SONOPULS
Applications

Emulsifying

Sonochemistry

Typical areas of application
- Disruption of cells without distroying the cell content
- Disruption of tissue, also mixed tissue
- Emulsifying of hardly mixable liquids, e. g. oil and water, particle size in nm range
- Deagglomeration of nanoparticles in material research (nanostructurised material) in medicine, biotechnology, automobile industry
- Acceleration of chemical reactions
- Dispersing

Analysis
- Preparing samples for grain size determination or environmental analysis
- Homogenising of cheese samples for determination of nitrates

Biochemistry – Biology – Medicine
- Sonication of small high-quality samples for analysis like EIA or RIA
- Due to high amplitudes, disruption of either high-resistant bacteria, cells are tissues is possible. Indirect processing of samples in cup booster BR 30 or in cup horn BB 6 are recommended to avoid crosscontamination
- Detection of prions by cyclic amplification of protein misfolding

Chemistry – Sonochemistry
- Acceleration of chemical reactions or destroying of highly-molecular compounds

Pharmacy – Cosmetics
- Production of larger volumes of long lasting emulsi-ons, e g. lotions and production of antigens, vaccines or liposomes

General information (extract)
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Professional hints (extract)

Molecular Biology – Microbiology – Pharmacy – Medicine
B-101 Protein extraction by indirect sonication
B-102 Disruption of yeasts cells
B-103 Procurement of stroma-free haemolysate / paternity test
B-106 Tissue disruption, especially „difficult" tissues – overview
B-108T Escherichia coli
B-109 Disruption of pseudomonas thailandensis
B-111 Protein isolation for Westernblot
B-207 Cell disruption of micro alges and cyano bacteria
B-209 Producing of lysates of eucaryontic cells

Materials
C-104 Dispersing of carbon nanotubes (CNT) in processing oil
C-203 Sample preparation of ceramic suspensions for measuring the particle size
C-209 Phase transfer of ferric oxides nanoparticles

Environment
C-106 Desagglomeration of water and sediment samples
C-110 Preparation of sewage samples
C-201 Extraction of magnesium out of soils
C-210 Sample preparation of sewage water for determining of TOC according to DIN EN 1484

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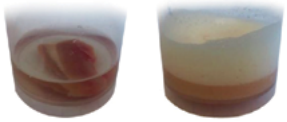
Typical applications

Producing an oil / water emulsion
Small production of pharmaceutical formulations, e.g. very fine emulsions like lotions
> no agglomerates, no sedimentation
Volume: 500 ml

Our recommendation:
HD 2200.2 with KE 76
HD 4200 with TS 106

Homogenising of brain
Volume: 50 ml

Our recommendation:
HD 2070.2 with MS 73
HD 4100 with TS 103



Homogenising of Pangasius fish
Volume: 20 g in 90 ml water

Our recommendation:
HD 2200.2 with VS 70 T
HD 4200 with TS 113

Homogenising of cheese for subsequent determining of nitrate
Volume: 10 g cheese in 25 ml water

Our recommendation:
HD 2200.2 with KE 76
HD 4200 with TS 106

Essential aspects for choosing the appropriate ultrasonic homogeniser

What is the difference between ultrasonic homogenisers and ultrasonic baths?
The power [W] of ultrasonic baths is fixed. The power density [W/l] is relatively low.
Ultrasonic homogenisers have an adjustable power [W] and produce very high power densities [W/l].
Probes with a defined radiating surface guarantee reproducible results.

What is more important when choosing the appropriate device – power rating or amplitude?
Power output [W] is not the sole criterion for selecting the ultrasonic homogeniser. This value only indicates the power of the ultrasonic generator but not the energy delivered into the sample. The amplitude at the radiating surface of the probe is the determining factor while considering the sample volume. SONOPULS homogenisers provide higher amplitudes than comparable devices in the market due to an optimal matching of all components.

Which information are necessary for an offer?

