

BERGHOF PRODUCTS + INSTRUMENTS GMBH

Speedwave

Microwave digestion for all requirements

Speedwave



BERGHOF

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speedwave microwave digestion

The matching device for every
microwave digestion task

BERGHOF PRODUCTS + INSTRUMENTS GMBH

Our philosophy

The philosophy of Berghof Products + Instruments GmbH can be summed up concisely: Adding value for our customers. Even in the product development stage, we attach great importance to designing reliable, easy-to-operate and safe instruments, which optimally satisfy the demands of our customers. Through our application expertise, we can create products as we ourselves and our customers want them: high-performance, safe and durable.

Digestion devices for all requirements

With over 50 years of experience, Berghof offers comprehensive expertise in the production of digestion systems used to prepare samples for subsequent elemental analysis. The needs of the users are at the core of our work. Intensive dialogue with our customers lets us develop innovative products with a variety of application options.

Our specially trained authorised representatives are pleased to give you the best possible advice. You can find your contact at www.berghof-instruments.com/en/contact.

Berghof digestion technology

Microwave digestion and pressure digestion



Microwave digestion **speedwave XPERT**

Innovative technologies for reliable digestions

Maximum flexibility for digestions up to 260°C and 100 bar

More information starting on page 8

Microwave digestion **speedwave ENTRY**

Focused on the essential

For routine digestions up to 230° C and 75 bar

More information starting on page 14

Pressure digestion **DAB-2 | DAB-3**

Reliability in the most difficult digestion tasks

For difficult digestions up to 250°C and 200 bar

More information is available in the brochure *Pressure Digestion Systems and Metal-free Reactors*

speedwave microwave digestion

Technical specifications

speedwave XPERT - Innovative Technologies for Reliable Digestions



speedwave XPERT

| | | | | | |
|---------------------------------------|---|---|---------|--------|---------------------|
| Loading | From the top | | | | |
| Pressure monitoring | Optical in real-time; each vessel | | | | |
| Vessel temperature measurement | Optical in real-time; maximum temperature | | | | |
| Sample temperature measurement | Optical in real-time; each sample | | | | |
| Magnetron power | 2,000 W (2 x 1,000 W) | | | | |
| Temperature range | 50° C to 350° C | | | | |
| Dimensions | Basic instrument: | 880 x 645 x 480 mm (W x D x H) with neutralization unit | | | |
| | Control unit: | 224 x 137 x 152 mm (W x D x H) | | | |
| Weight | Basic instrument: | Approx. 59 kg | | | |
| | Control unit: | 1 kg | | | |
| Oven chamber | Approx. 26 l Round microwave oven for homogeneous microwave distribution and even heating of all samples | | | | |
| Oven chamber coating | 90 µm PFA | | | | |
| Interfaces | USB, RS-232, 2 x Ethernet (also for printer connection), control via mobile devices possible | | | | |
| Vessel options | DAP-40X | 40 ml | 40 bar | 230° C | 24 vessels/turtable |
| | DAP-60X | 60 ml | 40 bar | 230° C | 12 vessels/turtable |
| | DAP-100X | 100 ml | 40 bar | 200° C | 12 vessels/turtable |
| | DAK-100X | 100 ml | 100 bar | 260° C | 8 vessels/turtable |
| Range of applications | Applicable for many types of samples, high level of flexibility for digestions at high temperature and pressure | | | | |

speedwave ENTRY - Focused on the Essential



| speedwave ENTRY | | | | | |
|---------------------------------------|---|--------------------------------|--------|--------|----------------------|
| Loading | From the front | | | | |
| Pressure monitoring | - | | | | |
| Vessel temperature measurement | - | | | | |
| Sample temperature measurement | Optical in real-time; maximum temperature | | | | |
| Magnetron power | 1,000 W | | | | |
| Temperature range | 75° C to 260° C | | | | |
| Dimensions | Basic instrument: | 510 x 470 x 330 mm (W x D x H) | | | |
| | Control unit: | 190 x 115 x 170 mm (W x D x H) | | | |
| Weight | Basic instrument: | Approx. 22 kg | | | |
| | Control unit: | 1 kg | | | |
| Oven chamber | Approx. 32 l 355 x 365 x 251 mm (W x D x H) | | | | |
| Oven chamber coating | - | | | | |
| Interfaces | USB, RS-232 | | | | |
| Vessel options | DAP-60K | 60 ml | 40 bar | 230° C | 10 vessels/turntable |
| | DAQ-10 | 10 ml | 75 bar | 230° C | 24 vessels/turntable |
| Range of applications | For routine digestion tasks, ideal for education and universities | | | | |

speedwave microwave digestion

Application overview

Berghof Products + Instruments GmbH has built up a continuously growing database of reference applications. These include a full process description for a wide variety of sample types. Examples of the application ranges for the **speedwave** microwave systems are shown in the following tables.

