Ultrasound against biofilm formation in industrial settings :

1 . Short history

The use of ultrasound technology to specifically treat liquids and their **inherent properties to form biofilm** on their contact surfaces was first discovered in 1998 by a Belgian inventor Mr. Hilaire Thomas. Due to his success with tomato growers (to avoid slime formation on drip feeding lines) and the treatment of ponds and pools (to avoid phytoplankton, algae and cyanobacteria growth) the system was further improved to **avoid diseases** in plant nurseries (i.e. stop the growth of all kinds of harmful bacteria such as fusarium oxysporum, agrobacterium and phytophthora)

Further investigation proved the succesful elimination of **Legionella Pneumophila** in humid environments such as industrial cooling towers and public showers.

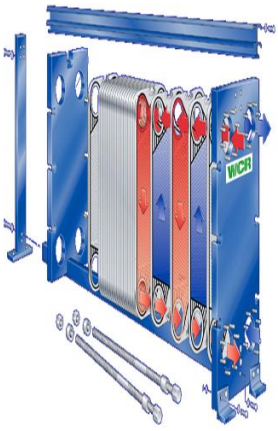
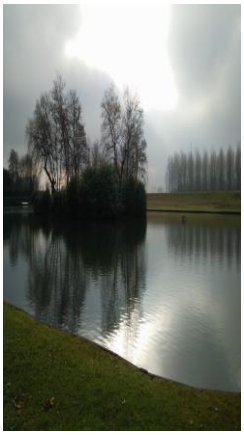
Trough a serendipitous event it was further discovered that also **calcium carbonate** ($CaCO_3$) can both be **prevented** and **removed** from pipes, tanks and heat exchangers.

This lead to the next obvious step in trying to remove similar Calcium-like layers like **beerstone** or calcium oxalate (CaC_2O_4). University studies and coöperation with some partners in the brewery sector resulted in a better understanding of the biological processes between ultrasound and beer. The devices were improvement accordingly.

As you can imagine, biofilm formation and subsequent contamination and fouling is a very wide subject involving many industries.

Therefore, new fields of application are regularly encountered.



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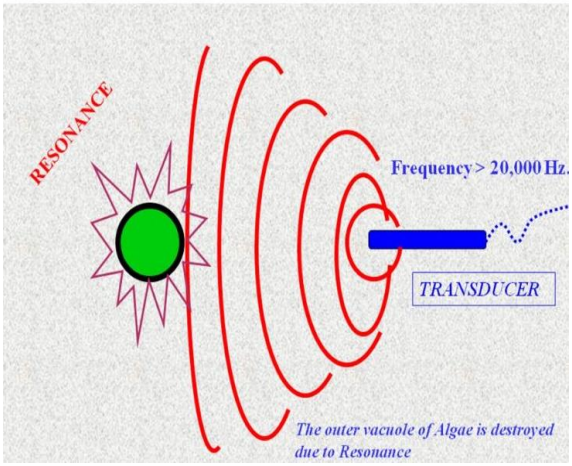
2. How the technology works?

Obviously this technology contains some proprietary rights and specifications but here is what we can share:

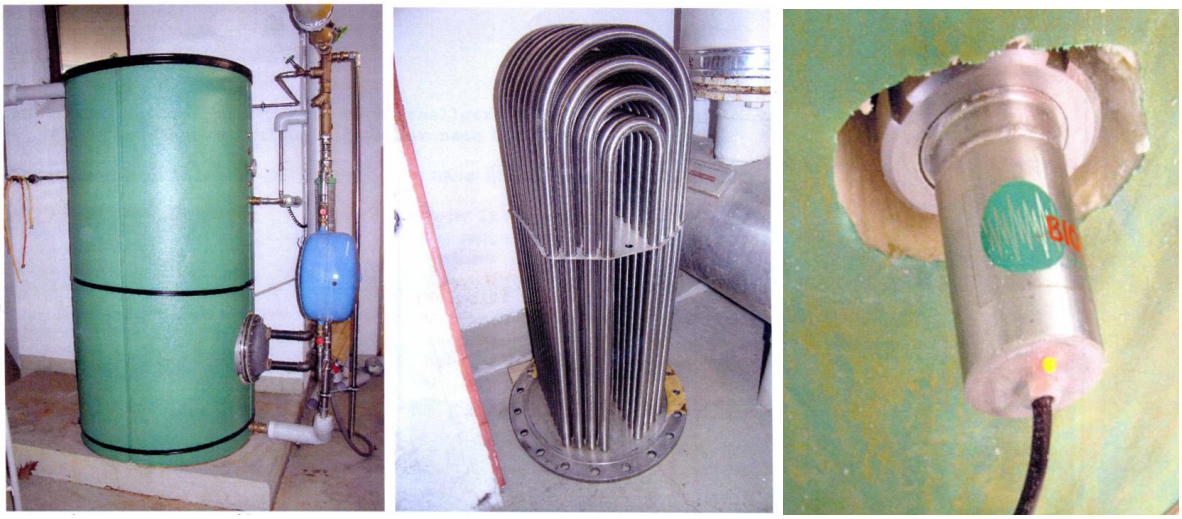


- Acoustic frequencies are chosen to mimic the resonant frequencies of bacteria and the vacuoles of algae. This results in cell membrane damage and finally stagnation of growth of single-celled organisms and algae.
- The acoustic signal-train has a specific algorithm and pulsed shape to avoid the habituation effect that microbes use to survive.
- Stress is induced on the micro-organisms troughout the liquid and walls to avoid the settling of any particle on a surface.

3. Beneficial effects of ultrasound techniques

The most important beneficial effects of this type of ultrasound systems are:

- the treated liquid is chemically **not** altered.
- The formation of **Calcium compounds** can be both **prevented** and, if already present, **removed**. Te scalant will be dissolved, layer-per-layer, back into the liquid in its natural form. (not abrupt with flaking or clogging as a result).
- the rate of (harmful)bacteria-growth (measured in cfu's) is reduced and finally **completely halted** over time.
- there is **no** degassing effect on the treated liquid.
- with ultrasound technology we **avoid** :
    - the use of **harmful** chemicals, herbicides or antibiotics
    - **dismantling** and **downtime** of the installation
- unlike most environmentally damaging chemicals and surfactants, ultrasound:
    - can reach **hair-cracks and pores**
    - can reach otherwise **difficult to reach places** (like dead-ends)
- the system can be used at places and circumstances where heat treatment is not practical or possible (for example >60° for Legionella prevention)
- there is no AntiMicrobial Resistance (AMR) or habituation effect as compared to many anti-microbial agents.
- In the food industry, another beneficial property is that the **texture** or **taste** of the liquids are **not** altered.



Example of calcium carbonate removal on a boiler system.

Since biofilm is a phenomenon that is widely present and with many negative effects in different industries, the applications are very wide.

Avoiding biofilm formation has proven its benefits on:

- Health and safety
- Production and quality
- Exploitation and labour costs
- Equipment availability (MTBF)
- Energy consumption
- Aesthetics

And this in an ecological and environmentally friendly way.

Examples of some industries and possible applications:

- Ponds and pools (both recreational and fish farming)
- Removing harmful bacteria from hydroculture and aquaponic systems
- (waste) Watertreatment and irrigation systems
- Water treatment for large airconditioning installations
- Removal and prevention of bio-fouling from tanks and heat exchangers
- Avoiding fouling on ships' hulls and seachests.
- …

