Improving the efficiency of biogas production

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The Wave-Box

Developed by PRE – Neubrandenburg, Germany

Who is PRE?

23 years experience in:

- Production and utilisation of energy from biomass
- Design and engineering of biogas plants
- Planning of heating, cooling and air conditioning systems
- District heating systems

Priority of work:

- Optimisation of production and utilisation of biogas
- Research and development (hydrolysis, ultrasound)

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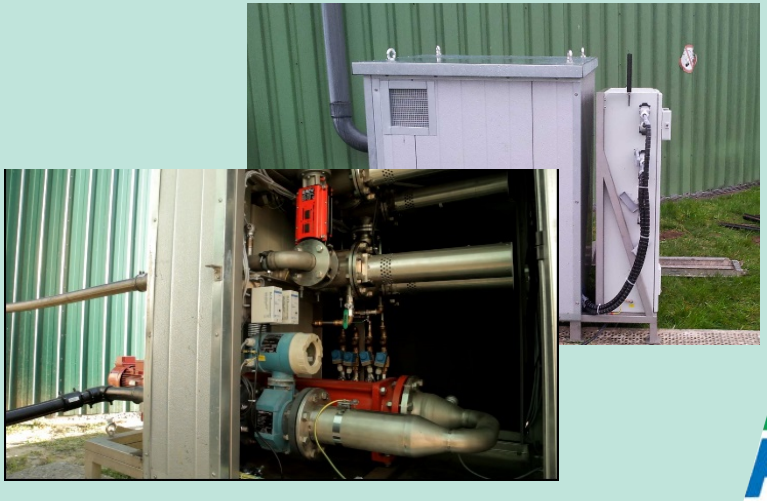
Examples of research products and patents

Express Hydrolysis

High Performance Digester

Kombi Hydrolysis



Ultrasound Wave-Box

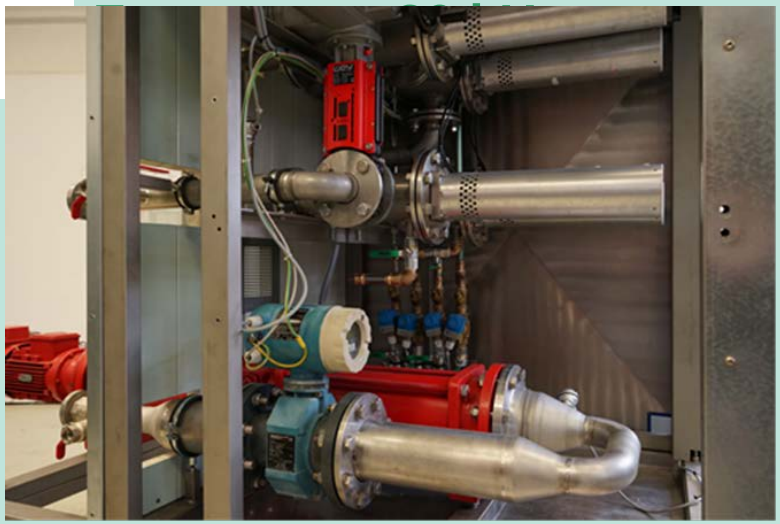
The Wave-Box

Developed by PRE (Neubrandenburg, Germany) supported by scientists of TU Hamburg

What is the Wave-Box?

