

Patent Application

New Method for the prevention of Biofilm and Algae formation

Description

Organisms that attach to and grow upon hard and soft (non-acoustic transmitting) objects below the surface of the water are numerous. In this environment, waterborne organisms such as algae and weed together with barnacles, tunicates and other organisms which form encrustations, colonize wetted or submerged parts of objects and surfaces. Fouling of the hulls of vessels, platforms, subsea structures, pipelines, cables and subsea facilities as well as to fish farm enclosures, harbour infrastructure, jetties, waterways and inland ponds, pools, lagoons and lakes are all associated with sometimes serious problems, be it mechanical interference, cleaning, access, inspection or health issues.

When fouling occurs then it tends mainly to be removed by mechanical or chemical methods. However, these alternatives can take considerable time and can be extremely costly or environmentally unacceptable. It will involve logistical issues and may require long waiting periods or "down-time". If for example a vessel hull is cleaned in dry dock, the vessel must be taken out of service. The costs are therefore significant as there is the cost of cleaning the vessel and the vessel down-time. However, the effect of fouling on fuel consumption and performance can be so extreme that it is necessary for owners to remove the vessel from the water, sometimes every two weeks for cleaning.

Existing ultrasonic based methods and systems are mostly established on acoustically coupling "resonating devices" onto fixed and "acoustically transmitting" structures and surfaces and they are all limited in that there is often a very low level of performance following installation. Additionally, objects which cannot be acoustically coupled, such as plastic, rope and polymer structures, are extremely difficult to protect from fouling. Systems tested in cooler waters may appear to operate effectively as the growth of organisms are slower. In warmer conditions, whether the system is working effectively or not will be more readily apparent and usually does not meet expectations. While the use of ultrasonic cavitation and waves in underwater "cleaning systems" is well known and has been proved to be effective in preventing, killing and removing bio-organisms, in practice standard ultrasonic fouling prevention systems do not appear to work effectively and reliably across a range of applications and operating conditions. Testing and feedback from numerous users have indicated that, in many cases, the system made no difference to prevention, adhesion or growth of organisms.

The proposed anti-fouling arrangement has fundamental and innovative differences in its design and application.

Instead of relying on "acoustic coupling" to a structure or surface, such as a ship's hull, the proposed arrangement uses a wire or tube "antenna / radiator / transmitter"

to radiate vibration directly to its environment. This wire or tube can be "free falling / floating" in the water or can be loosely attached to any surface in need of fouling protection. This mitigates many problems of vibrational losses, echo's, wave interference and ships structural interferences.

The "wire or tube" arrangement further allows for a bending or contouring of the "antenna / radiator / transmitter". This allows for applications such as, curving / profiling to ships hulls, following structural contours of submerged surfaces and objects, loose integration into fish farm net enclosures and other "soft" objects and assets, complete coverage of relatively long and curved (up to 20 meters and more) submerged pipeline interiors and exteriors, following waterways which may be curved or twisted.

Compared to "Ultrasonic Horn" arrangements, the proposed arrangement radiates vibration through a radial, axial and torsional manner and over a long length of wire (up to 20 meters and more). This leads to a greatly improved effectiveness compared to unidirectional horn arrangements which have limited coverage and tend to be largely effected by waves, water flow and obstructions.

When using a plurality of "actuator / wire or tube" arrangement, coverage of an area or volume of water can be maximised and efficiency optimised through intermittent and alternating use of power between each of the "actuator / wire or tube" arrangements.