Food & feed



Pharmaceuticals & cosmetics



APPLICATIONS ACCORDING TO DEVICE

| SAMPLE TYPE | XPERT | ENTRY |
|-----------------|-------|-------|
| Beverages | ✓ | ✓ |
| Animal products | ✓ | ✓ |
| Milk products | ✓ | ✓ |
| Fruit | ✓ | ✓ |
| Coffee | ✓ | ✓ |
| Beer | ✓ | ✓ |
| Cereals | ✓ | ✓ |
| Nutrients | ✓ | ✓ |
| Coconut oil | ✓ | ✓ |
| Animal feed | ✓ | - |
| Fish food | ✓ | - |
| Lactose | ✓ | - |

APPLICATIONS ACCORDING TO DEVICE

| SAMPLE TYPE | XPERT | ENTRY |
|--------------------------------|-------|-------|
| Blood | ✓ | ✓ |
| Hair | ✓ | ✓ |
| Bone | ✓ | ✓ |
| Products with high fat content | ✓ | - |
| Body lotion/creams | ✓ | - |
| Lipstick | ✓ | - |
| Toothpaste | ✓ | - |
| Algae | ✓ | - |
| Tablets | ✓ | - |
| Nail polish | ✓ | - |
| Perfume | ✓ | - |
| Lactose, dextrose, sucrose | ✓ | - |
| Ointments | ✓ | - |

Environment & geology



Technology



APPLICATIONS ACCORDING TO DEVICE

| SAMPLE TYPE | XPERT | ENTRY |
|-------------------|-------|-------|
| Filter/emissions | ✓ | ✓ |
| Sediments | ✓ | ✓ |
| Soil | ✓ | ✓ |
| Sludge | ✓ | ✓ |
| Waste water/water | ✓ | ✓ |
| Wood | ✓ | ✓ |
| Minerals | ✓ | - |
| Stone | ✓ | - |
| Ash | ✓ | - |
| Oil | ✓ | - |
| Carbon | ✓ | - |
| Concrete | ✓ | - |

APPLICATIONS ACCORDING TO DEVICE

| SAMPLE TYPE | XPERT | ENTRY |
|-------------|-------|-------|
| PET | ✓ | ✓ |
| Polyester | ✓ | ✓ |
| Bronze | ✓ | ✓ |
| Ceramic | ✓ | - |
| Polymers | ✓ | - |
| Metals | ✓ | - |
| Alloys | ✓ | - |
| Cement | ✓ | - |
| Leather | ✓ | - |
| Ink | ✓ | - |
| Melamine | ✓ | - |

speedwave XPERT - Product Benefits

Innovative Technologies for Reliable Digestions

The **speedwave XPERT** sets new standards in sample preparation. Due to innovative sensor technology and high-quality components, you not only achieve reliable and reproducible digestions. Low material wear and the outstanding lifetime of the vessels reduce sample preparation costs.



PHARMA CONFORM

A software package compliant with 21 CFR Part 11 is optionally available for the **speedwave XPERT**. The software package covers user management, password protection, audit trail and documentation as well as export and print functions.

An IQ/OQ package is also available for the **speedwave XPERT**. This qualification package ensures that the **speedwave XPERT** meets legal requirements.

The combination of the 21 CFR Part 11 compliant control software and the IQ/OQ package allows consistent traceability and documentation of the use of the **speedwave XPERT**. This guarantees that the **speedwave XPERT** fulfils internationally valid pharma regulations, especially those of the FDA and GLP/GMP or GAMP.

