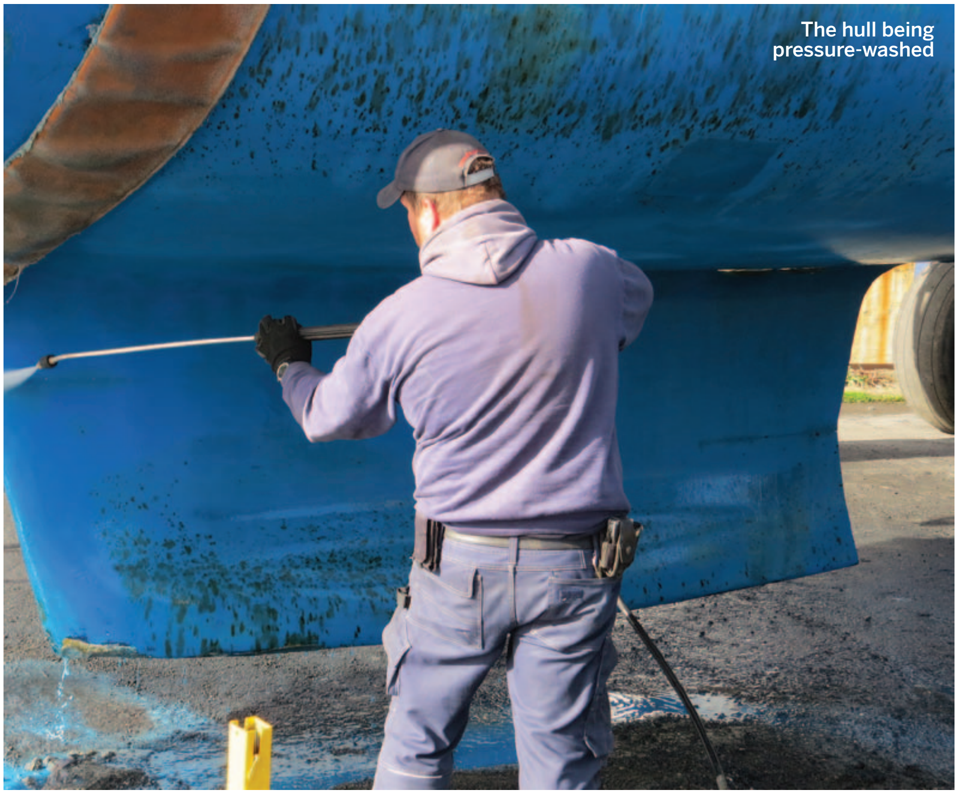
SONIHULL

Bad Vibes for Barnacles

Is ultrasonic antifouling the way ahead? by Nigel Calder



The hull being pressure-washed

Over the decades I have experimented with a number of different antifouling products and approaches. These have almost always been disappointing, and as a result I have invariably defaulted to the highest copper content antifouling paint that I can find, with my favorite being Pettit's Trinidad. (It has 75-percent cuprous oxide content in the red paint; the blue is lower.) Unfortunately, the paint is shockingly expensive (the list price is over $400 a gallon, although it can often be found at something around $250 a gallon) and increasingly environmentally unacceptable. The search for a viable alternative continues.

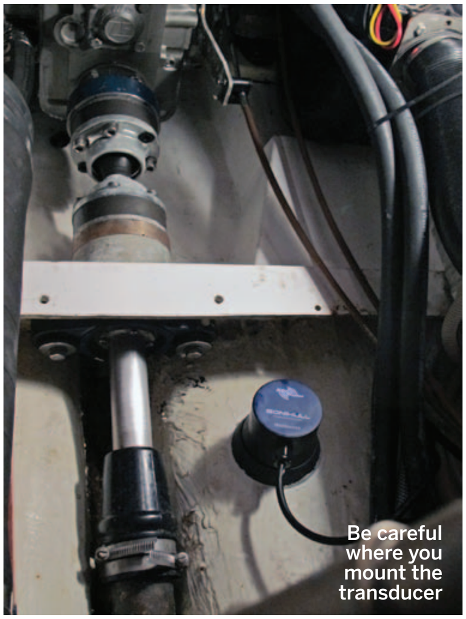
This past year we installed an ultrasonic antifouling system. There are at least four manufacturers jumping into this technology—Sonihull, UltraSonic, Ultra-SoniTec and CMS SonicShield. Our system comes from Sonihull, a UK-based company whose products are distributed in the United States by PYI. The reason I chose Sonihull is because I have a great deal of respect for PYI and the research the company does before taking on board any new products.