4. Main Specifications

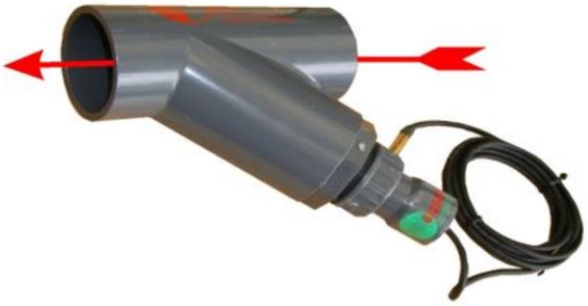
- a sturdy and splashproof electronic controlbox with indicating control LED.
- the connection is plug-and-play on 230V (or 110/130V on request).
- one or more transducer(s) (IP68) connected to the controlbox.
- a nominal power consumption of approximately 10W(e)/transducer.
- after installation, there is no further maintenance required.
- an expected lifetime of 20+years (oldest unit is now 17 years and still in use).
- the temperature, pressure or velocity of the liquid has no adverse influence on the efficiency of the treatment.

5. Installation

The installation can typically be done in four different ways:

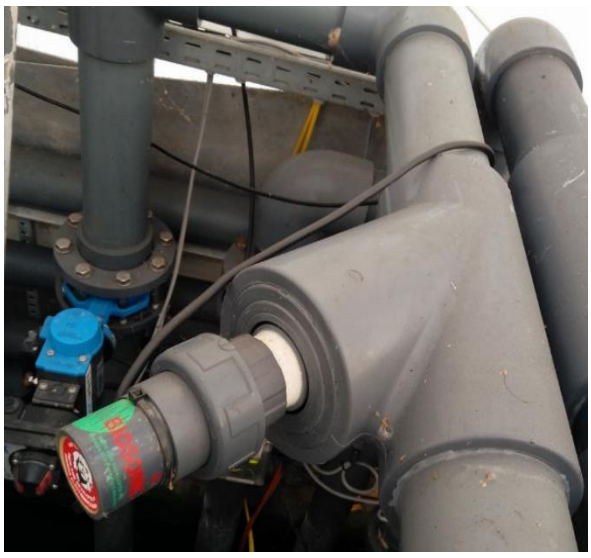
- Type '**biosonic**' :

  The acoustic signal is injected into the liquid of an existing piping system. The Y-piece can be delivered in stainless steel or PVC. Working pressures of up to 150bar are possible upon request.



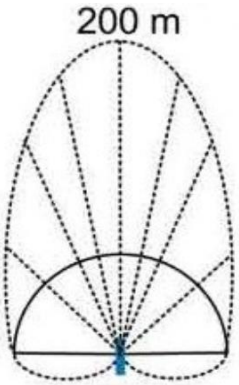
Example of installation on a plate heat-exchanger

Example of installation on a feedwaterline



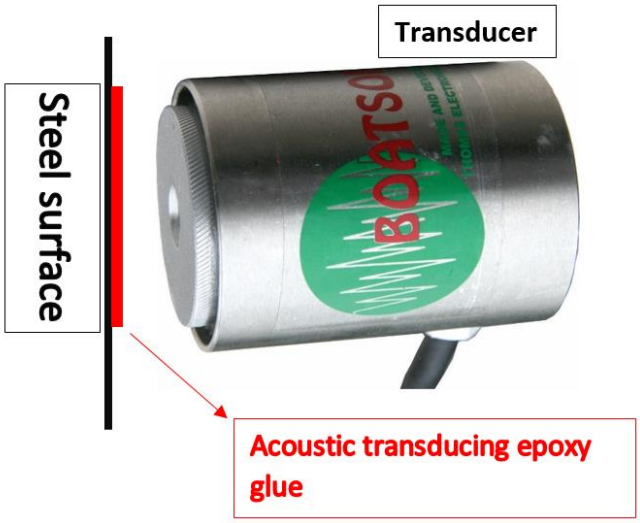
- Type '**aquasonic**' :

The transducer is placed submerged into the liquid. This can be done floating (on an optional PU-floater) or fixed to an existing structure in the tank/pond or reservoir.