SAFE

Maximum safety for users

- SwingTop loading and electronic cover lock
- Automatic regulation and shutdown of processes, in case of exothermic reactions, due to optical pressure control (OPC)
- Permanent ventilation of the oven chamber and removal of generated acid fumes by the fume collection system



REPRODUCIBLE

- No cross contamination due to minimal surface porosity of TFM-PTFE vessels
- Homogenous distribution of microwave radiation due to the round design of the oven chamber
- Permanent pressure and temperature control by optical sensors

ECONOMICAL

- Outstanding lifetime of vessels (up to 10,000 digestion cycles)
- Protection of the vessels against damage by optical pressure control (OPC) and temperature control (OTC)
- Corrosion protection of the oven chamber due to the high-quality PFA coating

VERSATILE

Numerous application options

- Suitable pressure vessels and liners for every application
- Extension of the application range using optional accessories, such as multi tube systems or filter holders
- Safe evaporation of the acid after digestion using an optional evaporation unit



USER FRIENDLY

Helpful features for intuitive operation

- Opening and closing of vessels without tools
- 7" touch controller with graphic illustration and control via mobile devices or PC/notebook
- Due to the use of optical sensor technologies, no additional cables and connections are necessary
- Vessels are removed individually after digestion



speedwave XPERT - Vessel Options

Numerous variants for versatile use

The **speedwave XPERT** vessels are manufactured with the highest quality standards by the Berghof Fluoroplastic Technology GmbH. They are made from high-quality TFM-PTFE and impress through reliability and an outstanding lifetime. Vessel volumes cover a wide range, from 40 to 100 ml. Multi tube systems or quartz glass inserts allow an even more variable use of vessels, thus the **speedwave XPERT** can be used for almost any microwave-digestion application.

APPLICATION ORIENTED

The vessels comprise only few individual parts. They are opened and closed manually and without additional tools. When the vessels are opened, the remaining pressure is released safely and controlled.

All vessels are equipped with a rupture disc as scope of delivery. The disc breaks when the overpressure is too high and allows immediate termination of digestion in case of unexpected exothermic reactions, avoiding expensive consequential damage.



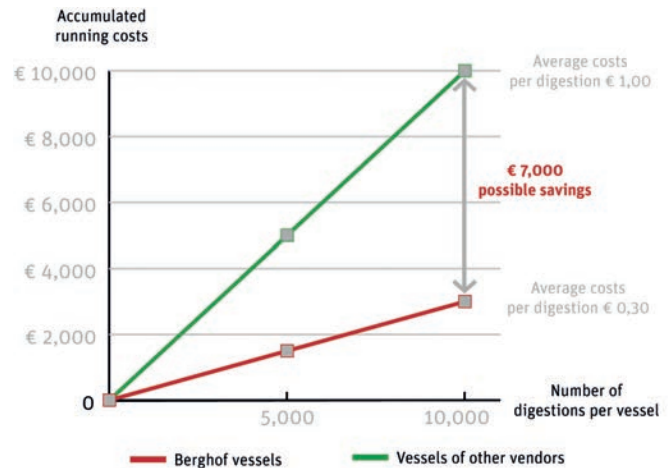
| OVERVIEW VESSEL TYPES | | | | |
|--------------------------------|------------------------------------|------------------------------------|------------------------------------|----------------------------------|
| | DAP-40X | DAP-60X | DAP-100X | DAK-100X |
| Volume | 40 ml | 60 ml | 100 ml | 100 ml |
| Working pressure | 40 bar | 40 bar | 40 bar | 100 bar |
| Test pressure | 50 bar | 50 bar | 50 bar | 130 bar |
| Operating temperature | 230° C | 230° C | 200° C | 260° C |
| Maximum temperature | 260° C | 260° C | 230° C | 300° C |
| Rotor | 24 vessels | 12 vessels | 12 vessels | 8 vessels |
| Original sample weight* | 1 g (inorganic) 0,3 g (organic) | 2 g (inorganic) 0,4 g (organic) | 2 g (inorganic) 0,5 g (organic) | 3 g (inorganic) 1 g (organic) |
| Options | - | DAQ-20H | DAQ-22H DAC-17 MT (10 ml) | MT (10 ml) |

* Weights are reference values. Actual original sample weights may vary, depending on the application and the acid.