Application field
e. g.: homogenising, dispersing, extraction, cell disruption

Target of sonication
e. g.: isolation of cell content

Volume
batch operation of flow-through operation (quantity per time unit)

Viscosity
in [mPas]

Solids content
suspensions in [%]

Temperature range
e. g.: temperature sensitive, cooling necessaray

Components
e. g.: alcoholic or acidic

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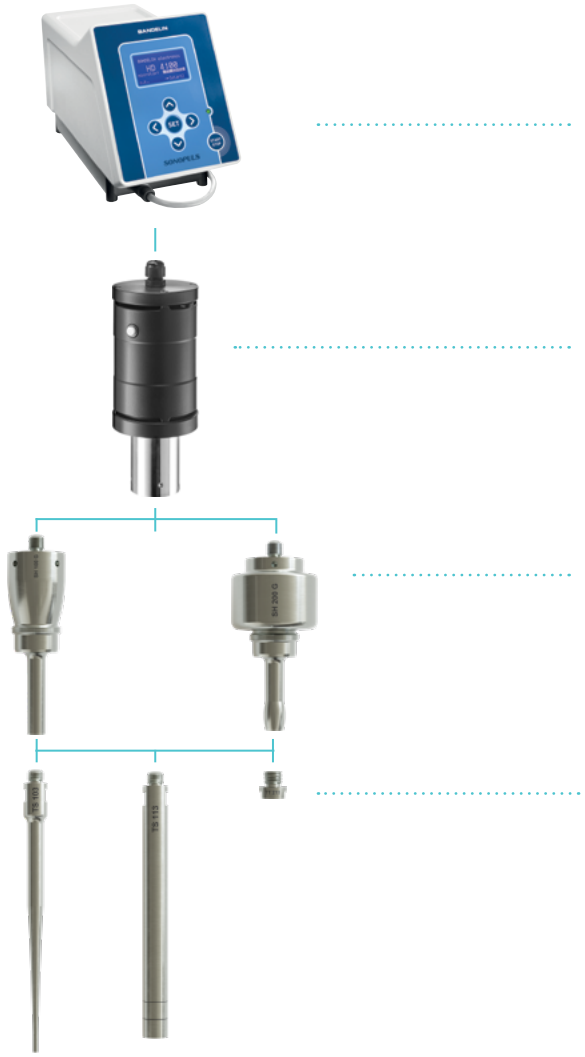
Construction and principle of operating



Ultrasonic generator (control unit)

Transforming of low-frequency voltage of 50 or 60 Hz into high frequency voltage of 20 kHz.
Controlling and displaying of process parameters and sequences.

Ultrasonic converter

Transforming electrical voltage delivered from the generator into mechanical vibrations of 20 kHz

Standard and booster horns

titanium alloy TiAl6V4 (3.7165)
Increasing amplitudes delivered from the ultrasonic converter. The amplification depends on the their shape.

Probes

titanium alloy TiAl6V4 (3.7165)
Transmitting the mechanical vibrations into the sample. The radiating surface is located on the tip of the probe, but not on the sides. The higher the amplitude the more intense the sonication and the more erosion at the radiating surface of the tip. Due to their shapes probes multify the amplitudes. This is followed by highest power densities in the sample.

Features

The AMPLICHRON-system guarantees a constant amplitude and thus reproducible results independently from changing conditions within the sample.
Settings within a range of 10 to 100 % are possible.
Verification of actual value at the display. Permanent control of ultrasound irradiation as well as indication of wear of the probe.

Pulsation
Limits temperature increase when processing heat-sensitive samples. The adjustable pulsation allows cooling during rest intervals.

Continuous operation
Constant sound radiation – extremely effective

Integrated timer
Duration of sonication storable; indication of elapsed time during continuous operation or of remaining time in countdown mode.

Switching ON / OFF – easy to handle
Either at the generator or directly at the ultrasonic converter via button or foot switch.

Foil keypad – easy-care and user-friendly.
Fail-safe during continuous operation and idling.

SONOPULS-homogenisers and their special accessories are „In vitro diagnostic medical devices class 5“ (according to 98/79/EG).