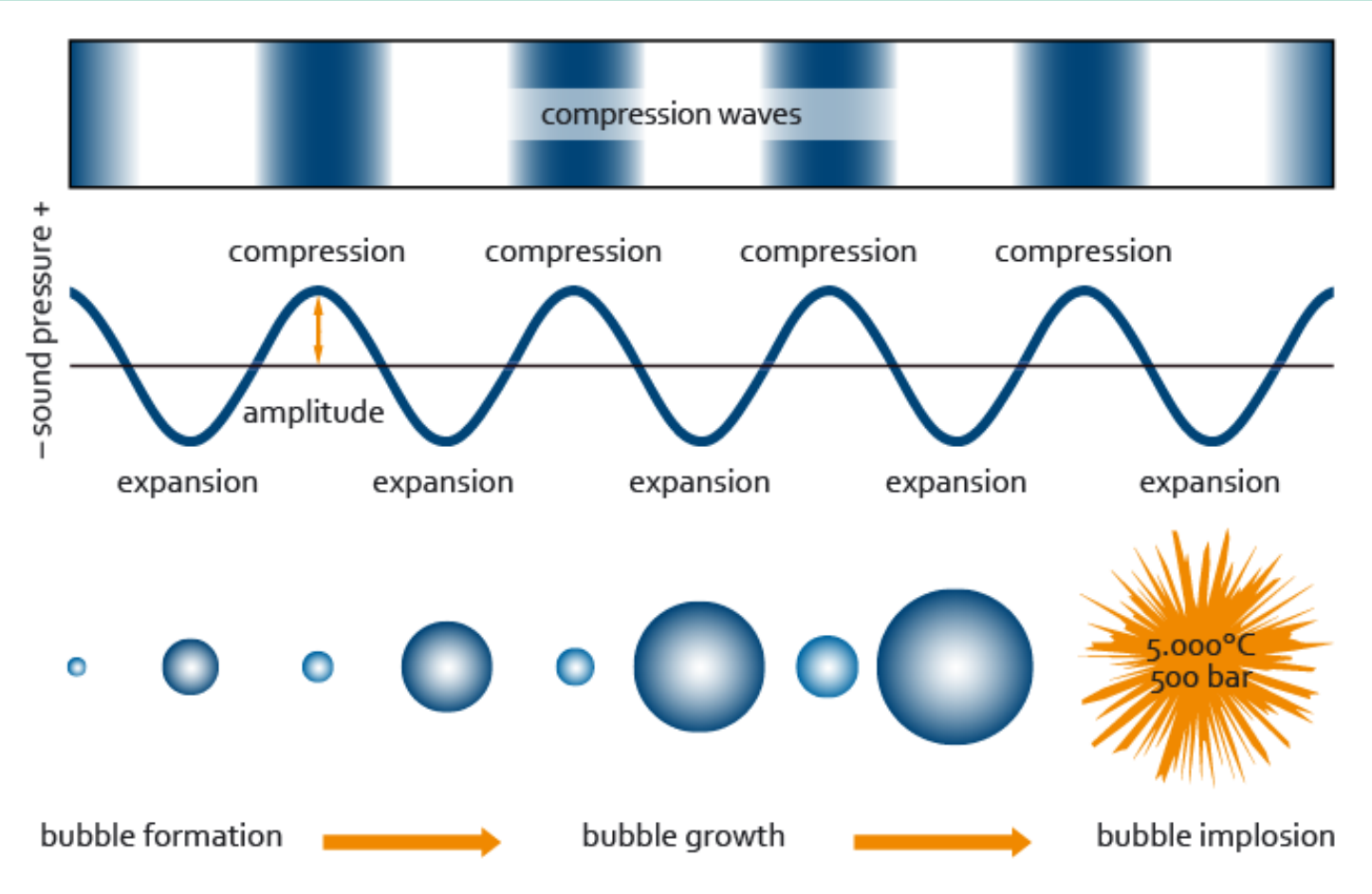
- > Ultrasound system for the disintegration of biomass
- > Usable for different kinds of biomass and VS content
- > Integrated High-Power-Ultrasound-Sonotrodes (HPUS)

Each sonotrode: 1 kW power



- Hydraulic optimised piping
- Compact design – adaptable and scalable
- Self-regulating control unit