COST-OPTIMISED

Vessels from Berghof significantly reduce the running costs for microwave digestions. Due to high-quality processing and outstanding lifetime, the cost per digestion for Berghof vessels is € 0.30 only.

In comparison: Vessels from other vendors generate average costs of € 1.00 per digestion. This means that the running costs can be reduced by approx. € 7,000 for 10,000 digestion cycles.



FLEXIBLE

Berghof offers a unique liner system ① to arrange the **speedwave XPERT** application options even more flexibly. The vessels can be equipped with inserts to support digestion of small sample quantities or complex samples.

| OVERVIEW BERGHOF LINER SYSTEM | | | |
|-------------------------------|------------|------------|------------|
| | DAQ | DAC | MT |
| Volume | 20 ml | 17 ml | 10 ml |
| Working pressure | 130 bar | 100 bar | 100 bar |
| Operating temperature | 230° C | 230° C | 230° C |
| Rotor | 12 vessels | 12 vessels | 36 vessels |

Multi tube system MT

- Ideal for small sample quantities (200 - 250 mg) and to increase the sample throughput up to 36 samples
- Made from premium PFA
- Three samples can be used per vessel

Quartz glass inserts DAQ ②

- Suitable for vessel types DAP-60X and DAK-100X
- Ideal for small sample quantities
- Very high acid resistance

Further solutions from the Berghof liner system

- High pressure ceramic inserts DAC ③ for difficult to digest samples
- Mini vessels for clinical samples

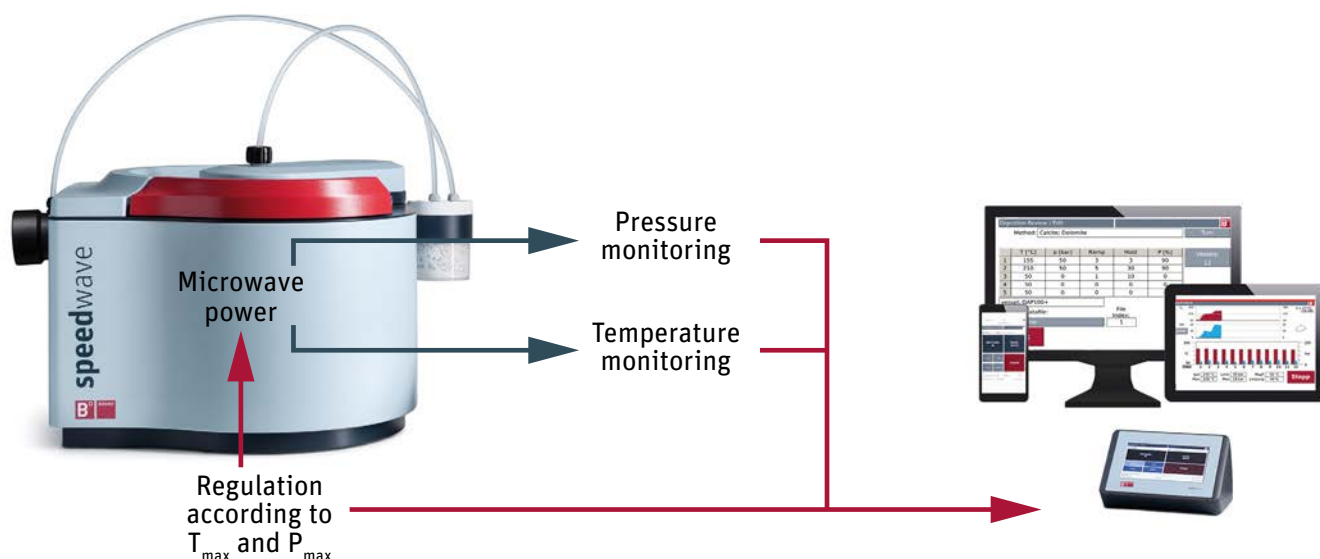


speedwave XPERT - Patented Sensor Technology

Temperature and pressure monitoring

Monitoring of the reaction parameters pressure and temperature in each vessel is essential, as samples rarely react identically during digestion. The temperature of a sample depends, for example, on the sample type and the sample amount.

To reduce safety risks from irregular heating or even spontaneously induced exothermic reactions, it is especially important to monitor the reaction parameters pressure and temperature. The sensor technology developed and patented by Berghof not only measures pressure and temperature, but also controls the microwave power.



