from environmental and food samples, derivatization reactions prior to analysis and polymer extractions.
- High sample throughput: up to 16 samples simultaneously.
- Optional magnetic stirring increases recoveries.
- Rotor 16SOLV is equipped with the same rotor and vessels as for digestion.
- Cone-type seal for quick handling without tools.
- Meets the requirements of **US-EPA** and **ASTM** methods.
- Precise temperature and pressure control in closed vessels allows extractions in 15 to 30 minutes.



➤ You need to use non-polar solvents?

Passive heating elements

- For non-polar solvents such as hexane and toluene.
- Heating without contamination.
- Made of silicon carbide (SiC): inert, stable and clean.
- Can be reused.
- Provide excellent coupling efficiency.

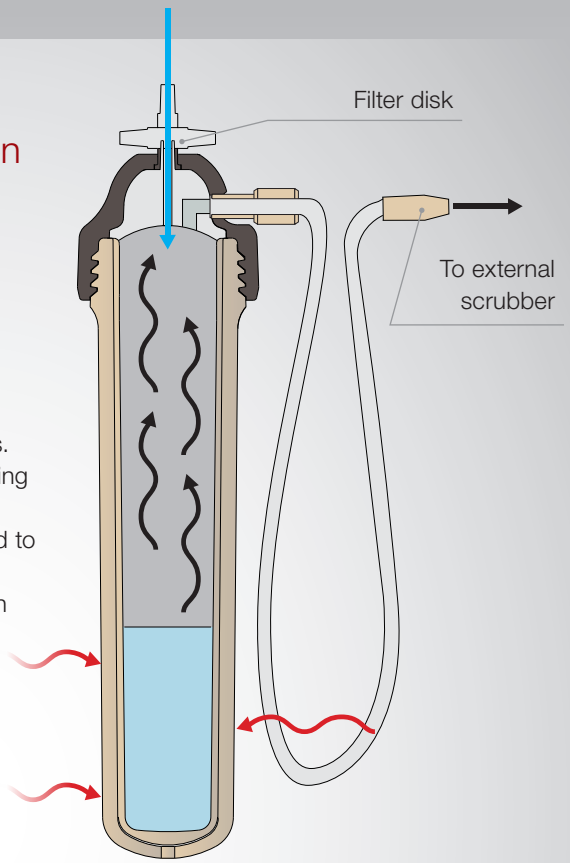
Evaporation & Drying

Concentration of aqueous samples, drying of sample material prior to digestion and removal of acids after digestion can be undertaken with Multiwave PRO in a fraction of the time required by conventional techniques.

➤ You want to accelerate your evaporation procedures?

Microwave-assisted evaporation

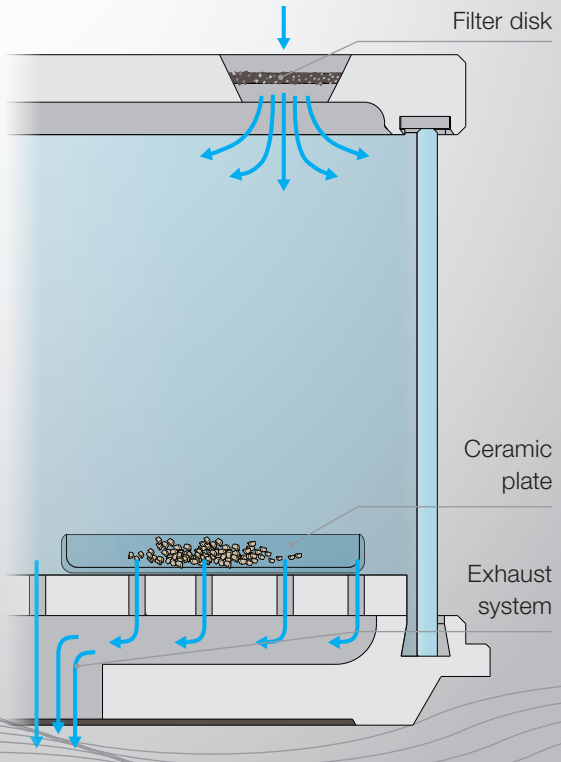
- Rotor 8EVAP simplifies and accelerates the microwave-assisted evaporation of acids and concentration of aqueous sample solutions.
- After digestion, acids can be fumed off directly from reaction vessels under controlled clean-room conditions.
- The external scrubber neutralizes the acid vapors, washing out up to 95 %.
- Prior to digestion, sample solutions can be concentrated to increase analyte levels and improve digestion efficiency.
- After evaporation, just transfer the liner into the digestion rotor.



