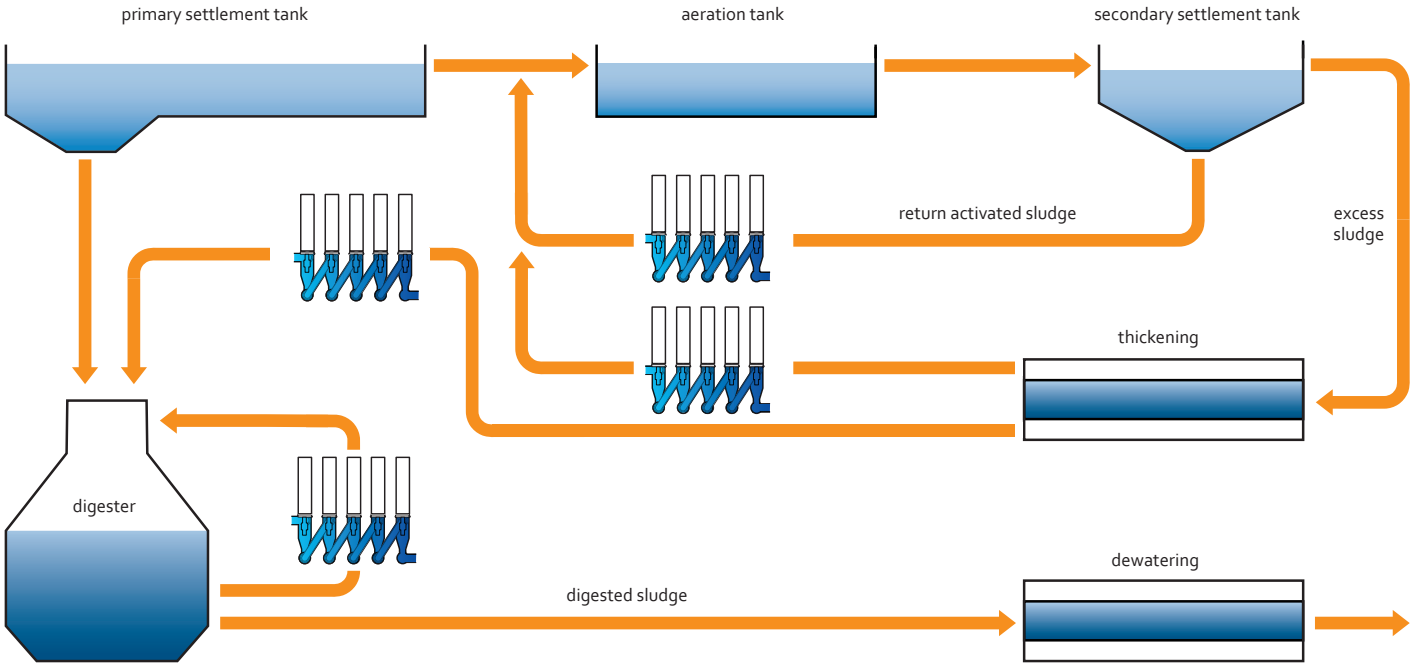
Wastewater treatment plants

Intensified sludge treatment by ultrasound

ULTRAWAVES
WASSER & UMWELTTECHNOLOGIEN GMBH

Ultrasound systems on wastewater treatment plants

Areas of use and advantages



Integration of the ultrasound technology in municipal and industrial wastewater treatment plants

