

ULTRAWAVES

Water and Environmental Technologies



ULTRAWAVES

Innovative environmental technology from Germany

Ultrawaves GmbH

Ultrawaves GmbH develops and markets innovative high-power ultrasound systems for water and environmental engineering. Apart from the disintegration of biomass in wastewater treatment and biogas plants, the systems are also used in industrial applications.



Dr.-Ing. Klaus Nickel
Founder of Ultrawaves

Successful for the environment

We follow this guiding principle by continuously developing our technology and products for applications in environmental engineering. We strive to achieve continuous, organic growth. In this way we create future-orientated jobs, both at home and abroad with our worldwide sales partners.

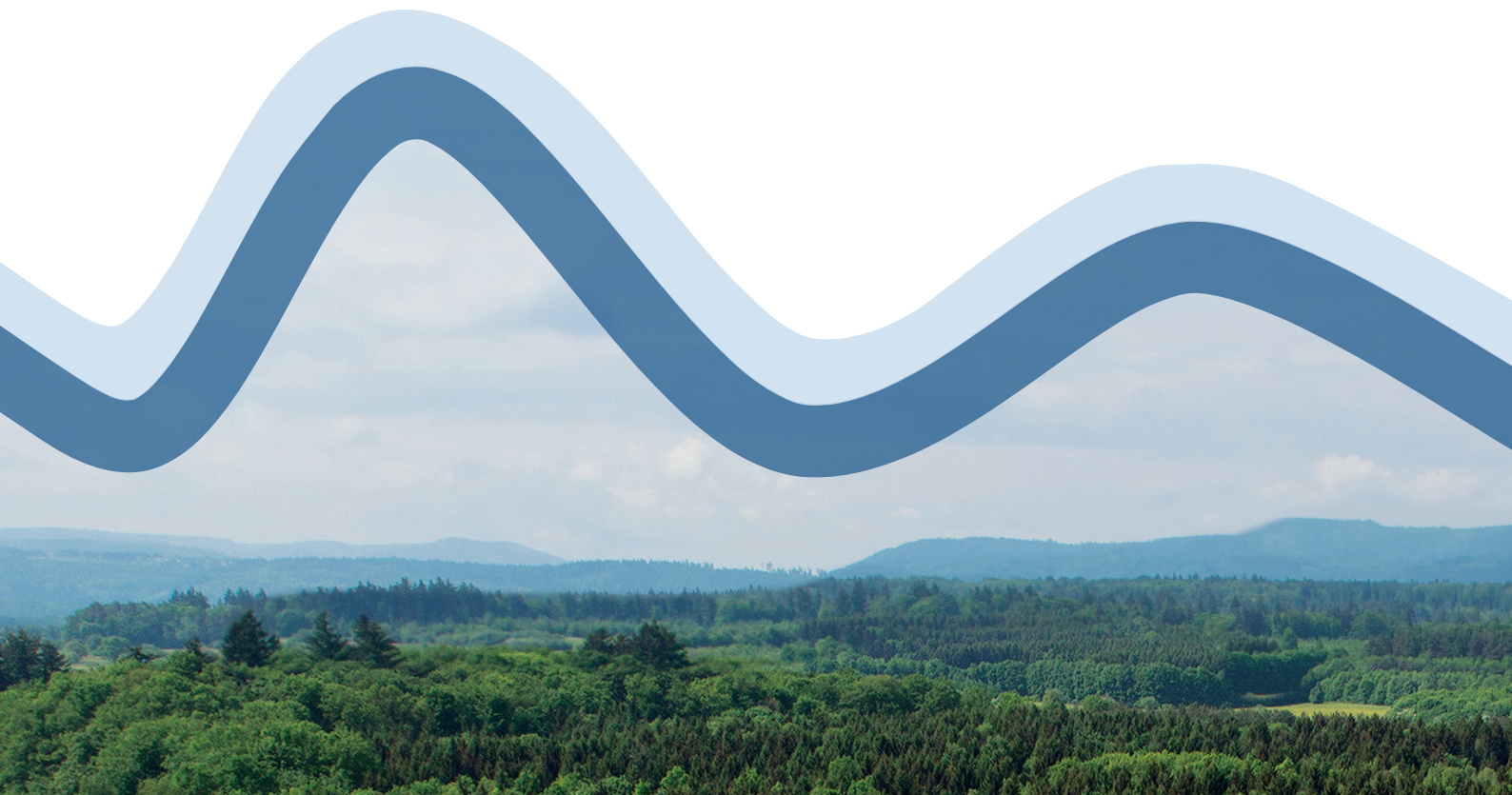
Our know-how

Ultrasound is a particular technology. Our know-how comes from many years of research work at Hamburg Technical University (TUH). There research was carried out on the physical, chemical and biological effects of different forms of ultrasound on aqueous media. The research focussed on the intensification of biological degradation processes for the treatment of water, wastewater and biomasses.