ADVANTAGES OF OPTICAL TEMPERATURE AND PRESSURE MONITORING

Monitoring in real-time

The sample temperature, the vessel temperature and the arising pressure are measured without delay by the optical sensors.

Minimization of contamination risk

The optical sensors of the speedwave XPERT do not get into touch with samples. Thereby, the risk of contamination is prevented.

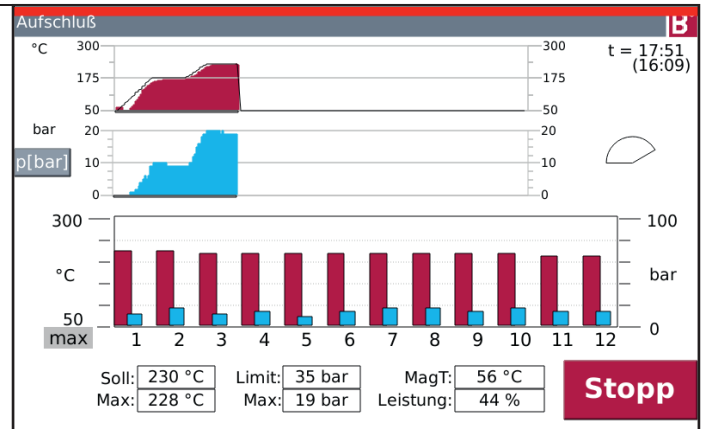
Sample handling

Thanks to the contactless temperature measurement and pressure monitoring, reference vessels must not be cabled additionally or be equipped with temperature probe.

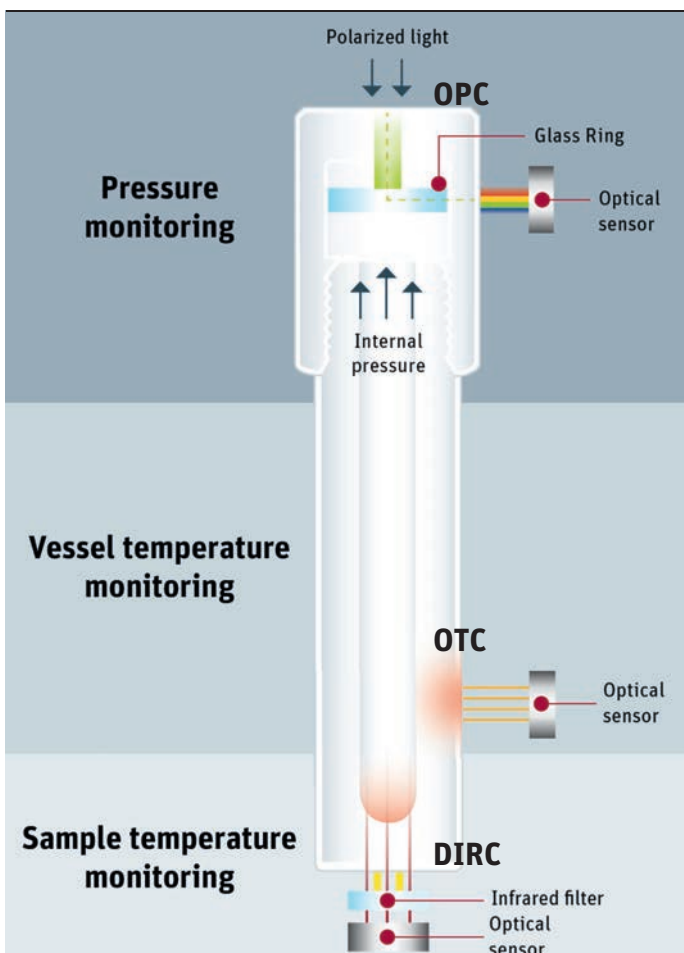
PRECISE

The patented optical sensor technology from Berghof not only allows contactless pressure and temperature monitoring in real-time, but also individual monitoring of all vessels.