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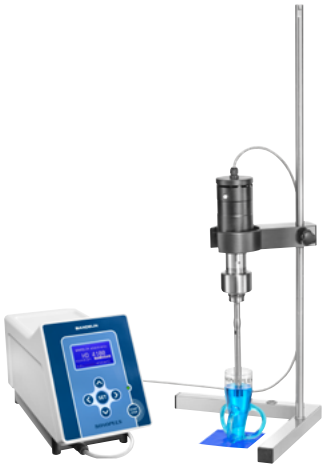
Ultrasonic homogenisers series HD 4000 – Features



Sample volumes **- Batch** **- Flow-through**	0.5 to 1000 ml up to 30 l / h
Ultrasonic converter	possible configurations: GM 4200 with UW 50 or UW 100 or UW 200 or GM 4400 with UW 400 or UW 200
Amplitude setting	10 to 100 %
Automatic amplitude limiting	after input of the assembled probe
Pulsation	ON cycles 0.2 – 600 s OFF cycles 0.3 – 600 s
Time setting	0:00:01 – 9:59:59 [h:mm:ss] or continuous operation
Safety shut-down	9 h: 59 min: 59 s
Indicators	alphanumerical LC display of amplitude, pulse level, time, energy input and temperature (optional)
Energy display	in kJ
Temperature display and measurement	optional, -10 to 120 °C, temperature sensor required, alternatively beep or switch off
Batch operation **Sequencing**	✓ several batches one after the other
Remote control with PC	RS 232 (Sub-D)
Fault diagnosis	✓
Operating frequency	20 kHz
Program memory	✓, 9
Functional test	✓
Mains connection	230 V~ (±10 %), 50/60 Hz

ADVANCED

SONOPULS HD 4050


for volumes from 0.5 to 100 ml

Ready-to-use set:
for volumes from 0.5 to 20 ml
ultrasonic nominal power max. 50 W
- Ultrasonic generator GM 4200
- Ultrasonic converter UW 50
- Probe TS 102, dia. 2 mm

Code No. 4050

SONOPULS HD 4100


for volumes from 2 to 200 ml

Ready-to-use set:
for volumes from 3 to 50 ml
ultrasonic nominal power max. 100 W
- Ultrasonic generator GM 4200
- Ultrasonic converter UW 100
- Standard horn SH 100 G
- Probe TS 103, dia. 3 mm

Code No. 4100

SONOPULS HD 4200


for volumes from 5 to 1000 ml

Ready-to-use set:
for volumes from 20 to 900 ml
ultrasonic nominal power max. 200 W
- Ultrasonic generator GM 4200
- Ultrasonic converter UW 200
- Booster horn SH 200 G
- Titanium flat tip TT 213, dia. 13 mm

Code No. 4200

SONOPULS HD 4400


for volumes from 100 to 3000 ml

Ready-to-use set:
for volumes from 500 to 2000 ml
ultrasonic nominal power max. 400 W
- Ultrasonic generator GM 4400
- Ultrasonic converter UW 400
- Booster horn SH 400 G
- Probe TS 425, dia. 25 mm

Code No. 4400





	HD 4050	HD 4100	HD 4200	HD 4400
Ultrasonic generator	GM 4200	GM 4200	GM 4200	GM 4400
l × w × h [mm]	150 × 220 × 335	150 × 220 × 335	150 × 220 × 335	150 × 220 × 335
Ultrasonic converter	UW 50	UW 100	UW 200	UW 400
Dia. × l [mm]	45 × 175	70 × 150	70 × 150	86 × 180
Available probes dia. [mm]	2 / 3 / 4,5 / 6 / 9	2 / 3 / 4,5 / 6 / 9 / 13	3 / 4,5 / 6 / 9 / 13 / 16 / 19 / 25	13 / 16 / 19 / 25 / 32 / 38