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Claims

1. An anti-fouling arrangement for submerged aquatic structures and objects which comprises of one or more ultrasonic actuators each of which are mechanically / acoustically connected to a wire or tube of metal construction in the form of a very flexible and slender rod or tube which acts as an antenna / radiator or emitter, whereby, each wire or tube can have varying diameters and lengths and the physical properties of the wire or tube enable it to be deflected / bent at angles without having any large effect on transmission of ultrasonic vibrations down the full length of the wire or tube in question, whereby the "actuator / wire or tube" arrangements can be used as single devices or can be used in a group or multitude of single devices enabling greater anti-fouling coverage / distance particularly when combined with a generator, based on Multi-frequency, Multi-mode, Modulated Sonic & Ultrasonic Vibrations, which allows for the production of extremely high number of harmonics and whereby the anti-fouling arrangement allows for ultrasonic vibration transmission, nearby but not connected to, the objects or surfaces to be protected, and into surrounding water directly from the wire or tube, which acts as an antenna / radiator or transmitter, and without the need for acoustic coupling to the surface or structure to be protected.
2. An anti-fouling arrangement according to claim 1. wherein an ultrasonic actuator is connected and powered by a specially designed ultrasonic generator (according to EP 1 238 715 A1)
3. An anti-fouling arrangement according to claim 1. & 2. wherein the ultrasonic actuator is acoustically coupled to a wire or tube
4. An anti-fouling arrangement according to claims 1. - 3. wherein the wire or tube acts as an antenna / radiator or transmitter of acoustic waves.
5. An anti-fouling arrangement according to claim 4. wherein the acoustic waves produced in the wire or tube are transferred radially, axially and torsionally into the surrounding water.
6. An anti-fouling arrangement according to claim 5. wherein the acoustic waves produced in the wire or tube mitigate the need for acoustic wave transmission via acoustic coupling to any "other" submerged structure or surface.
7. An anti-fouling arrangement according to claims 1. - 6. wherein the wire or tube may have a diameter ranging between 0,5mm to 10mm or more
8. An anti-fouling arrangement according to claims 1. - 7. wherein the wire or tube may have a length of up to 20 meters or longer

9. An anti-fouling arrangement according to claims 1. - 8. wherein the "actuator / wire or tube" device can be employed as a "singular" anti-fouling arrangement.
10. An anti-fouling arrangement according to claim 9. wherein the singular "actuator / wire or tube" device has a limited range for transmission of vibration to surrounding water
11. An anti-fouling arrangement according to claims 1. - 8. wherein several "actuator / wire or tube" devices can be employed as a "multiple device" anti-fouling arrangement.
12. An anti-fouling arrangement according to claim 11. wherein several "actuator / wire or tube" devices have a greatly extended range for transmission of vibration to surrounding water
13. An anti-fouling arrangement according to claims 1 - 12. wherein the ultrasonic generator may supply acoustic signals to the singular or multiple "actuator / wire or tube" device(s) on a continuous basis or an intermittent basis (on/off) depending on the specific "anti-fouling" environment
14. An anti-fouling arrangement according to claim 11. wherein the ultrasonic generator may supply acoustic signals to the multiple "actuator / wire or tube" devices on an alternating basis depending on the specific "anti-fouling" environment
15. An anti-fouling arrangement according to claim 11. wherein the ultrasonic generator may supply acoustic signals to the multiple "actuator / wire or tube" devices as a combination of alternating and intermittent transmission depending on the specific "anti-fouling" environment
16. An anti-fouling arrangement according to claims 13.-15. wherein intermittent or alternating transmission or a combination of both will lead to overall reduction in overall power requirement.
17. An anti-fouling arrangement according to claims 13.-15. wherein intermittent or alternating transmission or a combination of both will lead to the potential reduction in the total number of required power generators associated with the anti-fouling arrangement.
18. An anti-fouling arrangement according to claims 1.-17. wherein the singular or multiple anti-fouling arrangement may be employed for fouling protection of marine and fresh water vessels.
19. An anti-fouling arrangement according to claims 1.-17. wherein the singular or multiple anti-fouling arrangement may be employed for fouling protection of submerged structures and objects such as oil and gas pipelines, risers, cables, processing equipment and subsea facilities.
20. An anti-fouling arrangement according to claims 1.-17. wherein the singular or multiple anti-fouling arrangement may be employed for fouling protection of fishing nets, fish farm enclosures and other similar flexible and fixed structures.