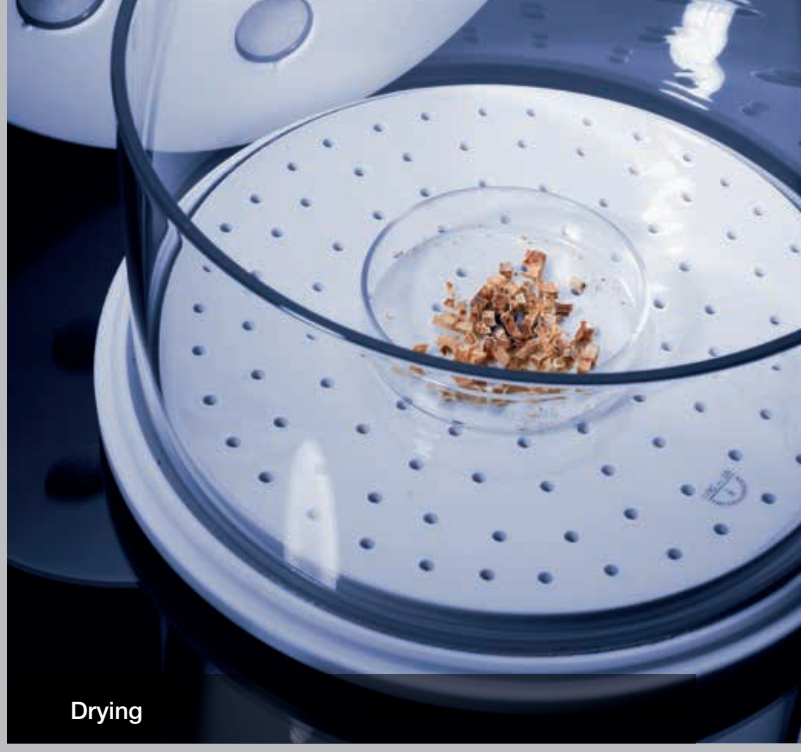
➤ You want to dry samples before digestion?

Microwave drying

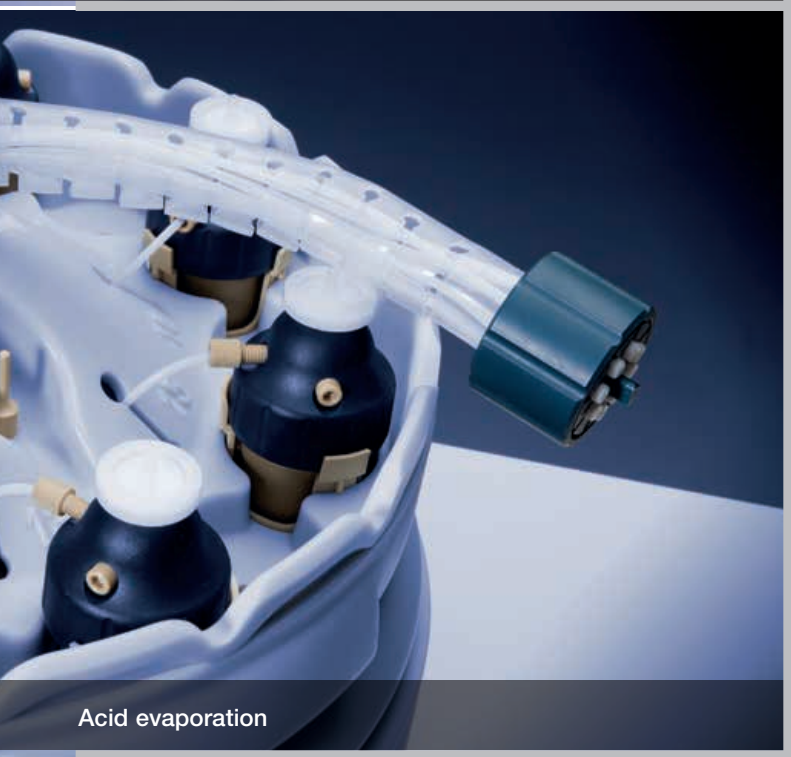
- **Rotor 1DRY** efficiently dries samples.
- Microwave drying with Multiwave PRO takes a quarter of the time required by conventional methods.
- It provides samples without carbonization or contamination.
- The exhaust unit of Multiwave PRO removes humidity and unwanted odors.