Keep track of the digestion process on the 7" display or on connected mobile devices - for each individual vessel. This allows monitoring of all reactions, which creates the basis for reproducible digestions



SENSOR TECHNOLOGY IN DETAIL



Optical pressure control (OPC)

Optical detection of the internal vessel pressure

- Patented technology
- No reference vessels, no evaporation into the oven chamber
- Expandable to several vessels at any time

Optical temperature cut-off (OTC)

Optical detection of the vessel surface temperature

- Increased safety and lifetime of digestion vessels
- Individually programmable upper temperature limit

Direct infrared control (DIRC)

Optical detection of each sample temperature

- Patented temperature measurement process
- No reference vessels

speedwave ENTRY

Focused on the Essential

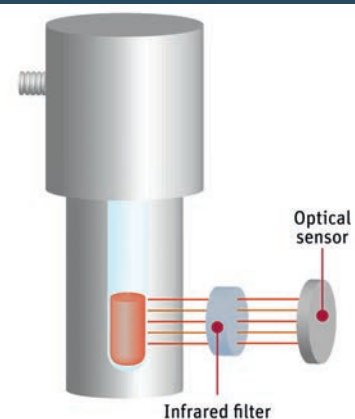
The **speedwave ENTRY** is especially strong in application areas where cost efficiency is essential. It is therefore often used in routine analytics for standardised digestion tasks in research facilities, education and at universities.



Patented sensor technology

The **speedwave ENTRY** also features the patented optical measurement technology speedwave® DIRC, which allows direct and contactless real-time recording of the sample temperature.

In contrast to other methods, the sample temperature is measured with the **speedwave ENTRY** in all vessels, not just in a reference vessel. The maximum sample temperature is displayed.



INTUITIVE

Quick and simple start

- Easy opening and closing of vessels without tools
- Pre-programmed applications for routine analytics
- Start of digestion in just two steps



SAFE

Integrated fume collection and external exhaust unit

- Released fumes are collected and discharged even if the rupture disc breaks
- Permanent ventilation of the oven chamber
- External exhaust unit - recommended when using hydrofluoric and hydrochloric acids



OVERVIEW VESSEL TYPES

| | DAP-60K | DAQ-10 |
|------------------------------|------------|------------|
| Volume | 60 ml | 10 ml |
| Working pressure | 40 bar | 75 bar |
| Operating temperature | 230° C | 230° C |
| Rotor | 10 vessels | 24 vessels |

REPRODUCIBLE & EFFICIENT

- No cross contamination, due to minimal surface porosity of the vessels
- Monitoring of all sample temperatures in real-time
- Outstanding lifetime of vessels (up to 10,000 digestion cycles)

VARIABLE

Intelligent vessel concepts for versatile application options:

- DAP-60K vessels are made completely from TFM-PTFE and show high chemical resistance to all mineral acids as well as high mechanical durability
- DAQ quartz glass inserts allow digestions of small sample amounts



speedwave microwave digestion

Accessories and additions

Making daily work in the laboratory easier - to achieve this goal, Berghof Products + Instruments offers not only instruments for microwave digestion, but also numerous accessories. The portfolio covers many products and services, from an acid purification instrument to an evaporation unit, to make sample-preparation processes more efficient and safe.

CONCENTRATION OF ACIDIC DIGESTION SOLUTIONS

An external evaporation unit can be connected to the **speedwave XPERT**. This unit concentrates acidic digestion solutions with nitric acid, hydrofluoric acid and hydrochloric acid by distillation at ambient pressure.

The escaping acid fumes are condensed and neutralized in a four-stage process in a water-cooled evaporation unit. The evaporation unit is connected to the **speedwave XPERT** and can be used to concentrate acids or fluids with a boiling point up to 200° C (392° F).



ACID PURIFICATION

The Berghof **distillacid BSB-939-IR** facilitates slow and gentle distillation with a high purification level. As all parts in contact with media are produced from fluoropolymers, the apparatus is ideally suited for purifying hydrofluoric acid, hydrochloric acid and nitric acid.

Starting with p.a. qualities, purity levels within the ppb to sub-ppb range are achieved after simple distillation. Further purification is possible with multiple distillation.