The beginnings

Ultrawaves GmbH was founded in 2001. Our patented high-power ultrasound systems were and are developed on the basis of the wealth of knowledge acquired over many years. Ultrawaves is now the worldwide market leader for ultrasound applications in environmental engineering.

**“Success through
research and development.”**



A special partnership

In order to implement its research work in practice, Ultrawaves entered into a partnership with a company in southwest Germany, Sonotronic Nagel GmbH (Karlsbad), one of the leading manufacturers of industrial ultrasound systems. Since then the high-power systems have continued to be developed in close cooperation. The manufacture of the systems and production of the ultrasound components – the hearts of the systems – are carried out by highly qualified employees in Karlsbad.

The growth

The continuously increasing demand for our ultrasound systems, the international spread and our continuously increasing number of employees are a reflection of Ultrawaves' growth. Our entrepreneurial services and products attract attention in leading media, e.g. the German public broadcaster ARD and Die Zeit newspaper, and have also received innovation prizes of German industry (environmental engineering category) and state of Baden-Württemberg (Dr.-Rudolf-Eberle Prize).

Worldwide networking

The interest and markets for innovative environmental technologies are not only large in Germany. Since 2002, our ultrasound systems have also been successfully marketed through our international sales partners. We are now represented in more than 20 countries – and the trend is increasing.

Your advantage

You can also profit from the technical progress, intensive research and development work and intelligent solutions, which lead to our ultrasound systems.



Consulting and service

Leading technology first-hand

Ultrawaves accompanies you from the initial idea through to operation of your ultrasound system. With our experience, our expertise and our efficient team, at Ultrawaves you are in the best hands when it comes to the use of innovative ultrasound technology in environmental engineering.

Project consulting

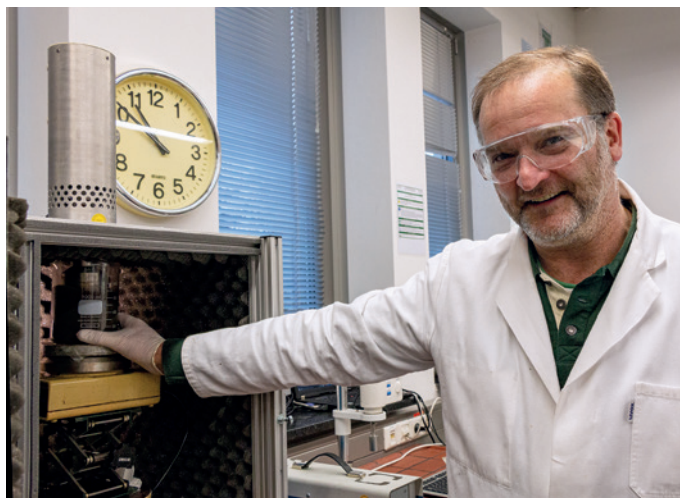
We discuss your project requirements and analyse your individual needs in consultancy meetings. This work is focused on increasing the efficiency and effectiveness of your plant. We exhaust all options to find optimum and flexible solutions for your application.