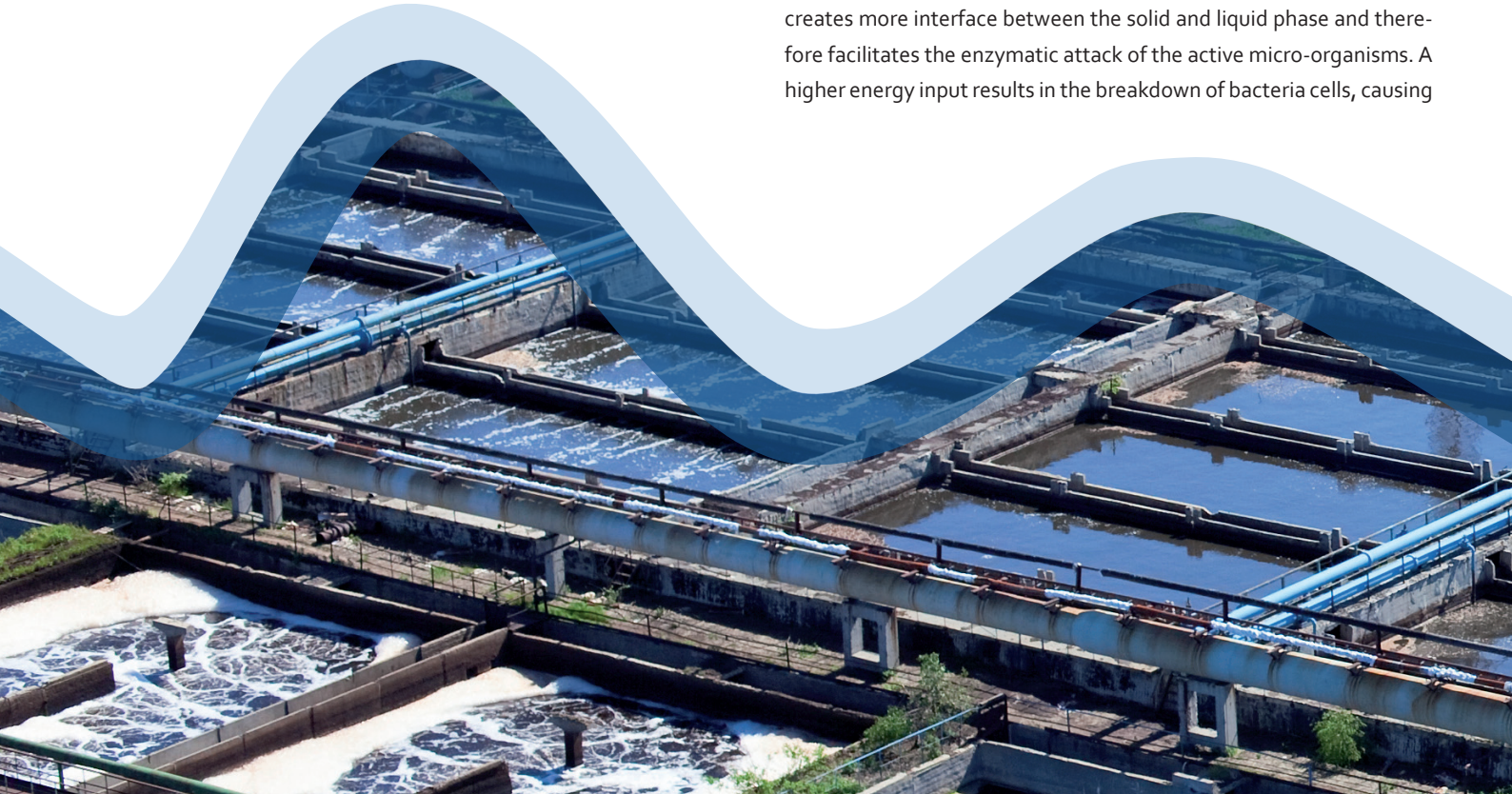
Ultrawaves' high-power ultrasound systems can be used for a large number of applications in both municipal and industrial wastewater treatment plants. These primarily include sludge treatment, but also wastewater treatment in the form of controlling bulking sludge and foaming and improved nitrogen elimination by providing internal carbon carriers.

Sludge treatment

Degradation of the organic sludge fraction by conventional anaerobic sludge stabilisation is limited by the rate-determining hydrolysis step. Degrees of volatile solids degradation of 50% are rarely achieved. The cause of this lies in the difficult to access and degrade bacterial biomass of the waste activated (excess) sludge. By applying the high-power Ultrawaves ultrasound technology this limiting hydrolysis step is overcome. Therefore the sonicated excess sludge biomass is more readily available for the subsequent biological enzymatic degradation process.

"Intensified digestion process and further degradation."

Ultrasound causes disintegration of the sludge floc structure and release of exo-enzymes even with small energy inputs. This also creates more interface between the solid and liquid phase and therefore facilitates the enzymatic attack of the active micro-organisms. A higher energy input results in the breakdown of bacteria cells, causing



the cell contents and endo-enzymes to be released. These enzymes further accelerate the degradation process. The entire digestion process is intensified and the organic fraction is further degraded. An important advantage from this is a significantly increased production of biogas and reduction in the quantity of residual sludge to be disposed of. As a result of the smaller quantity of residual organic matter, the dewaterability of the digested sludge is also facilitated (less flocculent addition) and increased (higher degree of dewatering).