The advantages of the **distillacid BSB-939-IR** at a glance:

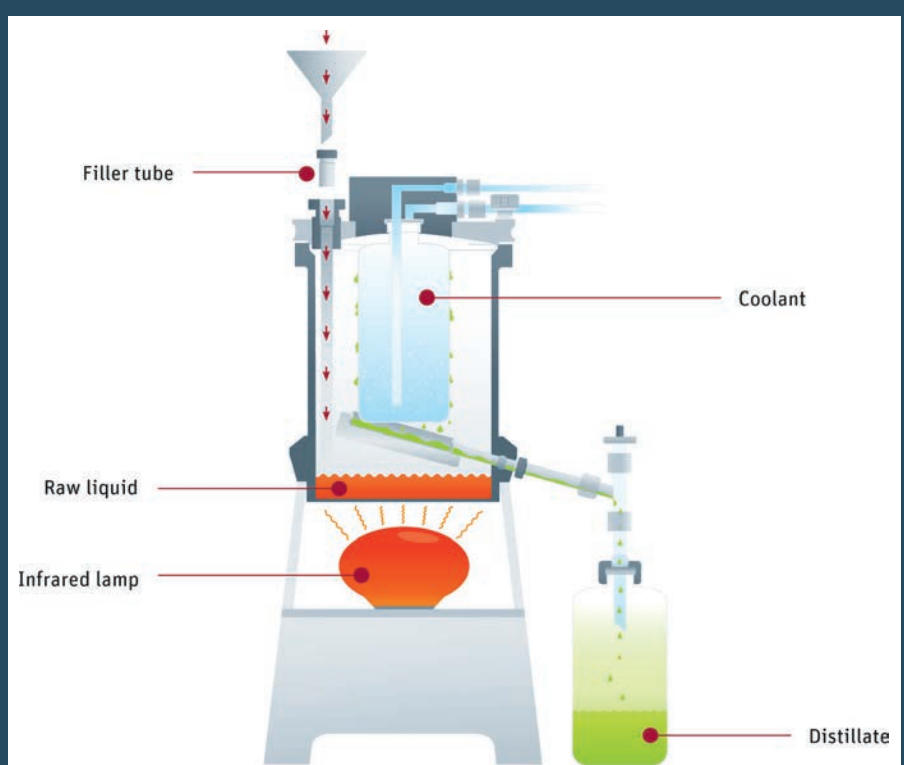
- Pure acids are permanently available and can be produced at a low price
- No contamination risk, due to the use of high-grade fluoropolymer components
- No corrosion, due to the non-use of metal components
- Simple handling, filling and cleaning
- Reduction of blank values
- Increased determination limit



Principle of operation

The initial acid is heated using an infrared lamp. The maximum temperature automatically adjusts at 10° C to 20° C below the boiling point of the respective acid.

This gentle distillation process allows substances with low volatility, such as salts, to remain in the sediment, so a high degree of purification is achieved. The scope of delivery includes a purity table for correct application of the **distillacid BSB-939-IR**.



speedwave microwave digestion

Devices and accessories



speedwave XPERT STARTER PACKAGES

| Article number | Description/scope of delivery |
|----------------|---|
| 5306000 | Speedwave XPERT basic instrument Without accessories |
| 5306910 | Speedwave XPERT DAP-60X Vessel type: DAP-60X Rotor: 12 positions Pressure control: 1 OPC vessel |
| 5306920 | Speedwave XPERT DAP-60X OPC Vessel type: DAP-60X Rotor: 12 positions Pressure control: 12 OPC vessels |
| 5306930 | Speedwave XPERT DAP-100X Vessel type: DAP-100X Rotor: 12 positions Pressure control: 1 OPC vessel |
| 5306940 | Speedwave XPERT DAP-100X OPC Vessel type: DAP-100X Rotor: 12 positions Pressure control: 12 OPC vessels |
| 5306950 | Speedwave XPERT DAP-40X Vessel type: DAP-40X Rotor: 24 positions Pressure control: 1 OPC vessel |
| 5306960 | Speedwave XPERT DAK-100X Vessel type: DAK-100X Rotor: 8 positions Pressure control: 1 OPC vessel |
| 5306970 | Speedwave XPERT DAK-100X OPC Vessel type: DAK-100X Rotor: 8 positions Pressure control: 8 OPC vessels |

speedwave ENTRY STARTER PACKAGES

| Article number | Description/scope of delivery |
|----------------|---|
| 5307000 | Speedwave ENTRY basic instrument Without accessories |
| 5307500 | Speedwave ENTRY DAP-60K Vessel type: DAP-60K Rotor: 10 positions |