Training

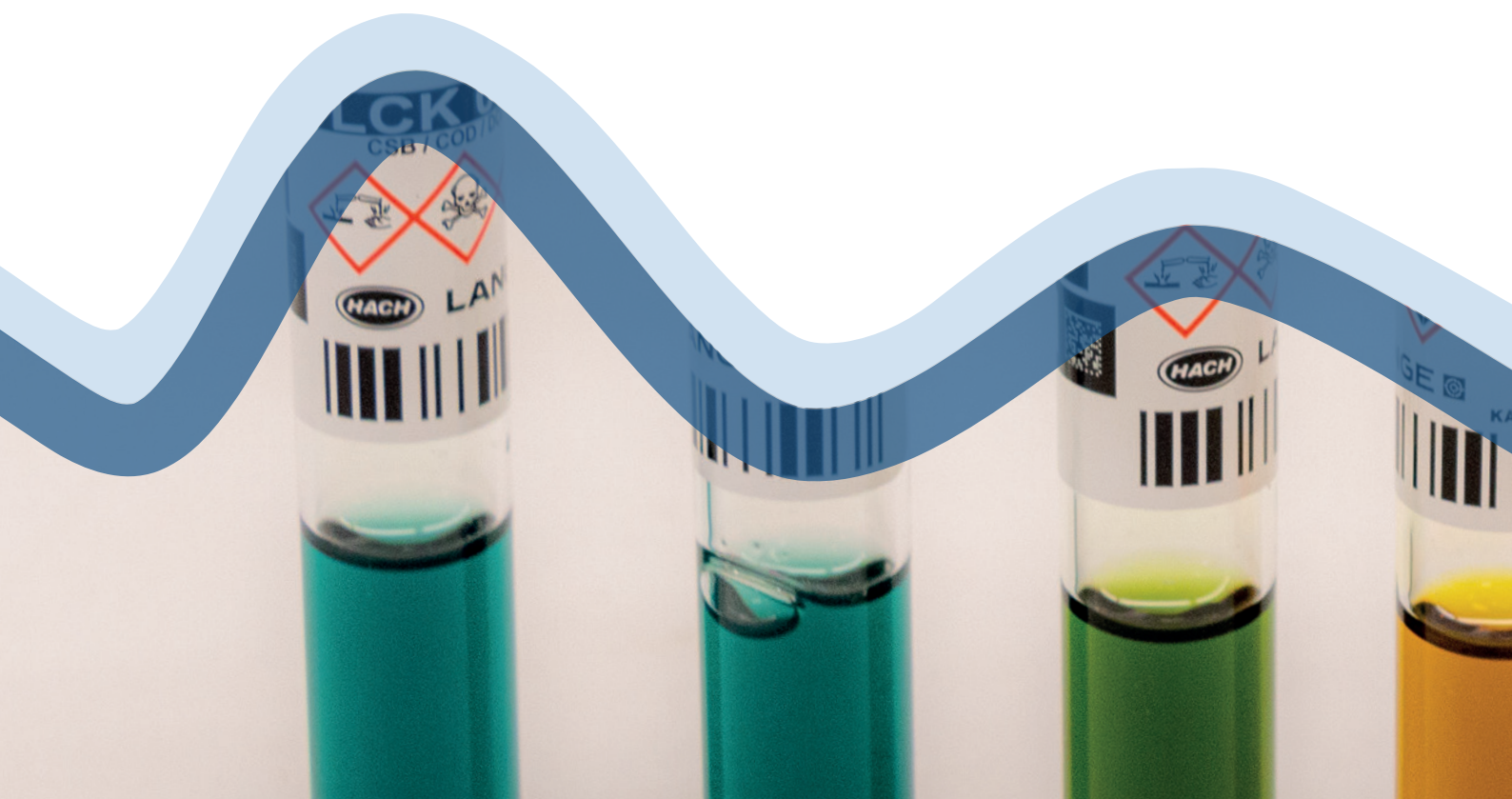
We instruct users in proper intended use of the ultrasound system: They understand the principle and function of our ultrasound technology and acquire application-oriented knowledge. You profit from our multi-disciplinary knowledge of all kinds of different applications.

Analytical support

Ultrawaves offers accompanying analytical support and evaluation during use of its ultrasound systems. Relevant parameters are determined and therefore the efficiency increase achieved by ultrasound is calculated.



"Successful together."



Practically orientated research and development

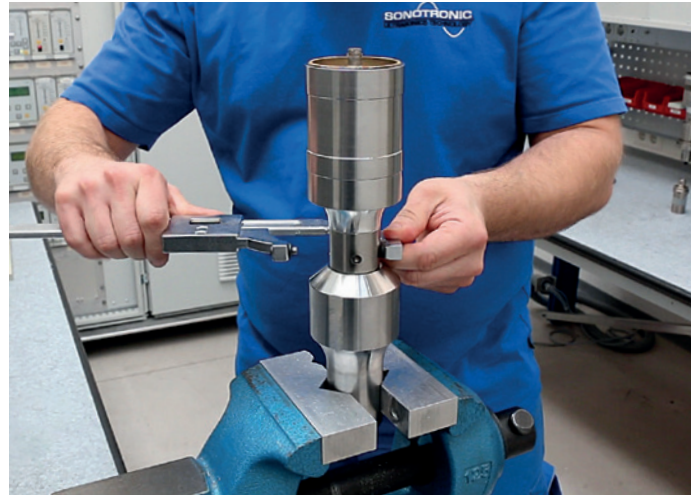
In our laboratory we routinely perform physical, chemical and biological analyses of the effects of ultrasound. We research new application areas for use of our ultrasound systems and continuously improve the existing processes. We also perform specific tests for our customers and accompany you until the ideal solution has been found.