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Probes for series HD 4000

Type	TS 102	TS 103	TS 104	TS 106	TS 109	TT 213	TS 113	TS 216	TS 219	TS 225
Code No.	3740	3741	3742	3743	3744	3750	3745	3746	3747	3748
Diameter [mm]	2	3	4,5	6	9	13	13	16	19	25
Length* approx. [mm]	157	147	133	128	126	–	130	137	145	153
Standard horn for HD 4100	SH 100 G	SH 100 G	SH 100 G	SH 100 G	SH 100 G	SH 100 G	SH 100 G	–	–	–
Booster horn for HD 4200	–	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G	SH 200 G
Amplitude HD 4050/ 4100/4200 (peak to peak) [µm]	125/260/–	118/245/280	90/195/235	70/155/210	58/130/185	–/80/128	–/82/132	–/–/90	–/–/68	–/–/50
Volume HD4050 [ml]	0,5–20	1–25	3–50	5–75	10–100	–	–	–	–	–
Volume HD 4100 [ml]	2–25	3–50	5–75	10–100	15–150	20–200	20–200	–	–	–
Volume HD 4200 [ml]	–	5–90	5–100	10–350	10–500	20–900	20–900	25–900	25–900	30–1000

Type	TS 413	TS 416	TS 419	TS 425	TS 425 L	TS 432	TS 438
Code No.	3752	3753	3754	3755	3759	3756	3757
Diameter [mm]	13	16	19	25	25	32	38
Length* ca. [mm]	139	132	129	130	254	136	144
Booster horn for HD 4400 [mm]	SH 400 G	SH 400 G	SH 400 G	SH 400 G	SH 400 G	SH 400 G	SH 400 G
Amplitude HD 4400 (peak to peak) [µm]	242	196	142	82	82	59	42
Volume HD 4400 [ml]	100 – 750	250 – 1000	250 – 1500	500 – 2000	500–3000	500 – 2500	500 – 3000

* Probes are tuned to their working frequency. Lengths may vary slightly due to variations in the titanium alloy.

Probe extensions

They are used for enlarging the length of the probe to operate in deep vessels and are mounted between standard or booster horn and probe/titanium flat tip.
TS 113 V between SH 100 G/SH 200 G and probe TS 113 or titanium flat tip TT 213.

Type	TS 113 V
for HD	4100/4200
Code No.	3666

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Probes for series HD 2000.2

Type	MS 72	MS 73	KE 76	TT 13	VS 70 T	VS 190 T	TT 25	VS 200 T
Code No.	492	529	530	497	494	3638	532	478
Diameter [mm]	2	3	6	13	13	19	25	25
Length* approx. [mm]	195	179	137	5	130	130	6	130
Standard horn for HD 2070.2	SH 70 G	SH 70 G	SH 70 G	SH 70 G	SH 70 G	–	–	–
Booster horn for HD 2200.2	SH 213 G	SH 213 G	SH 213 G	SH 213 G	SH 213 G	SH 219 G	SH 225 G	SH 225 G
Amplitude HD 2070.2 (peak to peak) [µm]	285	245	191	93	97	–	–	–
Amplitude HD 2200.2 (peak to peak) [µm]	286	308	255	165	170	81	53	51
Volume HD 2070.2 [ml]	1–25	2–50	5–100	10–200	10–200	–	–	–
Volume HD 2200.2 [ml]	2–30	5–90	10–350	20–900	20–900	25–900	30–1000	30–1000

* Probes are tuned to their working frequency. Lengths may vary slightly due to variations in the titanium alloy.

Probe extentions

They are used for enlarging the length of the probe to operate in deep vessels and are mounted between standard or booster horn and titanium flat tip.
VS 70 between SH 70 G / 213 G and TT 13
VS 200 between SH 225 G and TT 25

Type	VS 70	VS 200
for HD	2070.2 / 2200.2	2200.2
Code No.	500	415

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Accessories

Standard and booster horns SH and TH

They amplify and transmit the vibrations to the probe. The suitable horn will be tightened to the ultrasonic converter.