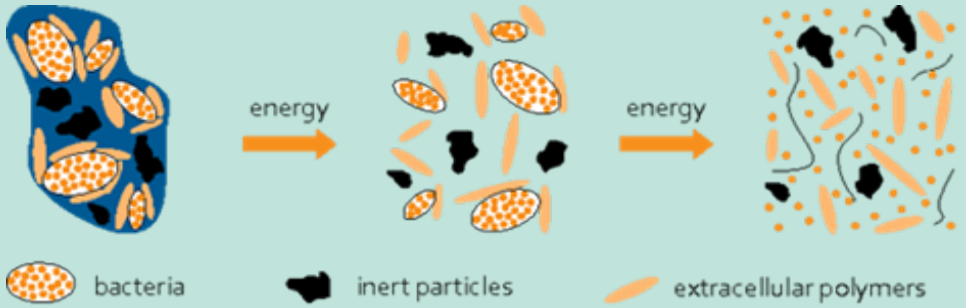
Generating of cavitation by ultrasound

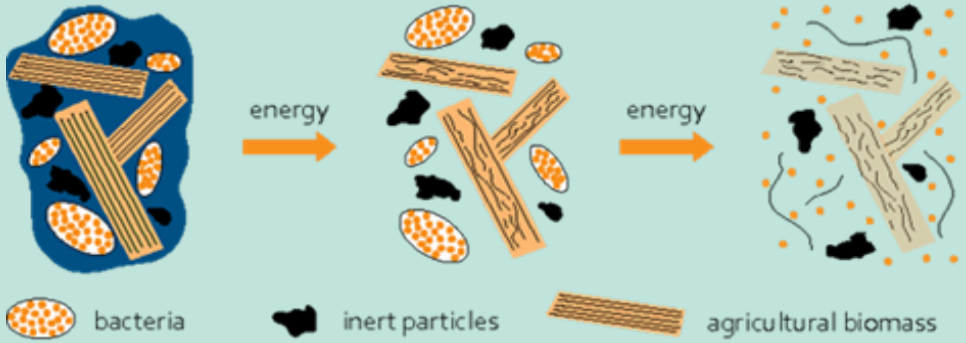


Physical process of cavitation

(Figure source: Sonotronic Nagel GmbH, Karlsbad)

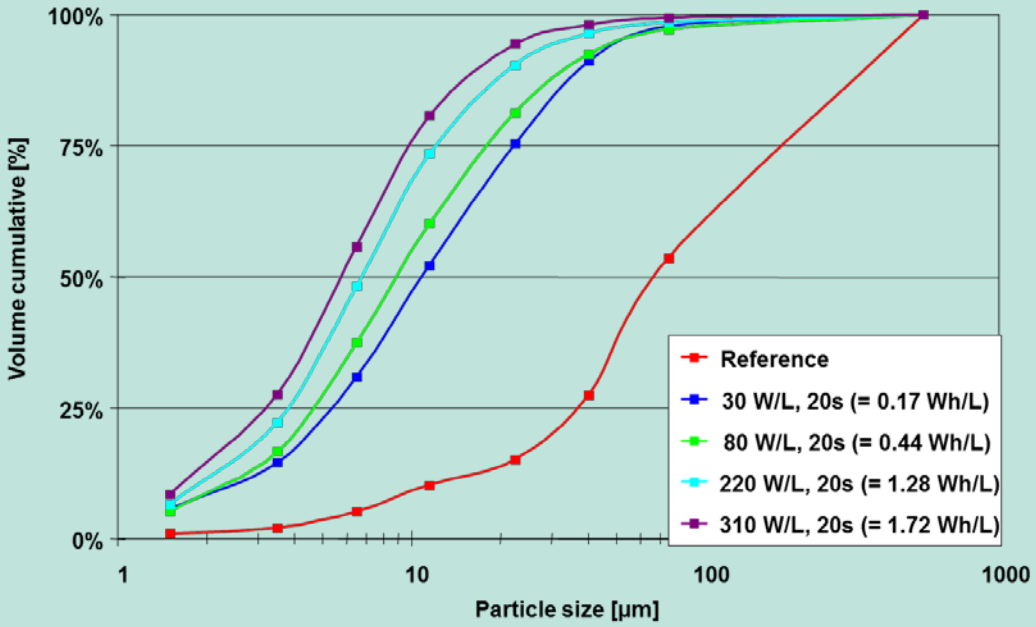
Effect of cavitation on organic structures





Upper line: effects on sewage sludge,
Lower line: effects on bacteria and agricultural biomass
(Figure source: Sonotronic Nagel GmbH, Karlsbad)

Effect of sonication on particle size distribution



Influence of increasing ultrasound energy input on particle size
(Figure source: TU Hamburg)

Physical effects:

- Lignin/hemicellulose-complexes destroyed
- Surplus of bacteria disintegrated: nutrients, enzymes and other organics become available
- Percentage of small particles increases
- Soluble COD increases
- Additional organic fraction available for methane production

The Wave-Box
Biological and physical effects

Degradation enhancement:

- Significant higher CH_4 content
- Lower VS after whole process

Reduction of viscosity:

- Reduction of agitating time in digester and digestate storage
- Shorter pumping time, reduced wear and tear

Physical-chemical stability:

- No uncontrolled chemical reactions,
- (substances are not thermally modified)

The Wave-Box

What are the operational advantages of the Wave-Box?