Production in Germany

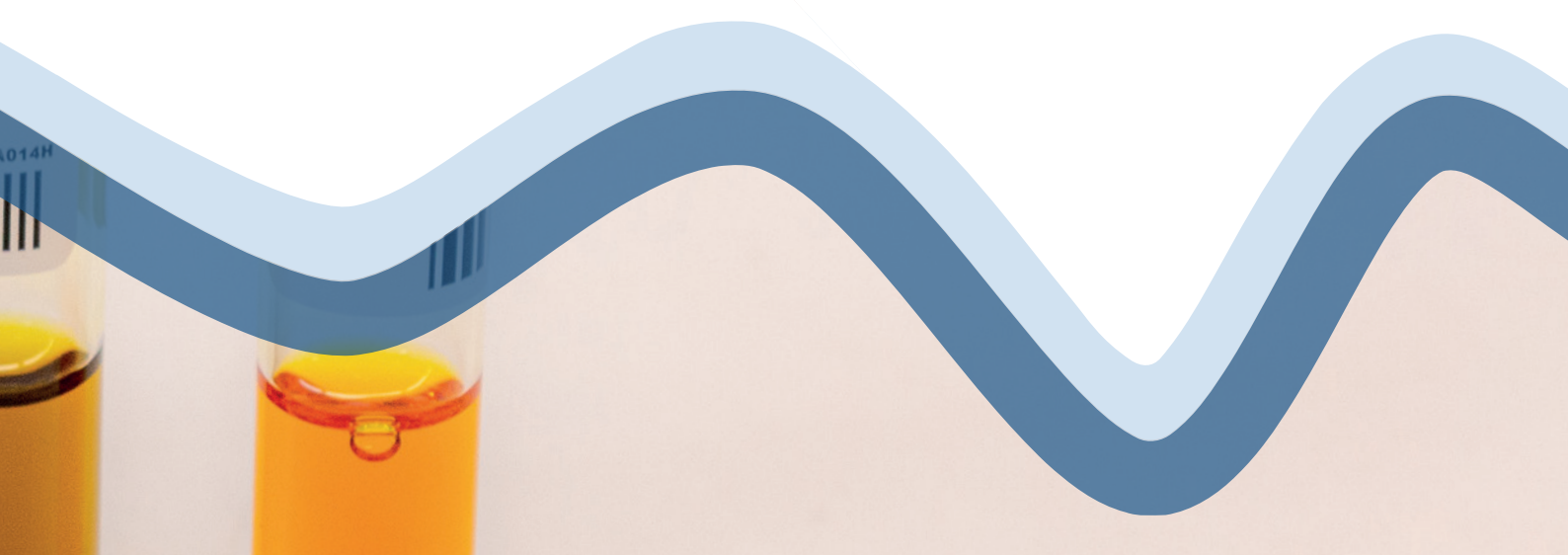
Each year, numerous ultrasound systems are produced at the Karlsbad location. Our customers' high quality requirements are satisfied through high-quality workmanship and leading technology. The decisive components of the ultrasound systems are developed and produced in the company's own toolmaking department as well as the generator and converter production departments.

Service

Through our worldwide service and sales network, we are available for you anywhere and anytime you need us and can flexibly respond to your ideas and wishes. Our technical staff is always ready to ensure optimum and permanent operation for you.



"Individual solutions.



Our high-power ultrasound technology

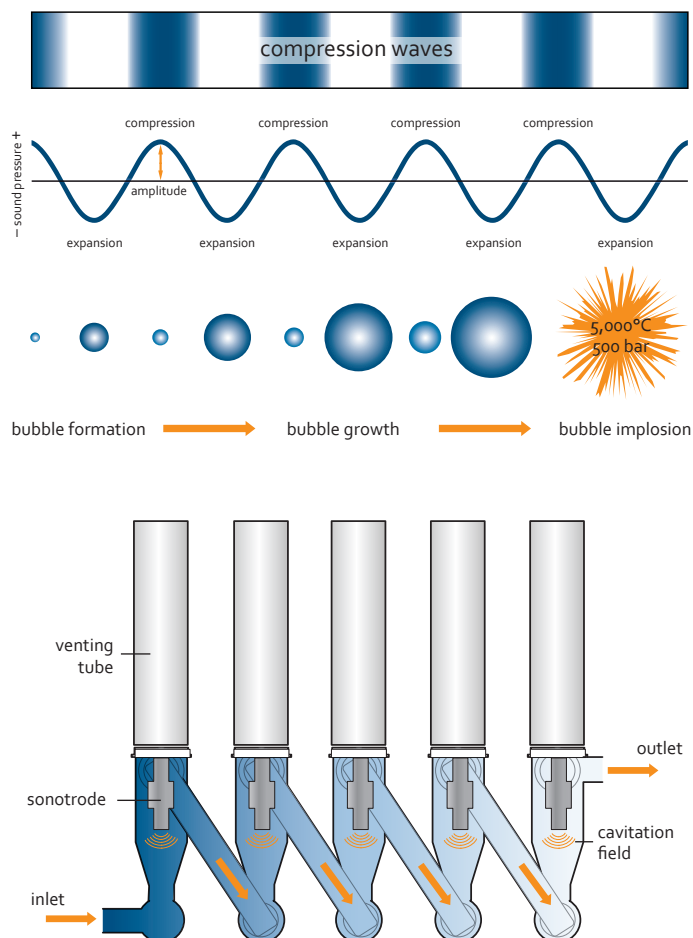
Breaking down biomass through cavitation

The principle

Ultrasound is sound with frequencies beyond audible sound, i.e. from 20 kHz up to the megahertz range. In aqueous media ultrasound waves cause periodic compression and extension of the water phase. High-intensity ultrasound is necessary to tear apart water molecules during the rarefaction phase, which results in the formation of microscopically small voids in the liquid. These voids become bubbles filled with water vapour or gas. They grow in extension phases and shrink in compression phases, until they implode. This event is called cavitation, a process under extreme (adiabatic) conditions. On a microscale, pressures of 500 bar and a temperature of 5,000°C are produced. Particularly large cavitation bubbles are produced within the frequency range from 20 to 100 kHz; when these bubbles collapse they cause extreme mechanical shear forces. These forces produced by ultrasound are capable of destroying even the most robust surfaces.