This disintegration of the sludge reduces its viscosity. This is important for practical operation, as this facilitates mixing the fermenter content, which in turn results in noticeable energy savings.

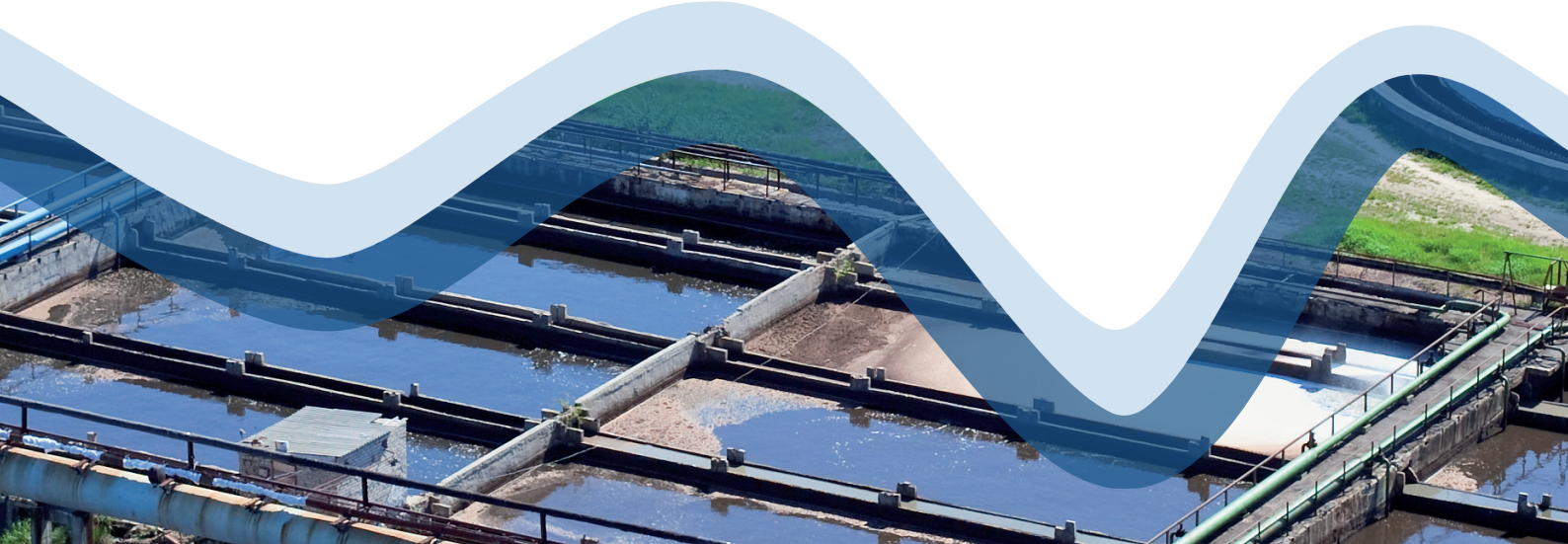
With the help of ultrasound technology, digesters which are at the limit of their capacity can easily continue to be operated long-term. In new installations the digesters can be designed with a shorter retention period.

"Removal of bulking sludge."

Bulking sludge and foam

Seasonal bulking sludge problems often occur in wastewater treatment plants. These are usually caused by filamentous organisms. Foaming in digester tanks is also a familiar occurrence and can cause substantial operational problems.

Sonication of a small quantity of the return activated sludge or returned excess sludge exposes this bacterial biomass to permanent stress through cavitation and fluctuating pressure in the liquid medium. Ultrawaves has proven that this process causes filamentous micro-organisms to particularly suffer and therefore forces them to be permanently eliminated. Use of high-power ultrasound can therefore prevent the formation of bulking sludge and stable wastewater treatment plant operation is maintained again.