- Type '**tanksonic**' :

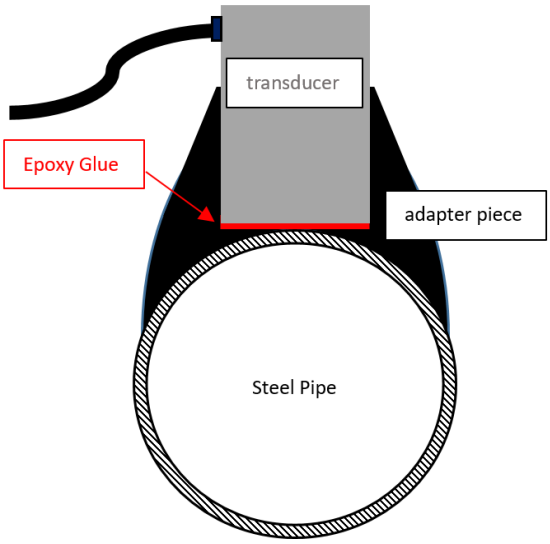
The transducer is glued onto the tank or pipe wall from the outside.
The tank or pipe has to be made from a hard and acoustic non-damping material. Preferably stainless or carbon steel.



The used glue is of the 2-component epoxy type with excellent acoustic conductance properties.

In the case of a steel pipe, an adaptor piece can be provided to optimize the contact surface.

Typical installation on a steel pipe:

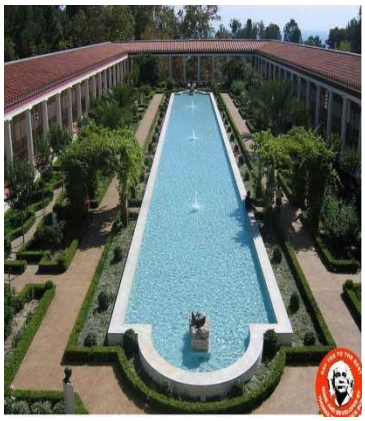


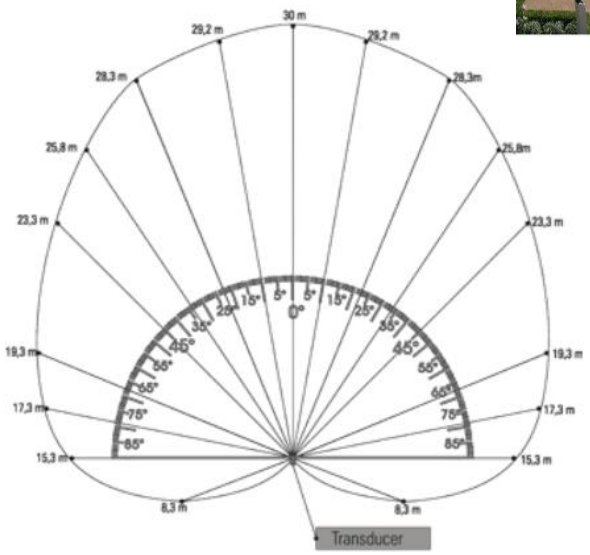
Depending on the diameter of the pipe, distances of up to 400m can be covered. Longer distances can be reached by amplification or adding transducers.

In all cases the acoustic signal can be measured at pipe and tank extremities to verify its effectiveness and adjustments can be made accordingly.

- Type **'poolsonic'** :

Here the installation is done trough a build in flush-mounted armature in the wall of a swimming pool. The acoustic signal has a beam width of 180° and follows a specific geometric shape.

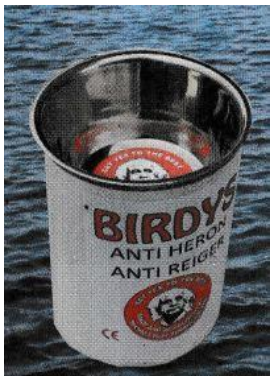




radiation chart

6. ***Other ultrasound products :***

Systems that are specifically designed to keep area's free from mammals such as foxes, squirrels, birds and pests such as rats, mice, etc…



References, client testimonials and studies are available upon request.