- Maintenance friendly
- Small footprint, no additional tank
- Long life cycle replacement intervals
- Hydraulic optimised volume stream
- Wide range of VS input possible without pre-thickening
- Enhancement of fiber rich feedstock (straw, manure)

Case study 1: Zarrenthin

500 kW_{el} unit

Zarrenthin 1 (without Wave-Box)

- 20 m^3/d cattle slurry
- 20 t/d maize silage
- 5 t/d grass silage
- CH_4-content 52%
- VS in digestate 5.8 %

Zarrenthin 2 (with Wave-Box)

- 20 m^3/d cattle slurry
- 17 t/d maize silage
- 3 t/d grass silage
- CH_4-content 56%
- VS in digestate 4.8 %

Case study 1: Zarrenthin

Wave-Box, treating second-step-digester medium, recirculating into Kombi-Hydrolysis

Case study 2: Göritz

Göritz before Wave-Box
76 m^3/d cattle slurry
6 t/d cattle manure
9 t/d maize silage
8 t/d grass silage
CH_4-content 52%

Göritz after Wave-Box
76 m^3/d cattle slurry
10 t/d cattle manure
5 t/d maize silage
4 t/d grass silage
CH_4-content 56%

Case study 2: Göritz

Göritz biogas plant: Wave-Box, treating second-step-digester medium, recirculation back to digester

Wave-Box installation at Demmin

Demmin biogas plant: 716 kW_{el}
Wave-Box, treating digester medium,
recirculation back to digester

Wave-Box installation at Rechlin

Rechlin Biogas Plant:
537 kW_{el}

Wave-Box,
treating digester medium,
recirculation back to digester

PRE Kombi-Hydrolysis

Efficient biogas production from manure and agriculture residues – can be combined with Wave-Box

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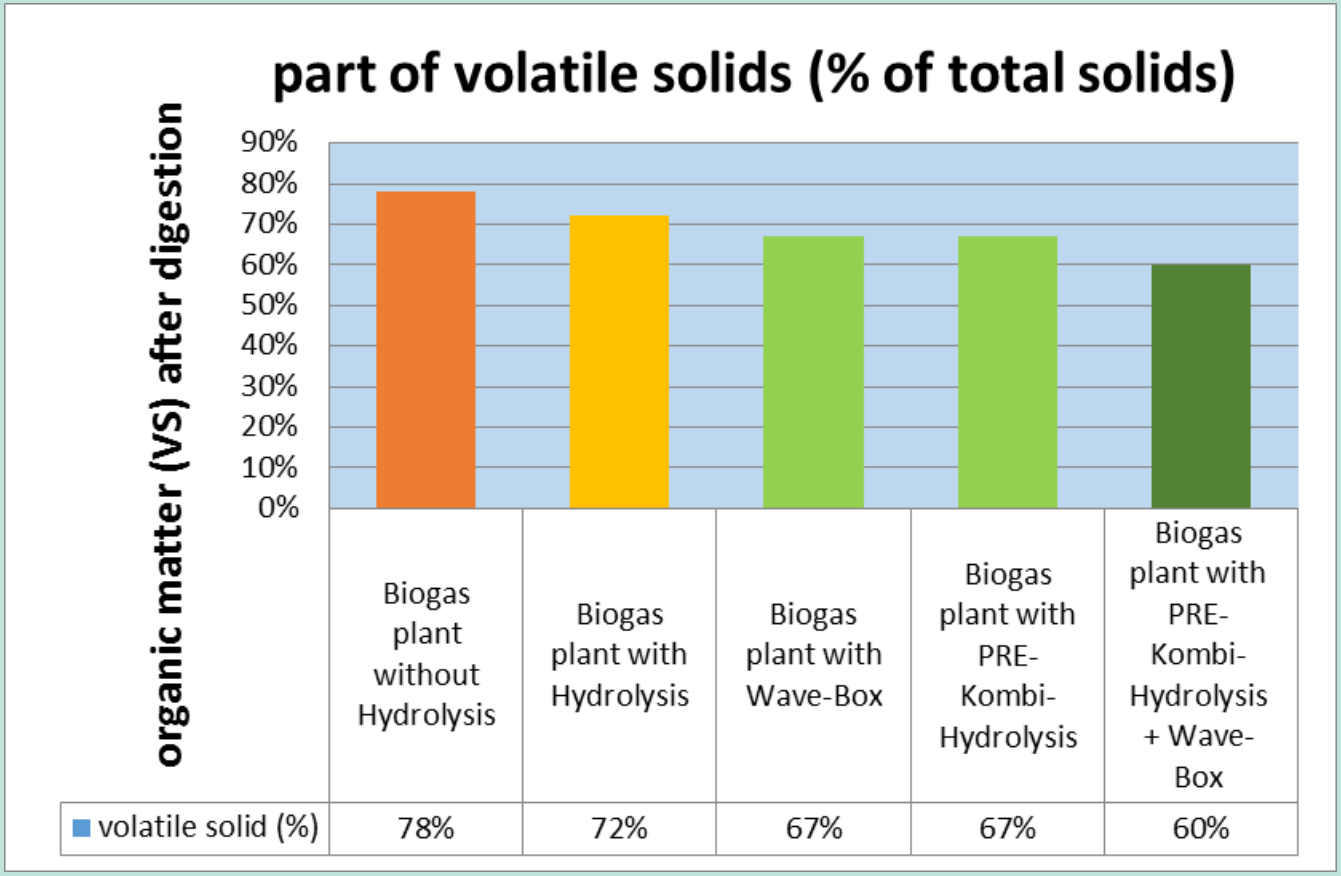
Potzlow Biogas Plant (North-East Germany) with Kombi Hydrolysis