Horns SH for adapting replaceable probes; horns TH have a fix peak. With external thread for connection of different vessels by the use of a sleeve adapter.

	for replaceable probes							with fix peak		
	Standard horns		Booster horns					Standard horn	Booster horns	
Type	**SH 70 G**	**SH 100 G**	**SH 213 G**	**SH 219 G**	**SH 225 G**	**SH 200 G**	**SH 400 G**	**TH 100 G**	**TH 200 G**	**TH 400 G**
for UW	2070	100	2200			200	400	100	200	400
Code No.	486	3731	527	3647	3634	3732	3734	3968	3969	3970

Flow-through horns FZ

They are used to produce stable mixtures of non mixable or hardly mixable liquids (oil / water). Different vessels with standard ground can be connected via adapters NA to the external thread of the horn. In combination with two different media flow-through cell DG 4 G can be sonicated directly in the cavitation field. A cooling is also possible.

	Flow-through standard horn	Flow-through booster horn
Type	**FZ 5 G**	**FZ 7 G**
for UW	2070 / 100	2200 / 200
Code No.	490	452
Accessories	Titanium flat tip TT 13 FZ, Code No. 496	

Sleeve adapters

made of PTFE are for tight mounting of standard ground glass vessels to standard or booster horns with external threads.

Type	**NA 29 G**	**NA 45 G**
for	▪ NS 29 / 32 ▪ SH 70 G / 100 G / SH 200 G / 213 G ▪ TH 100 G / 200 G ▪ FZ 5 G / FZ 7 G with probe diameters max. 13 mm	▪ NS 45 / 40 ▪ SH 70 G / 100 G / 200 G / SH 213 G / 219 G / SH 225 G / 400 G ▪ TH 100 G / 200 G / 400 G ▪ FZ 5 G / FZ 7 G with probe diameters max. 25 mm
Code No.	540	487

Flange adapter FA

made of stainless steel, for mounting standard or booster horns with external threads to processing vessels or pipe systems.

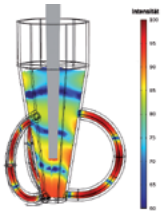
Type	**FA 3 G**
for UW	2070(2200/ 100/200/400
Code No.	474

Processing vessels made of glass for direct sonication

Rosette cells RZ

Caused by the sound pressure the sample will be pushed against the vessel bottom and can circulate well through the side arms. When placing the rosette cell into crushed ice, the sample will be effectively cooled because of an enlarged glass surface and improved circulation.

RZ 3



Intensity of distribution
(Distance between probe tip and vessel bottom = 3 cm)
Reference: Beuth Hochschule Berlin

Cooling vessels KG

They are used for processing temperature-sensitive samples. Their cooling jackets allow a circulation of the cooling liquid during the sonication.

Flow-through vessels DG

They are equipped with cooling jackets. A continuous sonication of sample up to 30 l/h is possible in flow-through. The cooling jackets allow a circulation of the cooling liquid during the sonication.

KG 3

DG 3

	Rosette cells					Cooling vessels		Flow-through vessels		
Type	**RZ 1**	**RZ 2**	**RZ 3**	**RZ 4**	**RZ 5**	**KG 3**	**KG 5**	**DG 3**	**DG 5**	**DG 6**
for probe dia. [mm]	2 – 3	2 – 6	3 – 13	13 – 25	19 – 25	2 – 13	13 – 25	2 – 13	13 – 25	25 – 38
max. volume [ml]	25	50	100	410	660	20	90	–	–	–
max. flow-through rate [l/h]	–	–	–	–	–	–	–	5.6	30	30
Internal dia. [mm]	27	40	50	75	90	20	35	20	35	71
Depth [mm]	80	95	130	200	240	55	95	55	100	120
Cooling jacket	–	–	–	–	–	✓	✓	✓	✓	✓
Sleeve adapters	–	–	–	–	–	–	–	–	–	–
Code No.	3606	3607	522	3256	483	536	481	538	482	3819

Flow-through processing vessels made of stainless steel for direct sonication

They will both directly mounted to the external thread of the standard or booster horn. They are especially used for emulsifying, mixing and homogenising.
The liquid will be pumped from below against the radiating surface of the probe, passes directy the cavitation field and leaves the processing chamber via the outlet. A multiple circulation is possible.
The sonication level depends on the set amplitude and the flow-through rate.