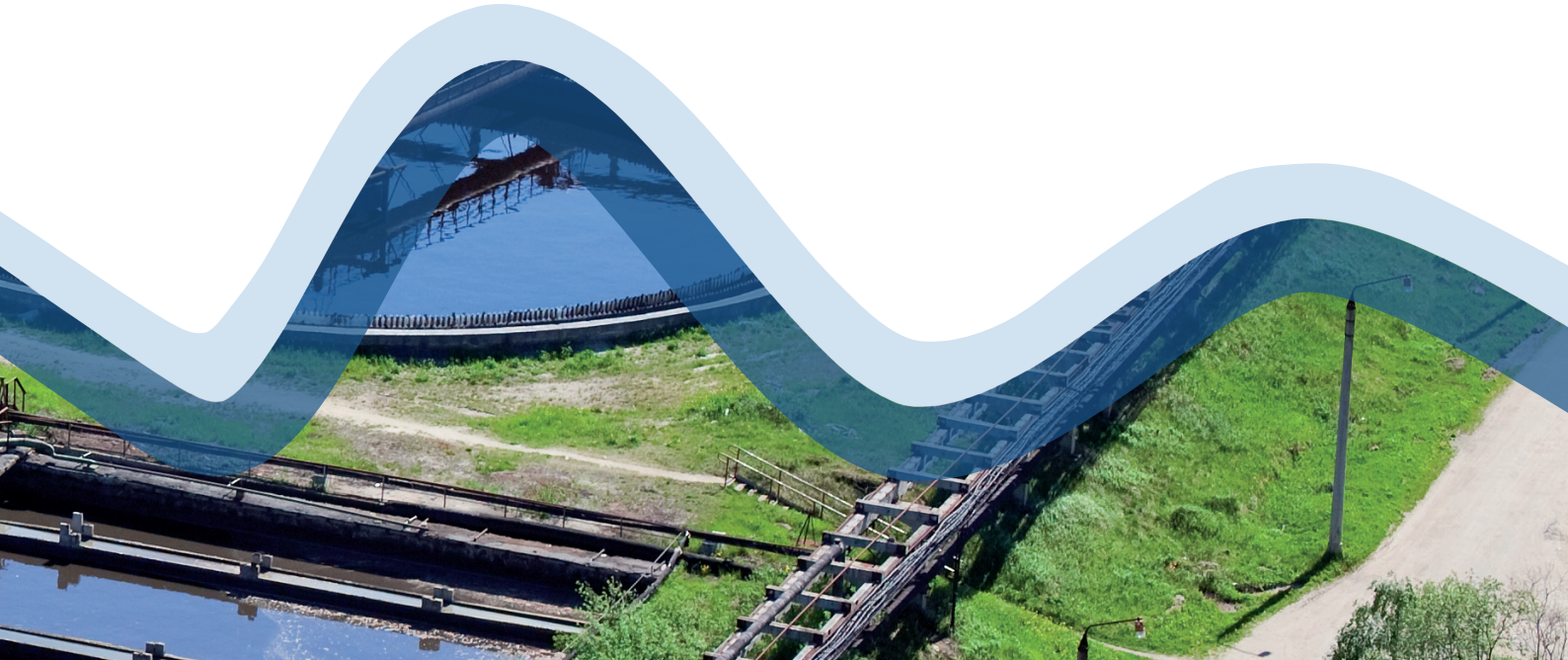
Wastewater treatment

Nitrogen degradation: The biological nitrogen degradation takes place through nitrification and denitrification. A successful degradation process requires an additional carbon supply to be provided for the denitrification stage. Normally, methanol or another external carbon source is bought in and added to the process for this purpose.

Sonication of the excess sludge with ultrasound breaks down the biomass. This releases the cell contents – i.e. ideal carbon carriers – which are then available as an internal source of carbon in the denitrification stage. Biological nitrogen degradation in the wastewater treatment plant can therefore be maintained or even intensified. If part of the sonicated sludge is returned to the biological phase, the quantity of sludge to be disposed of is automatically reduced. Use of ultrasound for the degradation of nitrogen was successfully tested in practice and, for example, has been in operation in Bünde municipal wastewater treatment plant since 2006.

"Provision of internal carbon source for denitrification stage."

Disinfection: Ultrasound can also be used for the disinfection of turbid and highly concentrated media, e.g. process water and wastewater, where the standard chlorine and UV methods fail. Germs attach to suspended particles or flocs and therefore easily escape disinfection by UV. Ultrasound can be used to break down these agglomerations, so that the germs exist in isolation and re-suspended. This makes them accessible to the classic methods once again and they can be successfully attacked. Whether ultrasound is used alone or in combination with conventional variants – effective disinfection is ensured.