How it works

Extensive empirical studies have led to the development of a patented high-power ultrasound system, which is optimally tuned to the disintegration of biomass. Our ultrasound reactors operate as a plug flow system. Ultrasound within the lower frequency range (20 and 35 kHz) and high intensity is applied. Our ultrasound systems can be used for volumetric flow rates of up to 2 m³/h, which means that the resulting sonication time for the medium is very short viz. only one minute. It is not necessary to recirculate the medium. The flow rate can even be higher for less concentrated suspensions.



Patented ULTRAWAVES ultrasound systems

Efficiency increase in the production of environmentally friendly energy

Compact design

As the medium itself only dwells in the ultrasound system for a short time, the unit has a very compact size. It can be easily integrated into existing plants via an inlet and outlet pipe, without any complications (plug & play).

The ultrasound components

The standard Ultrawaves ultrasound system is equipped with five oscillating units, consisting of a converter, booster and sonotrode. The number of oscillating units can be variably selected depending on the volumetric flow to be treated. Furthermore, it is possible to extend the number of ultrasound modular systems used as required and therefore adapt to any plant size.

Each oscillating unit is operated with a nominal power of 1 kW. However, in practice this power is not permanently called upon. The extremely robust units usually run continuously (24/7). They are low maintenance; only the sonotrodes, which come into direct contact with the sonicated medium, are wearing parts and can be easily replaced.

Effect on bacteria, algae and agricultural biomass

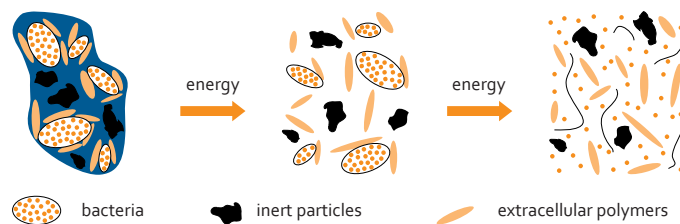
High-intensity ultrasound causes biomass to break down. Our newly developed ultrasound systems first decompose agglomerations of biomass material at rather low energy input (short sonication time). Further sonication opens up the biomass cells, so that the cell contents escape and dissolve.

This process releases enzymes from the bacterial biomass. Hence the sonicated biomass is readily available as a substrate for active microorganisms and is degraded better in a subsequent biological degradation process. Biological degradation processes are intensified, i.e., the use of ultrasound produces a greater yield of the end product and less residual materials. As a consequence of this, for example, in anaerobic sludge treatment, biogas production is increased and there is less residual sludge.

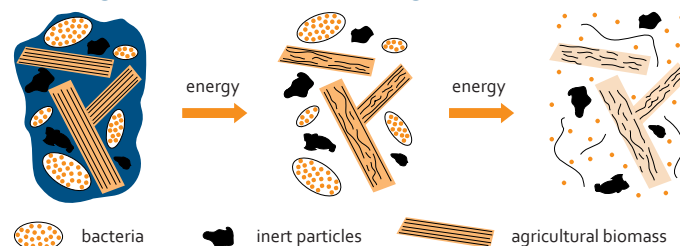


Dimensions (L x W x H) [mm]	1,450 x 250 x 1,126
Weight [kg]	101
Volume [m³]	0.029
Connected load [kW]	5
Material	V2A steel

Disintegration of biomass in wastewater treatment plants



Disintegration of biomass in biogas plants



Applications

Ultrasound on wastewater treatment plants

Ultrasound is used in municipal and industrial wastewater treatment plants, in order to intensify aerobic and anaerobic biological processes.

Sludge treatment

Conventional anaerobic digestion of sewage sludge is limited by the hydrolysis step (technical digestion limit). Treating (waste activated) sludge with ultrasound overcomes this limit. The anaerobic digestion process is intensified and further degradation is achieved. This reduces the quantity of digested residual sludge, while biogas production increases.

Wastewater treatment

In biological nitrogen elimination, carbon must be provided for the denitrification stage. Normally, methanol or other chemicals have to be bought in for this purpose. Ultrasound breaks down bacterial biomass from the excess sludge. This makes the cell contents available as carbon carriers, which can be added to the denitrification process. At the same time, nitrogen degradation increases.