Type	**DG 4 G**	**DZ 300 E***
for HD	2070.2 / 2200.2 4100 / 4200	4400
max. flow-through rate [l/h]	50	130
max. pressure [bar]	2	4
Cooling jacket	✓	–
Code No.	3608	3822

*not suitable for use with TS 438

Processing vessels for indirect sonication

An indirect sonication prevents the direct contact between probe and sample. These processing vessels can be compared with very small high-intense ultrasonic baths. The ultrasound is transmitted via the contact liquid into the sample vessels. The intrusion of titanium particles of the probe is excluded. An indirect sonication is especaillly recommended when processing smallest sample quantities: Foaming or sample lost do not take place. This method is suggested for treating pathogenic samples – crosscontamination is excluded.

To use cup horn BB 6 or cup booster BR 30 horn an probe must be replaced. Reaction vessels containing the samples are placed together with the suitable holder EH into BB 6 or BR 30. They are sonicated from below. The cavitation is produced in the contact liquid and transferred into the samples.

Microtube holder EH 3.1
For simultaneous sonication of up to 8 samples.
Three changeable discs for:
3 × 1 ml or 2 ml reaction cups
3 × 0.5 ml reaction cups
8 × 0.2 ml PCR cups

Microtube holder EH 6
For simultaneous sonication of up to 6 samples.

Type	BB 6	EH 6	BR 30	EH 3.1
for	HD 2200.2 4200	BB 6	HD 2070.2 / 2200.2 4100 / 4200	BR 30
Code No.	3605	7503	7510	7527

Configuration example of a LS 40 and HG 40
(WH 40 are a necessary accessories for an indirect sonication)

Configuration example UW 200 with BB 6, EH 6 and HG 40 with WH 40

Stand HG, holder WH, support AT

HG 40 includes one holder WH 40 for fixing the ultrasonic converter to the rod of the stand.
A second holder WH 40 is necessary either for indirect processing with BB6 / TR 110 / BR 30 or as a holder for the support table AT 40. WH 40 in combination with AT 40 enable an easy postioning of the sample vessel.

Type	HG 40	WH 40	AT 40
for HD	2070.2 / 2200.2 3100 / 3200 / 3400 4050 / 4100 / 4200 / 4400		
Code No.	3681	3900	3901

Foot switch TS

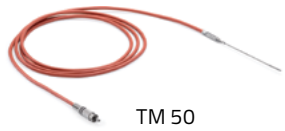
It is applicable for hand-free switching ON/OFF of the device. Delivered with 3 m connecting cable.

Type	TS 8
for HD	2070.2 / 2200.2 3100 / 3200 / 3400 4050 / 4100 / 4200 / 4400
Code No.	513

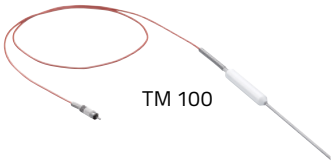
Temperature sensors TM

When connecting the temperature sensor to the ultrasonic generator the temperature module is activated. Temperatures in a range from 0 to 100 °C can be measured.

Type	TM 50	TM 100
for HD	3100 / 3200 / 3400 / 4050 / 4100 / 4200 / 4400	
Code No.	3733	3622



TM 50



TM 100

Sound proof boxes LS

Cavitation produces unpleasant noises for the user and other people nearby. We recommend the use of sound proof boxes to reduce the noise level.

Features LS 4:

- Noise reducing by approx. 10 dB-AU
- Openings at the rear side for hoses and temperatur sensor
- Full-sized plexiglass door enables process observation; with locking hinges at 0° and 150°

LS 4

LS 40

Features LS 40:

- Noise reducing by approx. 30 dB-AU
- LED interior lighting and acrylic glass for process viewing
- removeable drip tray made of stainless steel, easy cleaning
- Stainless steel insert easy to clean
- Closeable bushing at the rear side to accomodate lines and hoses for cooling or circulation systems or to connect a temperature sensor
- Ventilating system for reducing a process-related formation of moisture
- Door opening angle 180° for easy sample handling
- Sufficient space for either direct or indirect application by using stand HG 40 and other optional accessories

Type	LS 4	LS 40
for HD	2070.2 / 2200.2 3100 / 3200 4050 / 4100 / 4200	2070.2 / 2200.2 / 4050 / 4100 / 4200 / 4400
Damping in dB-AU	10	30
Code No.	416	3682

FAQs

What is the meaning of ultrasound?