speedwave ADDITIONS

| Article number | Description/scope of delivery |
|----------------|--|
| 5037000 | Distillacid BSB-939-IR Sub-boiling apparatus for acid purification |
| 5307200 | External exhaust unit For suction of exhaust air in the oven chamber of the speedwave ENTRY |
| 10000132 | Conformity Softwarepackage 21 CFR Part 11 Softwarepackage for speedwave XPERT |
| 10000231 | IQ/OQ-Qulification package For the initial qualificaion of the speedwave Xpert |

speedwave ACCESSORIES

| Article number | Description/scope of delivery | | XPERT | ENTRY |
|----------------|--|---|-------|-------|
| 5303290 | Vessel inserts DAC-17 12 pieces (17 ml / 130 bar) made from PTFE with ceramic support sleeve, cover and rupture disc For use with DAP-100 | | ✓ | - |
| 5014412 | Quartz glass inserts DAQ-20H 12 pieces (20 ml / 100 bar) with cover and rupture disc For use with DAP-60X | | ✓ | - |
| 5014442 | Quartz glass inserts DAQ-22H 12 pieces (22 ml / 100 bar) with cover and rupture disc For use with DAP-100X | | ✓ | - |
| 5308150 | Multiple tube system MT 24 pieces made from PFA with lifter and rack for MT vessels For use with DAK-100X | | ✓ | - |
| 5306990 | Evaporation set for DAP-60X and DAP-100X For concentration of sample solutions for distillation. Consisting of: 12 evaporation covers, 4-stage evaporation unit, water jet pump | ① | ✓ | - |
| 5306980 | Evaporation set for DAK-100X For concentration of sample solutions for distillation. Consisting of: 8 evaporation covers, 4-stage evaporation unit, water jet pump | ① | ✓ | - |
| 5306550 | Neutralization unit For neutralization of waste air, incl. 1 kg marble filling | | ✓ | - |
| 5014621 | Marble filling for neutralization 1 kg marble granulate | | ✓ | - |
| 5306555 | Wi-fi access point To connect mobile end devices. Configured in the factory for direct use with the Speedwave Xpert | ② | ✓ | - |
| 5306360 | Printer Inkjet printer with Ethernet connection | | ✓ | - |
| 5303612 | 2 ml weighing cups 12 x PTFE cups for sample weighing | ③ | ✓ | ✓ |
| 5303614 | 2.5 ml weighing cups 12 x PTFE cups for taking sample weighing | ③ | ✓ | ✓ |
| 5304260 | Transportation rack for DAP-40 For 8 vessels | ④ | ✓ | - |
| 5304265 | Transportation rack for DAP-60 and DAP-100 For 6 vessels | ④ | ✓ | ✓ |
| 5304263 | Transportation rack for DAK-100 For 6 vessels | ④ | ✓ | - |
| 5302817 | Blind plugs for DAC/DAK-70/100 To seal unoccupied vessel positions | | ✓ | - |
| 5302400 | Turntable DAQ-10 With 24 vessels | | - | ✓ |

①



②



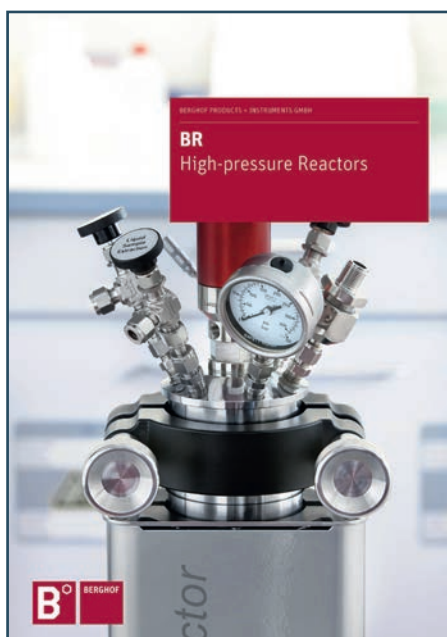
③



④



Gain an impression of the complete product range from Berghof Products + Instruments. You can find our authorised representatives at www.berghof-instruments.com/en/contact.



Your local contact:



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