21. An anti-fouling arrangement according to claims 1.-17. wherein the singular or multiple anti-fouling arrangement may be employed for fouling protection of harbour infrastructure and facilities such as jetties, harbours and marinas.
22. An anti-fouling arrangement according to claims 1.-17. wherein the singular or multiple anti-fouling arrangement may be employed for fouling protection of onshore ponds, pools, lakes, lagoons and other such large bodies of water.
23. An anti-fouling arrangement according to claims 1.-17. wherein the singular or multiple anti-fouling arrangement may be employed for fouling protection of any objects submerged in onshore ponds, pools, lakes, lagoons and other such large bodies of water.
24. An anti-fouling arrangement according to claims 1.-17. wherein the wire antenna / radiator or transmitter of acoustic waves can be formed or bent, with angles of up to 30 deg, or more so as to follow objects or surfaces, such as fish farm enclosures, ships hulls, pipelines and submerged structures.
25. An anti-fouling arrangement according to claims 1.- 17. wherein the acoustic waves transferred into the water cause vibrations and cavitations which destroy, denature or discourage attachment of algae and other single-celled organisms to submerged surfaces and structures.

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Summary

A new and unique method comprises of an ultrasonic based anti-fouling arrangement for an aquatic structure or surface. The method reduces fouling on underwater structures, through the use of acoustic vibration / cavitation to destroy, denature and discourage attachment of algae and single-celled organisms. The anti-fouling arrangement comprises of one or more ultrasonic actuators each of which are mechanically / acoustically connected to a wire or tube of metal construction in the form of a very flexible and slender rod or tube which acts as an antenna / radiator or emitter. This enables placement of such an arrangement near a structure or surface to be protected but without the need for acoustic coupling or connection to the structure or surface to be protected. Each wire or tube can have varying diameters and lengths which then determines it's specific emitting power, and wave characteristics. The wire or tube diameter can vary between 1mm and 10mm, or even larger diameters if necessary for very large structures and reservoirs, and the physical properties of the wire enable it to be deflected at angles of up to approximately 30 deg or more without having any large effects on transmission of ultrasonic vibrations down the full length of the wire in question. Some decay and attenuation will always exist along very long wires and tubes.

Through the agitation of the wire or tube / actuator from an acoustic generator, based on Multi-frequency, Multi-mode, Modulated Sonic & Ultrasonic Vibrations (also known as MMM), axial, radial and torsional vibrations are created in the wire which are then transferred to the surrounding water and amplified via the MMM generator so as to effectively radiate vibrations radially from the wire and along the complete length of the wire which can be as long as 20 meters or more. Depending on the specific application, each "actuator / wire or tube" arrangement can be positioned and utilized as either, a single ultrasonic anti-fouling device or as one of a group of similar single devices to form a "multiple device system" enabling larger volume or distance coverage. The novel "actuator / wire or tube" arrangement, its bending capability, it's radial transmission and simple application in free standing water or loose attachment to solid objects enables effective ultrasonic fouling prevention of various hard and soft surfaces and objects over large distances especially when in combination with the MMM based generator.

When operating as a "multiple device system", the anti-fouling effects may be achieved through continuous ultrasonic operation of all individual devices or through alternating and / or cyclic operation between the single devices which would lead to

overall reduced power consumption and the need for a reduced number of power generators (or possibly only one single power generator)

This new and unique method relates to an ultrasonic anti-fouling system: More particularly, this invention relates to a system and method of preventing, reducing and removing growth of bio-films, marine organisms, unicellular organisms' algae, and Crustacea (barnacles, zebra shells etc) in both fresh water, inland waterways and sea water environments. Applications could include ships hulls, and other types of marine and fresh water vessels along with other submerged structures and objects such as oil and gas pipelines, risers, cables, processing equipment and facilities, fishing nets, fish farm enclosures, harbour infrastructure and facilities such as jetties, harbours and marinas, whether they themselves transmit / conduct ultrasonic vibrations or not.