THE THEORY

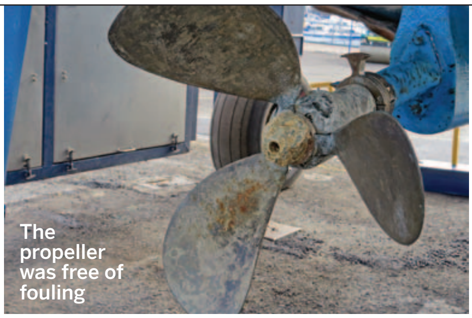
There is nothing new about the technology itself. You can find technical papers going back to the late 1960s describing how it works. What has changed are the legal and environmental frameworks governing the use of antifouling paints, and the cost-effective adaptation of modern electronics to this application. Concurrently, there has been a significant amount of research, which is ongoing, into what kinds of acoustic frequencies at what kinds of power levels and for how long are required to provide effective antifouling.

Here's the theory. All the devices on the market create pulsating acoustic waves in a transducer that is rigidly connected to a hull or other solid medium (such as pipework in a cooling system; in this piece I look only at hulls). The acoustic waves are transmitted to the hull, which acts like a sounding board, converting the acoustic waves into mechanical waves and feeding these into the water, agitating water molecules in contact with the hull. This inhibits algae (the building blocks within the food chain that result in seaweed and barnacle attachment and growth) from settling on the hull, and also cyprids (larval barnacles). For those algae and cyprids ("critters") that do settle, there is an additional defense mechanism. The critters each have a natural frequency. The critters oscillate at the frequencies transmitted into the water. When these frequencies coincide with the natural frequency of the critters, a considerable amplitude of vibration occurs (the resonant frequency) resulting in critter cell damage and death. Without the presence of live critters, the food chain is disrupted and no other growth occurs.

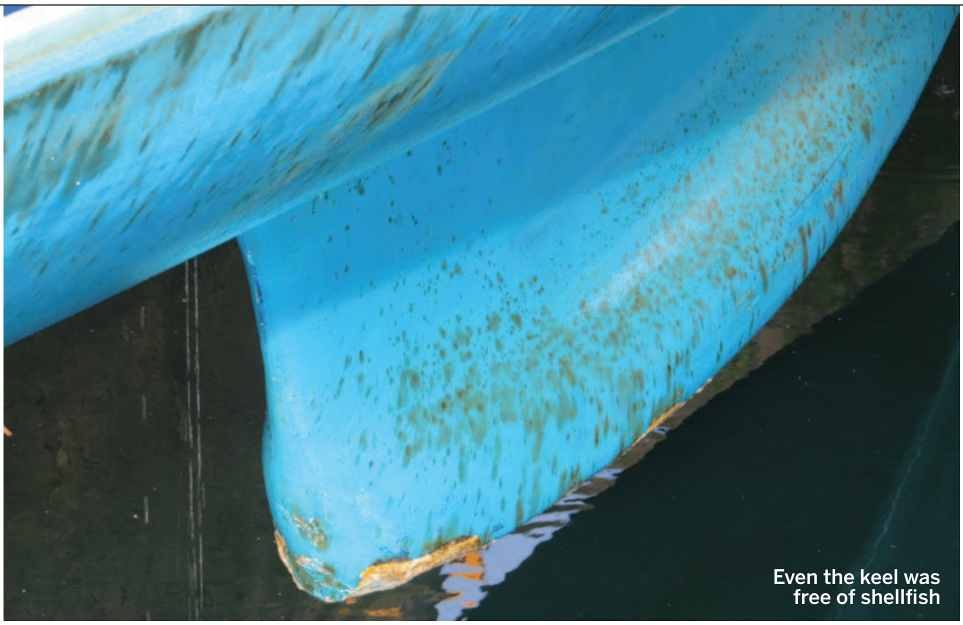
Certain frequencies cause microscopic cavitation in the water around the boat—the formation of tiny bubbles—while other frequencies cause the bubbles to collapse, generating microscopic shock waves. These shock waves



Be careful where you mount the transducer


The propeller was free of fouling


No critters on the rudder


Even the keel was free of shellfish

also damage cells and help to dislodge dead critters from the surface of the hull. Critters are also washed off when the boat is underway. Any remaining debris is easily brushed off.