Bulking sludge and foams

The creation of bulking sludge and foams due to mass development of filamentous micro-organisms is a widespread problem in waste-water treatment plants. Foaming frequently also occurs in the digester as an independent phenomenon. Continuous sonication of a rather small partial flow of the return sludge by means of ultrasound causes permanent stress on the active biomass in the activated sludge tank. We have demonstrated that predominantly filamentous bacteria are damaged by this permanent “ultrasound” stress. As a consequence, the filamentous micro-organisms are eliminated easily and reliably.



Ultrawaves ultrasound system in use



Ultrasound on biogas plants

Biomass treatment

The production of biogas as a renewable energy source is currently very important, which is why the number of agricultural biogas plants with fermentation of organic substrates (renewable raw materials, slurry, etc.) is steadily increasing. Although fermenters in agricultural biogas plants are dimensioned with longer retention times, the speed-determining hydrolysis step also has to be overcome here. Sonication of the active bacterial biomass from the fermenter or secondary fermenter with ultrasound has proven to be an effective solution. The result is intensified anaerobic degradation with increased biogas production and in general a higher methane content.



Ultrasound for industry

Disinfection of process water and wastewater

Ultrasound is ideal for disinfecting water with high solid concentrations (turbidity). In these cases, classic methods such as UV or chlorine are ineffective.

Organic contaminants

The chemical structure of persistent organic contaminants, which can usually only be treated with expensive chemical methods (e.g. landfill leachate), is changed by ultrasound treatment. Chemical bonds are broken up, molecule size is reduced with the result that these substances are made biologically available.

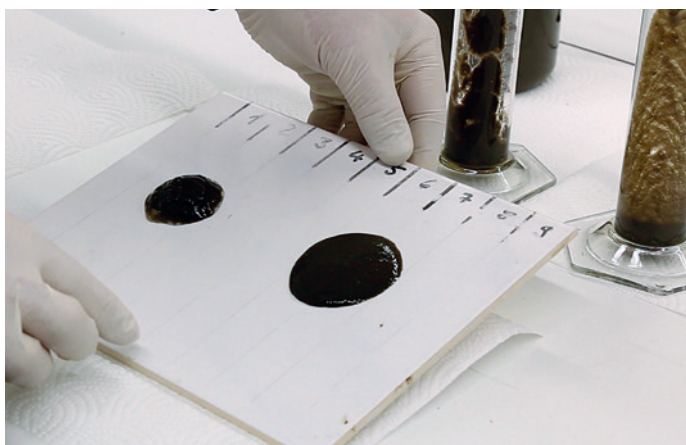


Detailed descriptions of case studies and our reference list are given on our website.



Services of the ULTRAWAVES laboratory

Our laboratory tests



Ultrawaves has set up its own laboratory to satisfy specific requirements of its customers. As a result, we are able to provide you with reliable information on the effect of our high-power ultrasound systems on aqueous suspensions (e.g. biomass, sludges) or other feasible applications in industry.

This usually requires a preparation phase during which the appropriate samples are sonicated with variable ultrasound energy input, in order to define the optimum ultrasound setting for the planned practical operation. Our ultrasound systems normally operate with a frequency of 20 kHz or 35 kHz, as the required cavitation effect can be most effectively produced within this frequency range.