Practical results

Bamberg wastewater treatment plant – one of the first reference plants

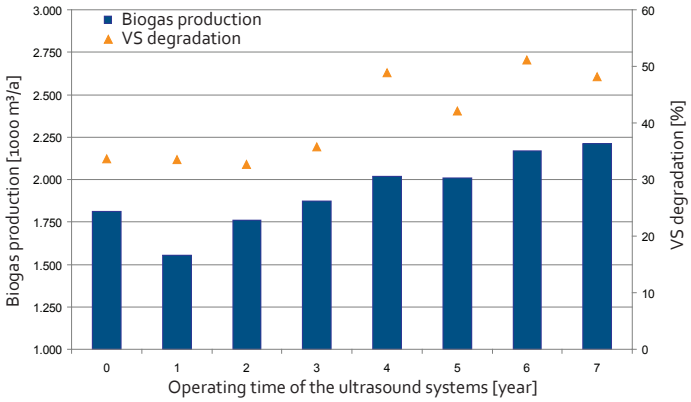
One of our first installations has been in operation on the Bamberg wastewater treatment plant since 2004. The plant is equipped with two ultrasound systems (5 kW each), which sonicate an excess sludge volumetric flow, of around 80 m³ daily. On the long-term average, we have recorded an average specific energy consumption as low as 2.4 kWh/m³.

This remarkably low value shows that use of our ultrasound equipment is far more economical in practice than is often assumed, and is not comparable to often published data from experimental laboratory tests.

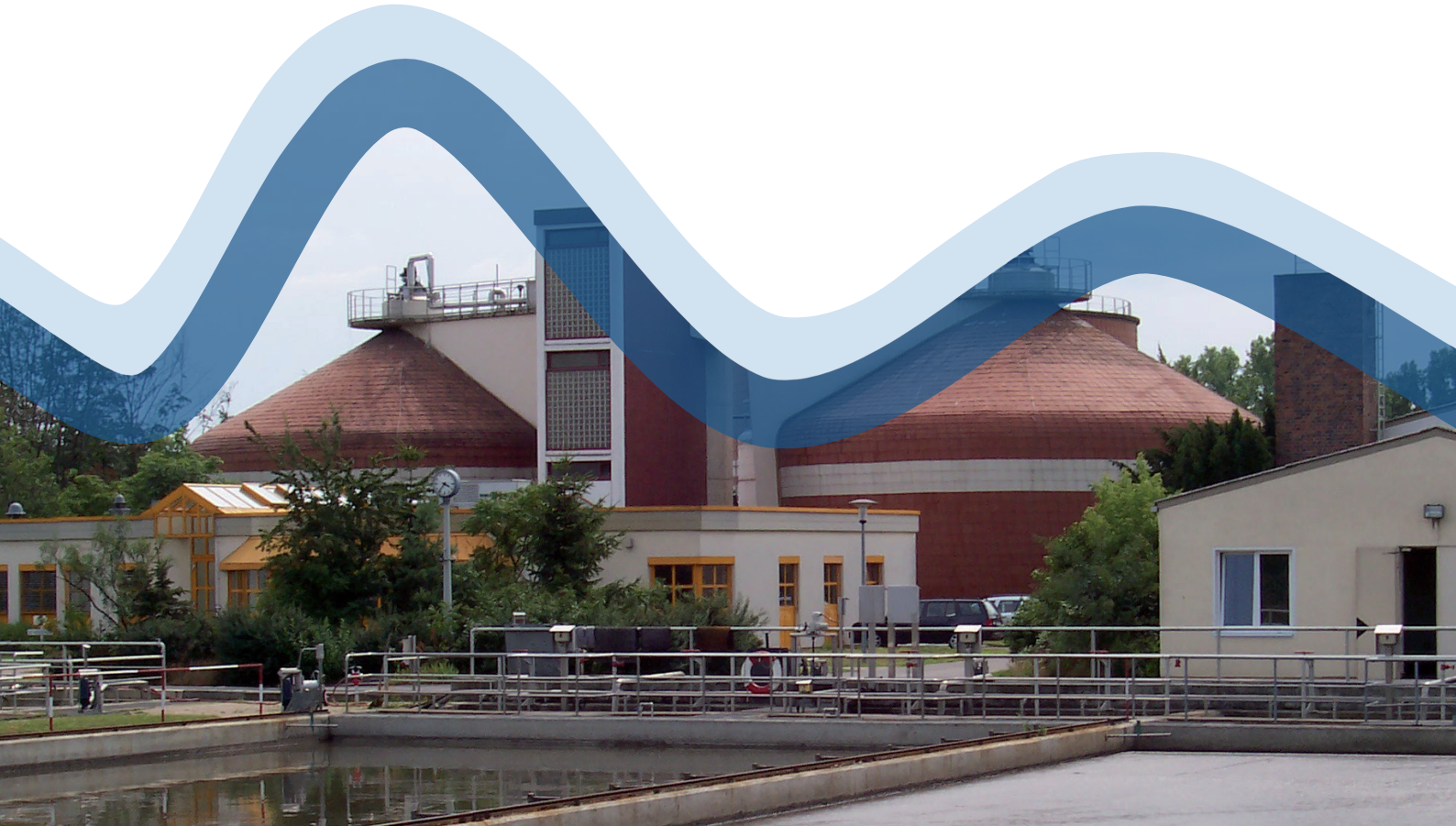
"Permanent positive development of biogas production and degradation rate of the wastewater treatment plant in Bamberg."