Vibrations at frequencies exceeding 18 kHz (18.000 vibrations per second) are called ultrasound. As a result of these vibrations millions of smallest vacuum bubbles are formed in liquids. They implode during the high pressure phase and create highly effective pressure waves. This process is called cavitation. Lower frequencies of approx. 20 kHz which are applicable in cell disruption, produce bubbles with larger diameters and stronger pressure waves than higher frequencies of approx. 35 kHz which are used for intense but gentle cleaning. All ultrasonic baths use SweepTec. A very homogeneous and even ultrasonic field is achieved. The pulse function guarantees a steady high ultrasonic peak power.

Advantages of ultrasonic cleaning

Ultrasonic cavitation removes dirt rapidly from items, thoroughly and deep from pores, even from difficult to reach places such as cavities or holes. Ultrasound cleans only in a few minutes and exceeds in its efficiency other cleaning methods. Ultrasonic cleaning is also gentle because even slight damage like scratches are eliminated.

Advantages in process engineering and sonochemistry

Cavitation not only can be used for various purposes, but a very fine emulsion of oil and water can be produced by ultrasonic application. Compared to other manufacturing processes this emulsion is more stable.
For sonochemical processes in an ultrasonic bath, the reaction vessel should have a thin bottom. Thus, the ultrasonic energy is radiated directly and effectively into the reaction vessel.

How do I select the proper device?

SONOREX ultrasonic baths work with the cleaning intense ultrasonic frequency of 35 kHz. Size and number of objects to be cleaned determine size of the bath. When selecting the unit, dimensions of the accessories, e. g. baskets have to be considered. To avoid overloading, it is recommended to choose a slightly larger unit. This also allows additional applications at a later stage.

Should an ultrasonic unit have a heating?

Warm cleaning solutions reduce the cleaning time; dirt is removed faster. With heaters are the preferred choice for cleaning processes in laboratories.
Disinfectant solutions must not be warmed-up because protein coagulation starts at a temperature of 40 °C (104 °F) and this poses an obstacle for some cleaning and all disinfection processes. Therefore, units without heaters are recommended for the use in the medical field.

Is it necessary to use either a basket or a holder for positioning the parts to be processed?

In case of direct contact between parts to be sonicated tank bottom an excessive wear is possible (increased caviation erosion). When using either a basket or a holder the tank bottom will be protected and damages on sonicated objects will be avoided. A free space of approx. 2 to 3 cm is necessary for creation of cavitation.

Is the use of a lid necessary during sonication?

Yes, while using a lid the sound level will be reduced and the tank liquid will be protected from outside dirt. Condensed water runs back into the ultrasonic tank because of the lid design.

Which cleaning agents are appropriate?

TICKOPUR and STAMMOPUR cleaning and disinfectant agents have been especially developed for application in ultrasonic baths. Water without any cleaning agent does not clean. Household detergents as well as distilled water should never be used. It is necessary to use plastic inset tubs, when working with acids or removing acid residues. Flammable liquids must not be used directly in the ultrasonic tank.

When should the cleaning solution be changed?

It depends on the level and kind of contamination and on the quantity of parts already cleaned. In case of too much contaminated liquid there is a noticeable decrease in ultrasonic cleaning action and the liquid has to be replaced. The user always assumes the responsibility.

What does SWEEP mean?

SWEEP is a special frequency modulation (Sweep) around an optimally fixed operation point in order to prevent load-dependent vibrations.
Very rapid frequency changes of approx. ± 1 kHz after each 10 ms reduce standing waves in the bath. It is followed by an improved cleaning effect.
Very homogeneous ultrasonic field to avoid damages at sensitive parts.