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Sketches

Fig. 1

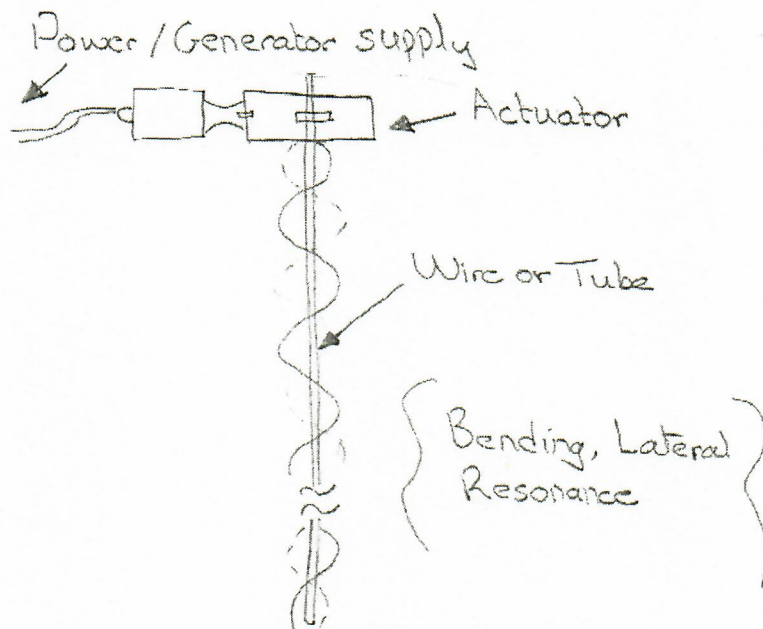


Fig. 2

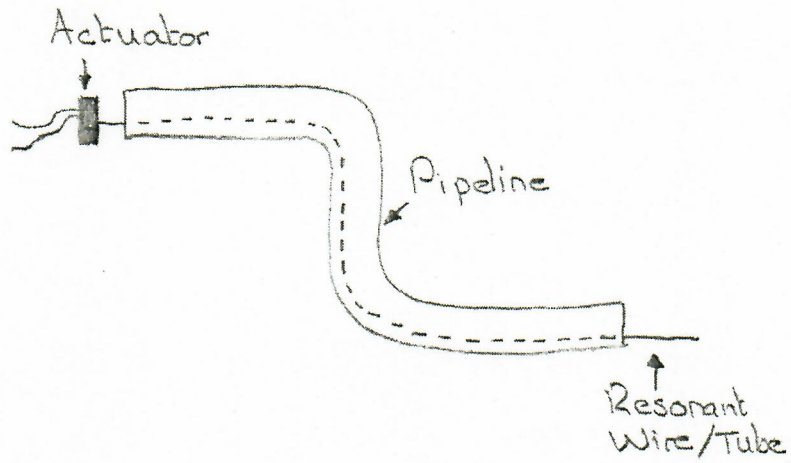
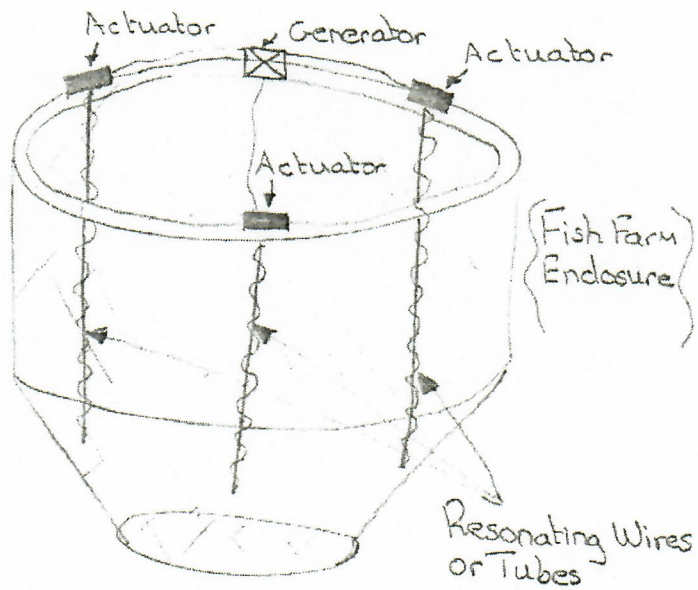


Fig. 3



- Fig. 1 = Actuator / wire / tube arrangement
- Fig. 2 = A typical "non-linear" application
- Fig. 3 = Fish farm enclosure with example of alternation and/or intermittent use of wire/tube resonating assemblies