Installation of the ultrasound systems

Ultrawaves ultrasound systems can be very easily integrated into municipal and industrial wastewater treatment systems. The standard ultrasound unit (5 kW) is very compact with a footprint of only 1.45 m x 0.25 m and therefore requires little space. On-site, it is only necessary to provide inlet and outlet connections as well as an electrical and water connection. The ultrasound units usually operate 24 hours a day.



Development of biogas production and anaerobic sludge degradation on Bamberg wastewater treatment plant



Reduction in greenhouse gas emissions

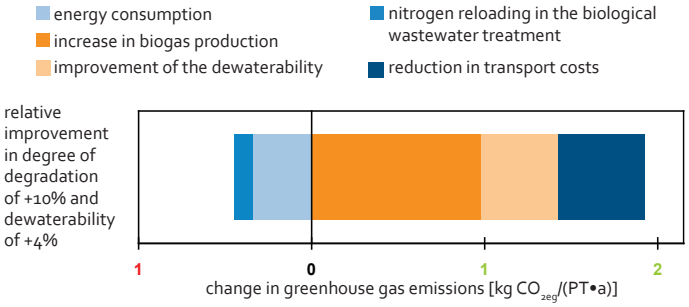
Positive CO_2 balance due to ultrasound

Electricity produced from biogas is climate-neutral, which is particularly positive for the greenhouse gas balance. Therefore, by using the Ultrawaves ultrasound systems, the CO_2-neutral energy production can be further increased.

"Significantly lower CO_2 emissions."

The mathematical model drawn up by Ultrawaves calculates the emission reduction achieved by using ultrasound, as the following example shows: In a wastewater treatment plant with 100,000 p.e. ultrasound achieves a 10% relative increase in anaerobic sludge degradation. As a further consequence the dewaterability of the digested sludge is increased by 4% (relative). These effects result in a reduction in the annual greenhouse gas emissions by 1.5 kg CO_2 equivalents per p.e. This corresponds to a reduction of around 150 tonnes CO_2 equivalents per year for this wastewater treatment plant.

Further and more detailed descriptions of case studies as well as our reference list are presented on our website.



Reduction in greenhouse gas emissions through ultrasound

About ULTRAWAVES

Ultrawaves GmbH develops and markets innovative high-power ultrasound systems for water and environmental engineering. Apart from the application on biomass in wastewater treatment and biogas plants, our systems are also used in industrial applications. The company was founded in 2001 as spin-off company from Hamburg Technical University (TUHH) and since then has worked closely with research facilities and industrial partners. Through our extensive sales and partner network we are represented internationally and offer a worldwide service.

The advantages in summary

Sludge treatment

- Improved degradation of the organic fraction of sludges
- Increased biogas production
- Less residual sludge
- Better dewaterability
- Safe, reliable operation even with short retention time

Bulking sludge and foam

- Prevention of bulking sludge and foam

Wastewater treatment

- Optimised nitrogen degradation
- Reduced quantity of sludge at disposal
- Disinfection of highly turbid waters

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