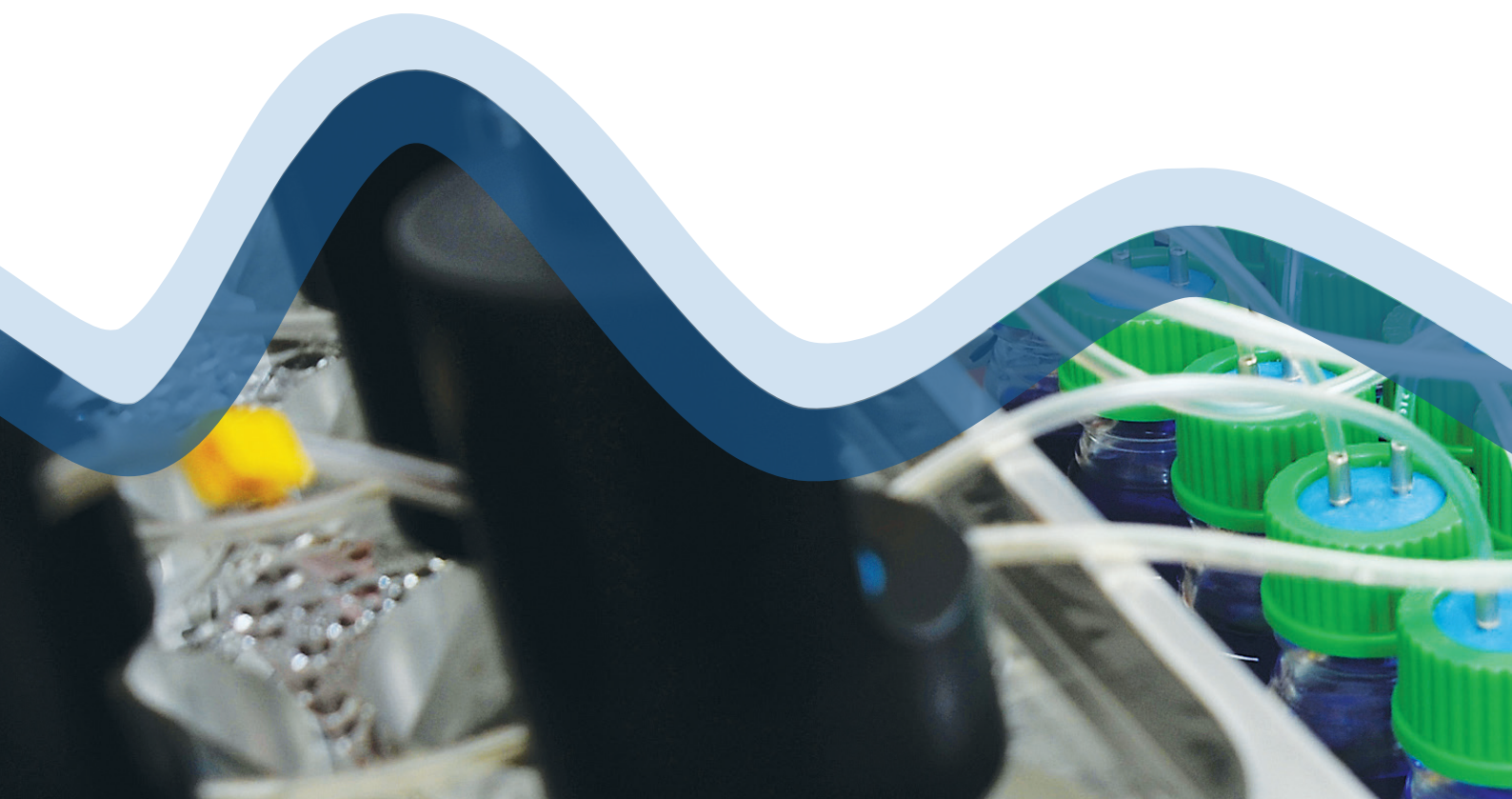
Ultrasound

Accordingly, the following ultrasound units are permanently available in our laboratory:

- Ultrasound oscillating unit 20 kHz frequency, 1 kW output, 25-50 W/cm² intensity
- Ultrasound oscillating unit 35 kHz frequency, 0.8 kW output, 60-120 W/cm² intensity

These oscillating units correspond to those installed in our standard Ultrawaves units.

Special applications for fundamental studies require a wider range of frequency. To this end we are equipped with a range of laboratory ultrasound units, which cover the wide frequency range between 40 kHz and 3,200 kHz.



Determination of the optimum ultrasound settings

Viscosity

The sonication of all kinds of suspensions leads to a reduction in the suspension's viscosity. This is often a very welcome effect, as the mixing in digester tanks or fermenters of biogas plants is significantly improved as a result. We use a rotational viscosimeter (Bohlin Instruments) to verify this positive effect.

“Individual ultrasound settings for practical use.”