Feed stock: manure and dairy slurry

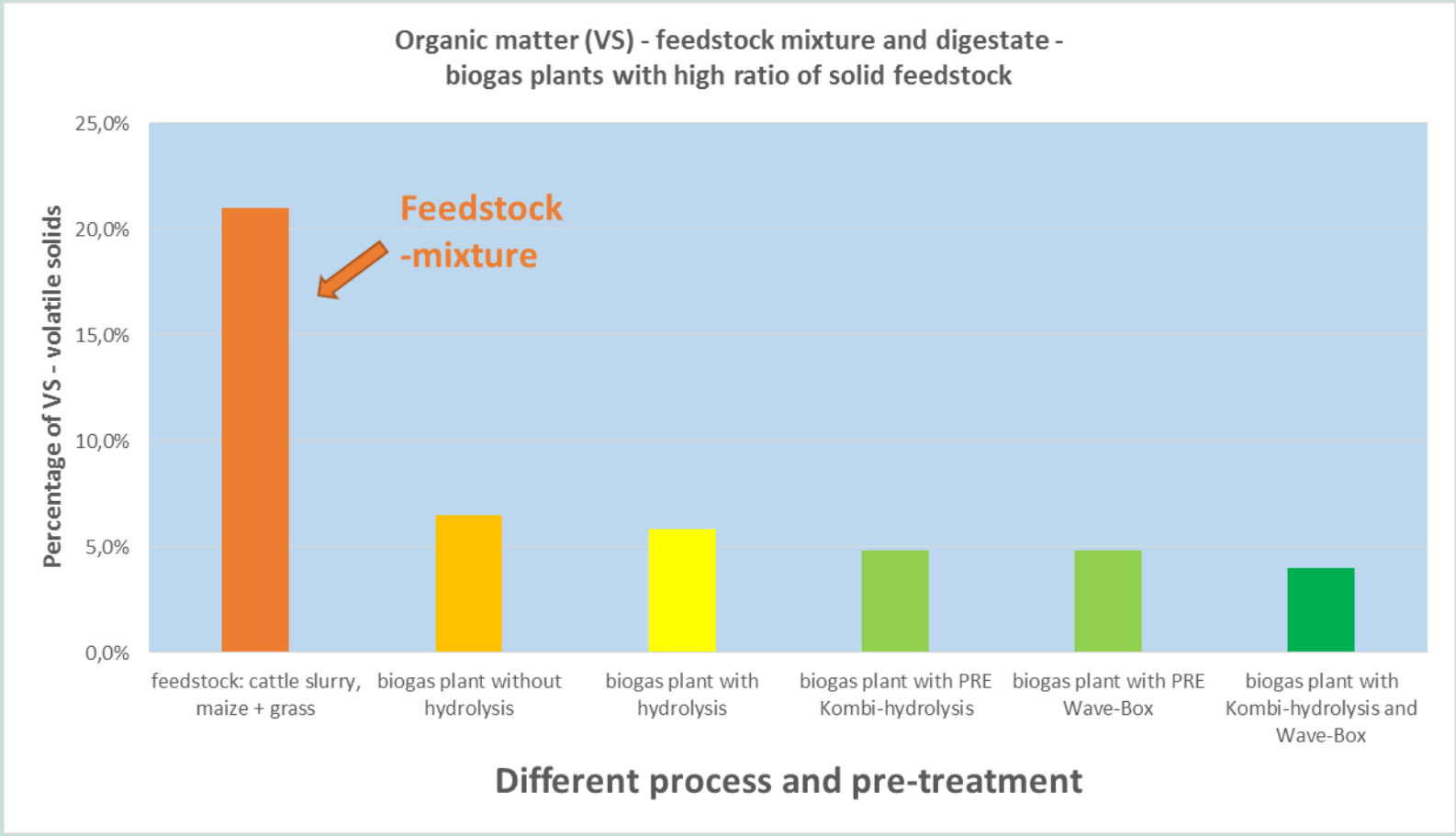
Degradation of organic matter

Effect of different pre-treatment systems on organic material with low degradability (straw, manure)



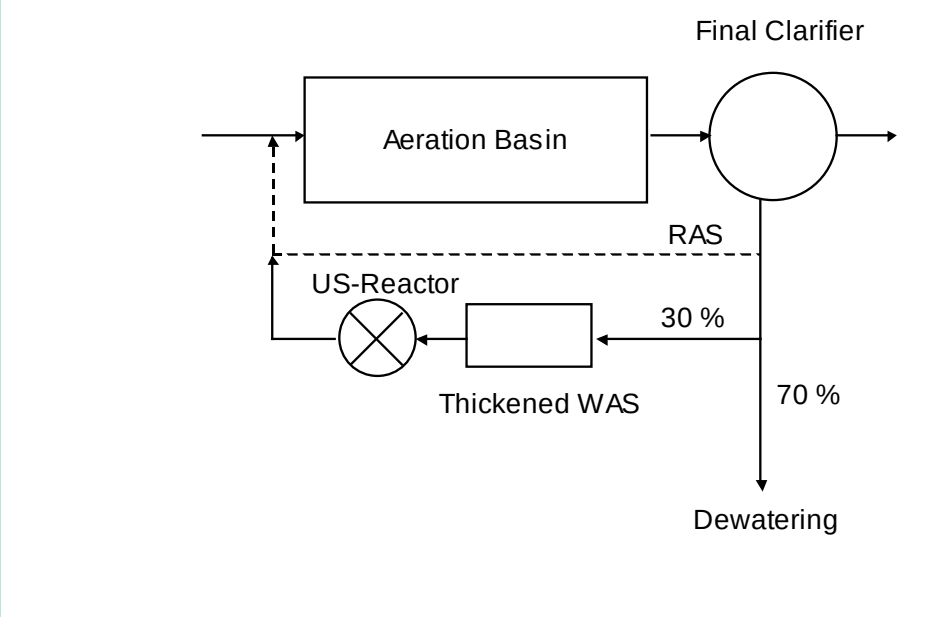
Degradation of organic matter

Effect of different pre-treatment on organic matter content (compared with fresh feedstock mixture)



Ultrasound Waste Water SludgeTreatment

Ultrasound technology reducing activated sludge (WAS)



Leinetal, Germany

- Designed Load: 50,000 PE
- Actual Load: 65,000 PE
- Extended aeration
  (18 d sludge age - aerobic)

Goals:

- Increasing VS destruction
- Reducing sludge volume

Solution:

Sonication of 30%
of the WAS (~ 33 m³/d)
@ 3.6 kWh/m³

ULTRAWAVES
WASSER & UMWELTTECHNOLOGIEN GMBH

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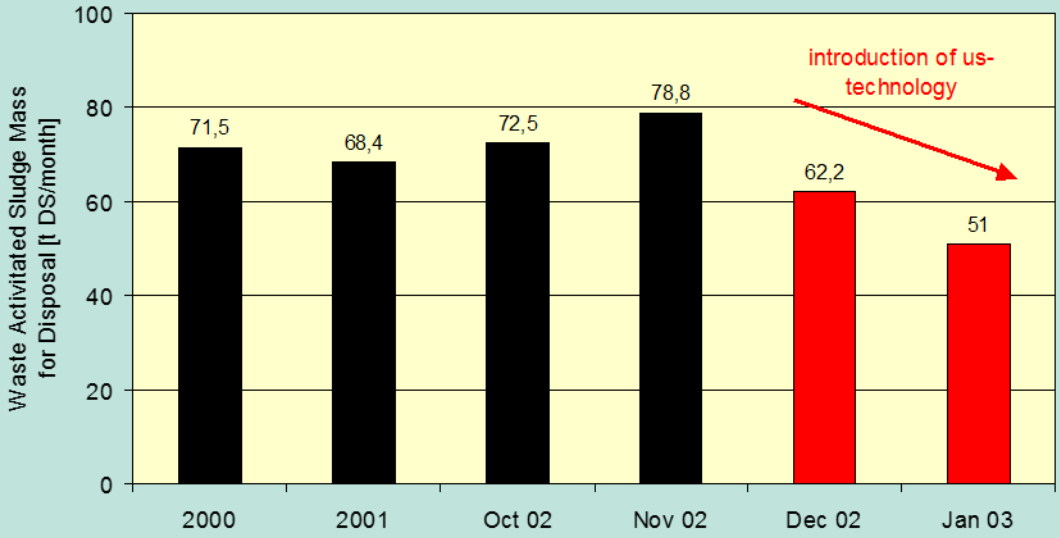
Ultrasound Waste Water Sludge Treatment

Ultrasound technology reducing activated sludge (WAS)



Results of US-installation in Leinetal:

- 25% reduction of sludge mass
- Better stabilized end product (reduced organic content)
- No foam and no floating sludge in the aeration tank
- Avoided construction of a new aeration tank

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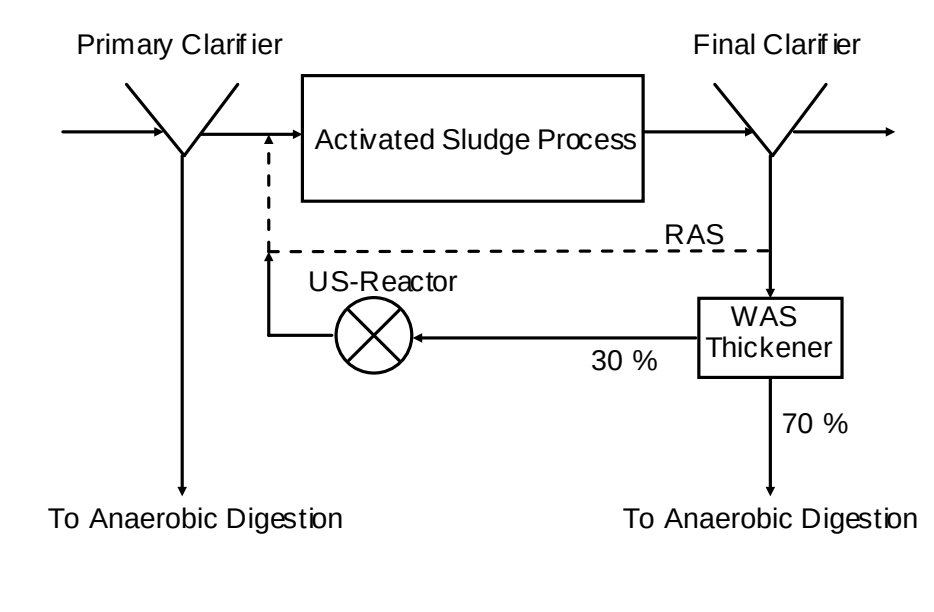
Ultrasound Waste Water SludgeTreatment

Ultrasound technology reducing activated sludge (WAS)



Bünde, Germany

- Designed Load: 40,000 PE
- Actual Load: 54,000 PE
- 22 d sludge age (anaerobic)

Goals:

- Sustainable N-reduction
- Reducing sludge volume
- Reduction of filamentous bacteria

Solution:

Sonication of 30%
of the WAS (~ 30 m³/d)
@ 4.0 kWh/m³

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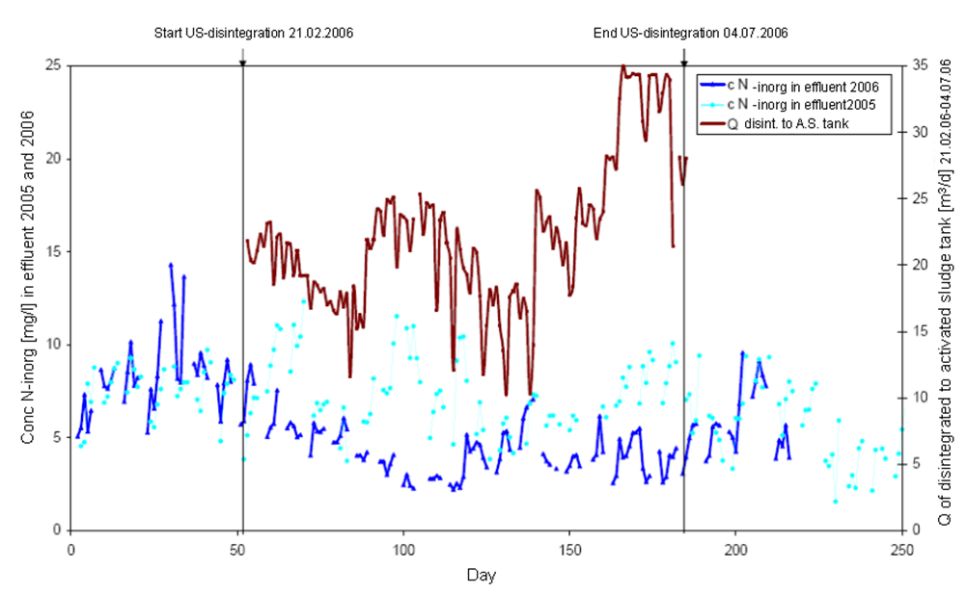
Ultrasound Waste Water Treatment

Ultrasound technology reducing activated sludge (WAS)



Results of US-installation in Bünde:

- 25% reduction of waste activated sludge (WAS) mass
- No foaming or bulking sludge in the activated sludge tank
- Reduction of the nitrogen concentration in effluent (N < 5 mg/l)

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The Wave-Box: Summary

Conclusion:

- Short payback period (<3 years), return of investment up to 50% p.a.
- Low parasitic energy load. 15x return on parasitic load.
- No operational staff required
- Remote, on-line monitoring by supplier
- Availability of spare parts assured
- Easy to install and maintenance friendly
- Small footprint: < 10 m^2 for a 700 m^3/h biomethane plant
- Helping to lower biogas GHG emissions
- Increase percentage of biogas from wastes and residues

The Kombi-Max: Outlook

R&D funding project:

- Participants: PRE, Uni Rostock, INP Greifswald
- Combination of ultrasound and plasma technology
- Cavitation and ionisation in one chamber
- Proposed synergistic effects (physical and chemical)
- Increasing efficiency in biomass disintegration (lignin)
- Increasing of biomethane/biogas
- Destroying of hazard chemicals in waste water
- Using the experience of Wave-Box construction and operation

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Different PRE - biogas plants

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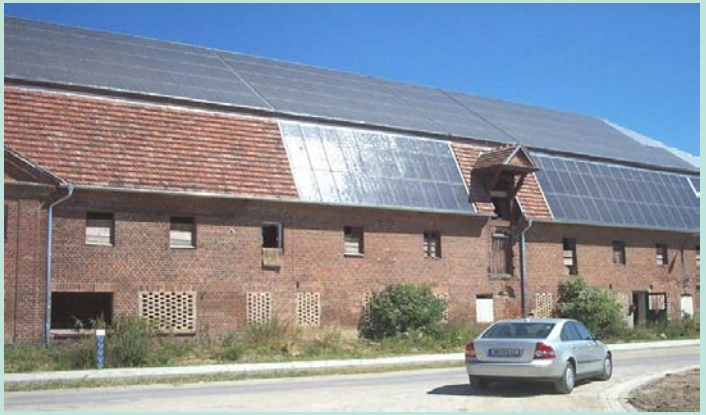
Renewable energy village with biogas plant, district heating and power generation by CHP; photovoltaic system



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Trust ultrasound – your benefit!

Thank you for your attention!

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