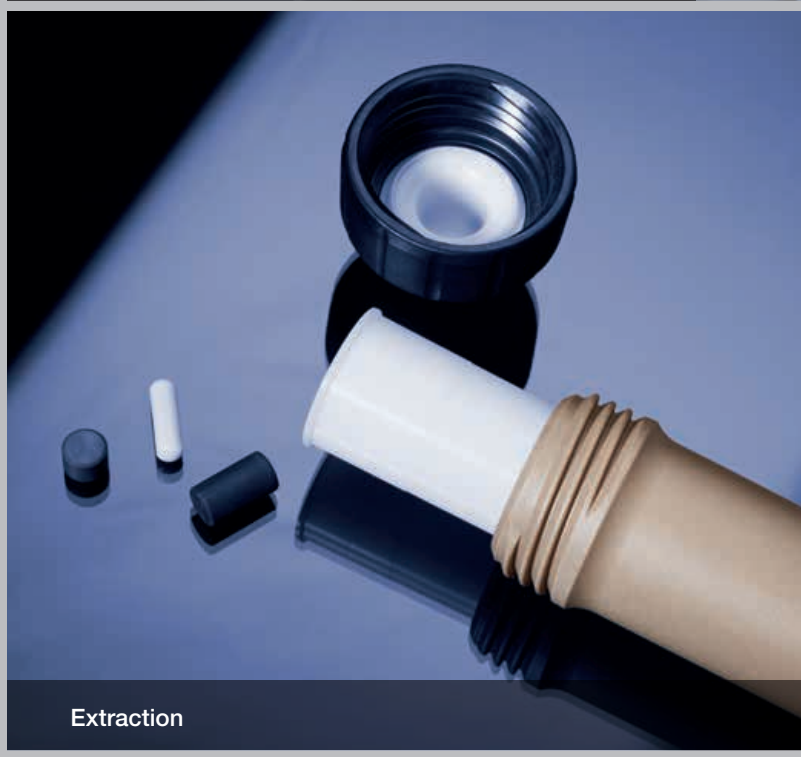
Hydrolysis



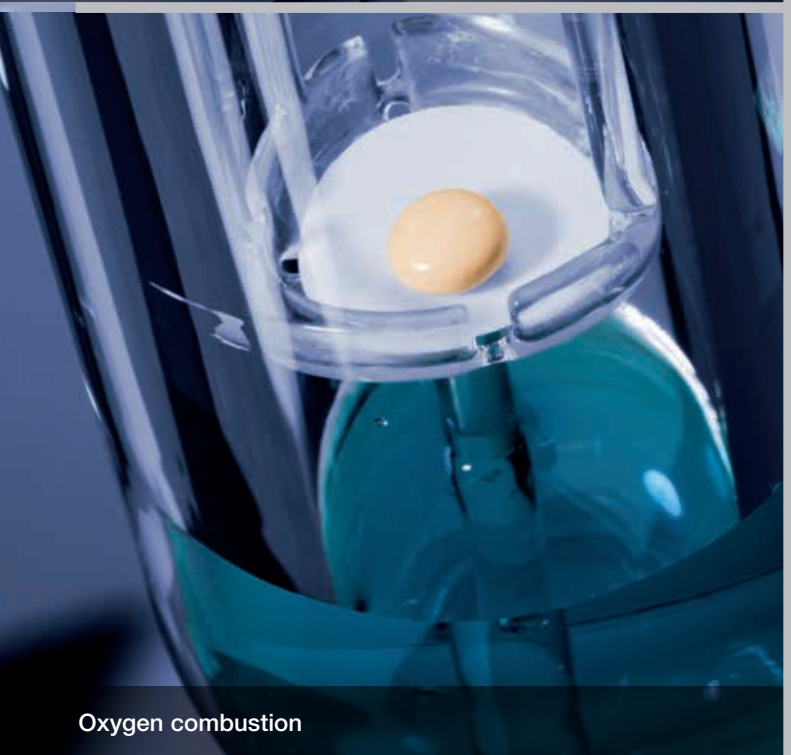
Drying



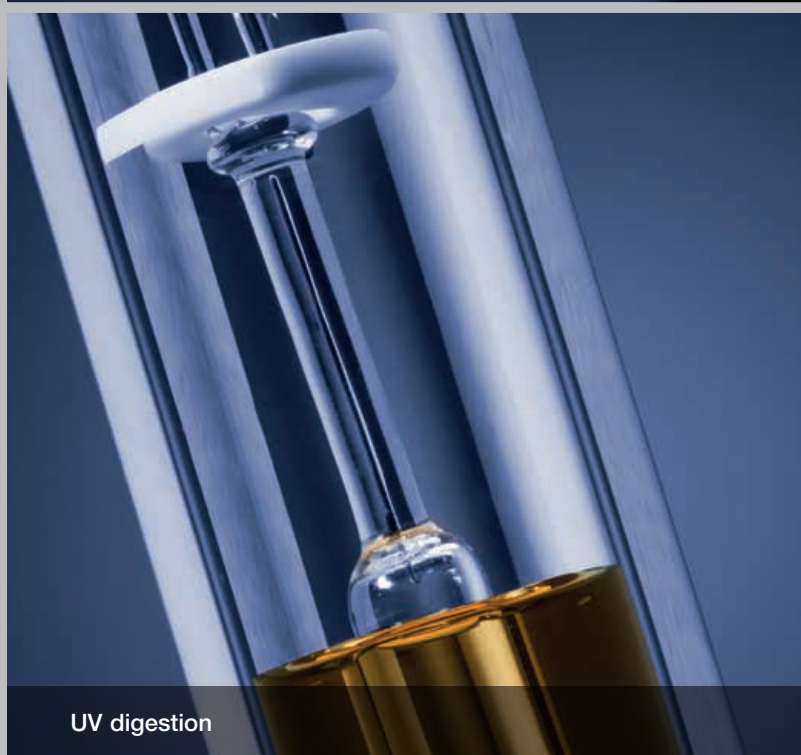
Acid evaporation



Extraction



Oxygen combustion



UV digestion

Subject to change without notice
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