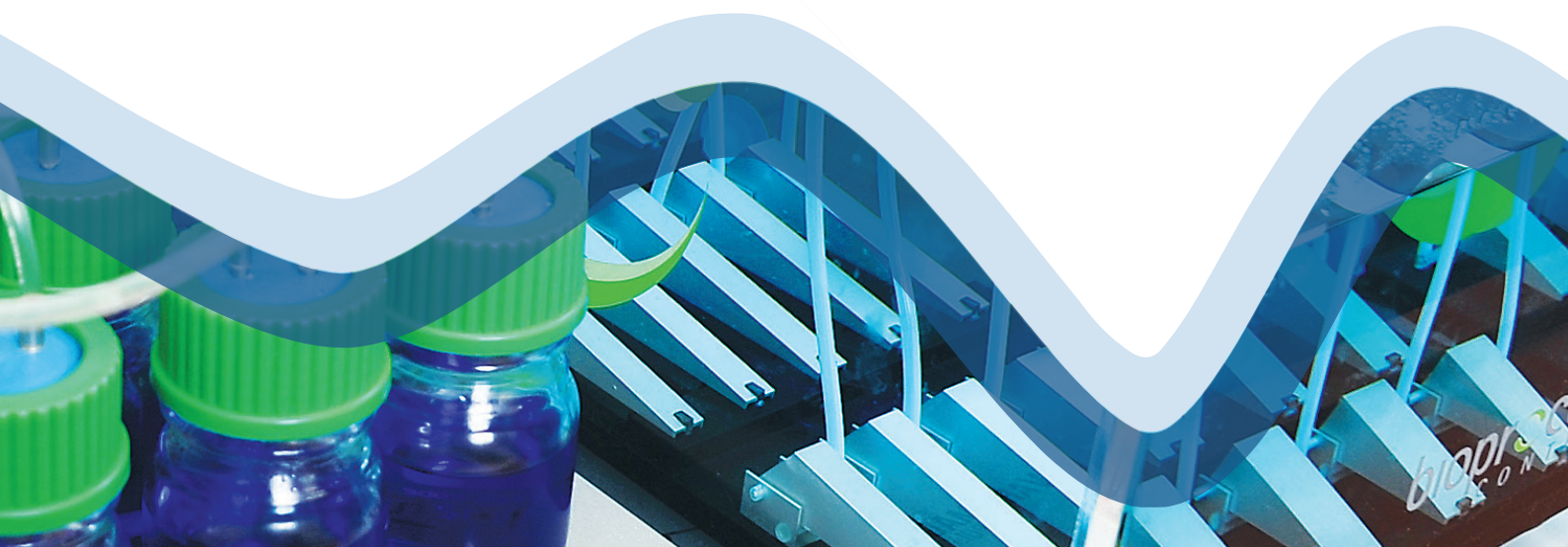
Particle size distribution

Sonication causes a change in size distribution of the particles or flocs in suspensions. On request, we analyse the particle size distribution using a particle analyzer CIS 100 (Galai).

Methane potential

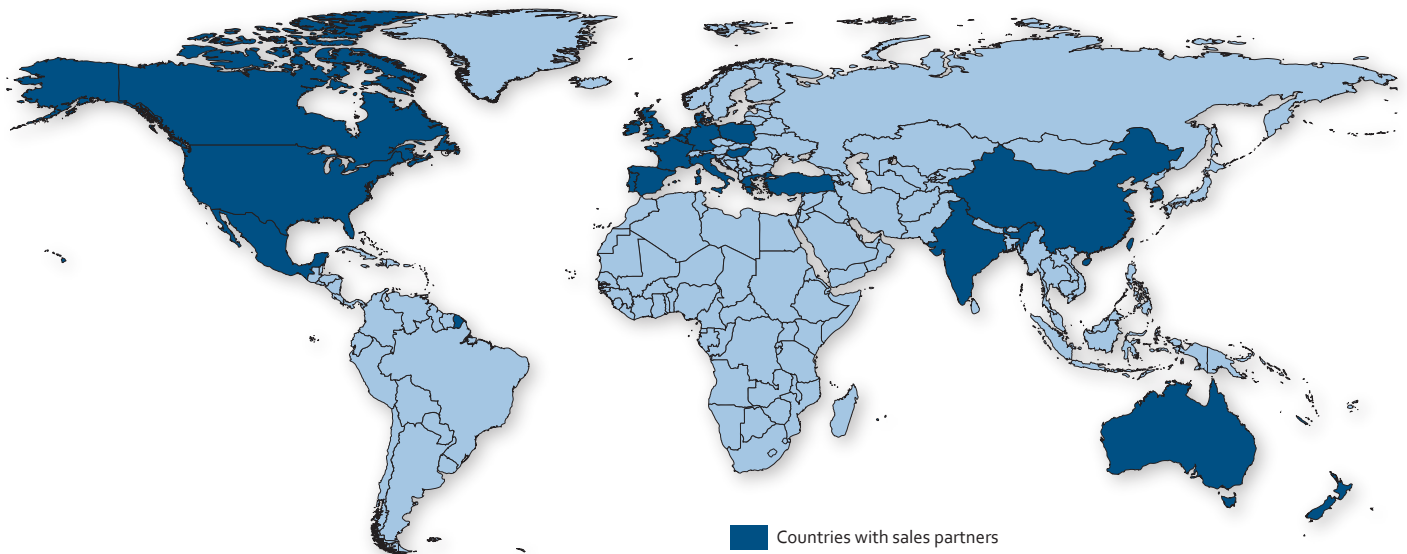
The AMPTS methane potential test system enables automated recording and evaluation of biogas volumetric flow rates, which are produced during the anaerobic degradation of different substrates. The parameters measured are gas production (biogas or methane) and the substrate degradation rate. From this we obtain information about the biogas potential of the substrates and determine the comparative increase in biogas yield as a result of the ultrasound treatment (AMPTS, Bioprocess Control).

We routinely determine water chemistry parameters of the samples according to DIN 38414: Dry solids and volatile solids concentration. Chemical oxygen demand (COD) and nitrogen concentration are determined by photometry.



Locations and partners

Worldwide partner network for quality from Germany



From the company's head quarters in Karlsbad ULTRAWAVES delivers global its high-performance ultrasound systems and coordinates its international partner network. Apart from research and development, regular partner meetings, training courses and project consultations.



SONOTRONIC Nagel GmbH, our partner company from the very outset, produces the high-power ultrasound systems at its company base in Karlsbad, in the middle of the technology region of Karlsruhe with long-standing experience in-house.



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