48.- USO_3, ultrasound based technology

Title and name of product or technology
USO3 cleaning the future - **ULTRASOUND BASED DISINFECTION TECHNOLOGY**
Abstract
Usable water is the most significant precious resource on earth and is quickly becoming the scarcest. Over the coming decades increased demand for hygienic clean water is reaching a critical point. The availability of usable sanitary water is an explosive issue and has strong impact on the economic situation. This premise underlies the drive to improve water and waste water treatment capabilities and its attendant economics. Wastewater treatment challenges apply to all industries, businesses – public and private - national, regional and local in scope. The diminution of water quality coupled with the high cost of treatment expresses the necessity to develop new technical solutions offering lower operation cost and increased performance. The internationally patented **USO3** technology covers most aspects of today's water and waste water treatment problems. The **USO3** consists of two implemented processes, leading to excellent results by a unique combination of ultrasound and ozone. This combination allows a utilization of the **USO3** for different waste water problems, such as disinfection, EDC reduction, upgrading biological treatment plants by improving the aeration and therefore reducing the overall discharge parameters such as COD, Nitrogen and Phosphate etc. The fundamentals for the conceptual and the final series engineering were derived from pre-tests with a technical scale model and industrial scale models supported by an EU LIFE project. The technology was awarded as one of the Best LIFE-Environment Projects 2006 – 2007 by the European Commission.
Description including main features/advantages
The liquid enters the system through a pump or the hydrostatic pressure. The first treatment step is the exposure of the liquid to ultrasound in a resonance section. In contradiction to state of the art applications the ultrasound is introduced directly into the water through ceramic transducers. This leads to low power consumptions while at the same time high frequencies can be transmitted to the water. A monitoring system controls and levels the frequency tolerances of the ceramic transducers by utilizing a digital synthesis. The second treatment step is the ozone-gas-injection. Besides the ultrasound treatment and the alignment of the ceramic transducers inside the resonance chamber the quality of the ozone-gas dissolving is playing a very important role in the overall efficacy of the **USO3**. The optimized gas dispersion is accomplished by a specially developed mixing disc – the **OPTIMIXER**. The **OPTIMIXER** dissolves gases, such as ozone, at atmospheric pressure extremely efficient at low power consumption rates. In the third treatment step the liquid is exposed to another ultrasound section following the **OPTIMIXER**. Hence the **USO3** utilizes the cavitation phenomenon as well as the efficiency of an AOP (advanced oxidation process). The cavitation generated through the use of ultrasound causes extremely high local pressures and temperatures without increasing the liquid temperature above ambient level. The complete unit is computer controlled and can be monitored and operated remotely. The main advantages of the **USO3** are:

General:

1. It can be operated in a system overlapping manner - meaning one technology offers multiple solutions which normally would need more than one technology component.
2. It reduces cost for water treatment at improved cleaning efficacy.
3. In addition to solving current problems the technology also offers problem solutions for the future, e.g. EDC's and PPCP's without the necessity to invest in additional equipment.
4. The technology offers a modular, compact and flexible design with easy implementation in existing processes.
5. The maintenance and personnel demands are very low.

Specific:

1. Destruction of all pathogenic bacteria, fungus and viruses
2. Degradation of DNA
3. Reducing EDC's and PPCP's
4. Odor elimination
5. Discoloration
6. Inactivation of algae
7. Micro flocculation
8. COD reduction
9. Effective oxidation
10. Effective in clear and turbid waters

Innovative aspects

There are two different innovative aspects:

1. Ultrasound:

   The way to use and to introduce the ultrasound to the water is unique and extremely successful. In contradiction to the current market-ready and available ultrasound systems, the ultrasound is applied directly into the effluent via a ceramic piezo instead of using a sonotrode.
   Therefore a significantly lower amount of energy is necessary and higher frequencies can be generated. Due to the direct application of the ultrasound, the specific generated frequencies can be controlled and adjusted to the given design variations of the ceramic transducers by a digital synthesis. The created acoustic field compresses and expands the liquid in the rhythm of the generated frequency leading to extreme pressure changes.
   The liquid exposed to such pressure loads is disrupted within the dilution phase and creates small vapour bubbles with a diameter of up to 100 micrometers. These so called cavitation bubbles collapse rapidly and create additional pressure waves. On the inside of the bubbles a vacuum with extreme pressure conditions is created. In the following positive pressure phase the cavitation bubbles implode – these characteristics contribute to the distinguished cleaning effect of the **USO_3**.

2. **OPTIMIXER**

   A fast rotating disc with a defined profile, surface and hole-pattern dissolves the ozone gas into water through an inverted venturi effect. Due to the high circumferential speed, which is integrated over the whole surface area of the disc, a turbulent flow is created. This flow optimizes the inverted venturi effect leading to high gas dissolving rates.

   In combination with the ultrasound a special water condition is generated originating in a direct correlation between efficiency of the gas dispersion and a combination of ultrasound and the mixing disc.
   One of the major advantages is the small weight of the disc which is the only

moving part. Other systems either move great amounts of water through a small nozzle or press air with high pressures through porous membranes.
The low weight of the disc and the direct operation in the actual water stream of the **USO$_3$** lead to very low energy consumptions.
The major novelty is the shape, the profile and the hole-pattern of the mixing disc in conjunction with the ultrasound. They all contribute to the ideal efficacy of the **USO$_3$**.

Current and potential industrial users/domains of application

- Food & beverage industry
- Fish-farming
- Chemical industry
- Pharmaceutical industry
- Hospitals
- Drinking water works
- Pulp and paper industry
- Municipal treatment plants
- Industrial treatment plants
- Each application in need of water/liquid disinfection
- Each application in need or already using ozone.

Current state of development

After 10 years of development two series products in different sizes are already available and are actively being marketed. A 4inch unit and a 12 inch unit each for gas-injection or as complete **USO$_3$** system.
With these two sizes throughputs from 1-5 m³/h up to 50m³/h can be covered. Higher throughputs can easily be provided by parallel operation allowing high performance safety.

Higher throughput might be developed in the middle-term.

The R&D department is currently concentrating on various different projects such as turbidity control of the **USO$_3$** operation, MAP flocculation and MAP recycling set-ups, two sided piezo design and oxygen gas recovery for reuse for the ozone generator operation.
For the near future special research on the effect of antibiotics should be an interesting field for the R&D group of Ultrasonic Systems.

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