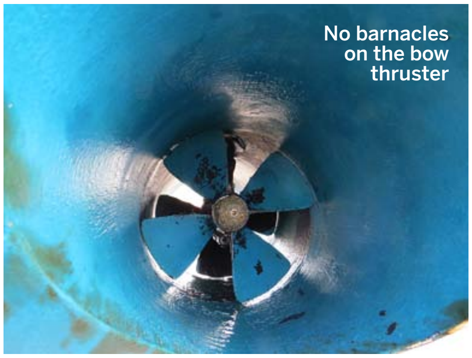
TRANSDUCER INSTALLATION

The equipment necessary for ultrasonic antifouling consists of two core components: the control module that generates the acoustic signals and transducers that transmit the acoustic waves to the hull. Installation of all systems is remarkably simple. It consists of—in one way or another—bonding the transducers to the hull, plugging them into the control module and supplying power to the control module.

The various systems on the market offer one to four transducers for most pleasureboat installations up to 60ft. More transducers can be used to cover vessels of just about any size. (There are a number of superyachts up to 200ft now using these systems.) As you might expect, those with fewer transducers claim they have more powerful or effective systems and as such don't need additional transducers, while those with more transducers claim they get better results. I have no way of judging competing claims.

Transducers need to transmit acoustic energy directly to a hull. As such, they do not work if installed over cored sections of hull, so the core must be stripped out and the inner skin bonded down to the outer skin in the transducer location. Similarly, they will not work on wooden hulls, because the wood absorbs the signals. Where they work best is on single-skin fiberglass and on metal hulls, although it is important that even in these two cases they not be located too close to bulkheads or any other structures that may be fastened to the hull as these will dampen the acoustic vibrations. (They should be at least a foot away.) Although the effective range of a transducer suspended in water is claimed to be as much as 40ft to 50ft, once fastened to a hull the damping effect of even fiberglass or metal substantially reduces this, which in turn limits the impact on semi-isolated components, such as struts, propellers and rudders. To protect these it is important to have a transducer as close as is practicably possible or, better yet, to mount a transducer on the transmission (to resonate through the propeller shaft and propeller) and the rudder post (to resonate through the rudder).

Good performance is dependent on getting a solid surface-to-surface connection between the face of the transducer and the hull. There are a couple of ways of accomplishing this. One is to cover the face of the transducer with epoxy and bond it directly to the hull, allowing the epoxy to fill in any unevenness between the hull and transducer to create a solid, void-free connection. The other is to bond a mounting ring to the hull into which the transducer is screwed once the epoxy has set up. In the latter case, petroleum jelly or something similar is sometimes used to fill the voids between the transducer and the hull. In other instances, a


No barnacles on the bow thruster

metal disc is smeared with epoxy and inserted into the mounting ring before the transducer is screwed in. The transducer then sits squarely on the disc with the epoxy on the other side of the disc being squished out to fill any voids.

Some transducers come with attached cables, in which case if mounted into a sealing ring the cables are held in a bundle and rotated with the transducer until it is fully screwed home. Some come with plug-in cables. The attached cables are generally preferred, as this creates a watertight cable connection. One way or another, transducer installation is remarkably easy, does not require a boat to be hauled out of the water and takes very little time.

CONTROL MODULES

The control module generates the acoustic frequencies. There will be a central processor programmed to control one or more generating devices that feed the signals to the transducers. Some systems have a single generating device, in which case if more than one transducer is used they are wired in parallel to the same generator. However, most have separate generating devices for each transducer. The latter is preferred both in terms of performance and redundancy. With separate generating devices, in some systems the transducers are synchronized to create the same frequency at the same time which helps to boost the effect at the signal overlap areas furthest from the transducers, but in other systems they are deliberately not synchronized in order to reduce the power drain at any given time. Other differentiating features between systems are the degree of waterproofing of the control box and its connections and switches, and the sophistication of any display device and the information available to the user.

The generating devices cycle through a range of acoustic frequencies, starting around 20 kHz, which is just above the audible range for human hearing, and going as high as 100 kHz. (The Sonihull runs through 13 different frequencies in a five-second cycle.) In theory the systems should not be audible, but in practice there is some noise at the transducers, which varies significantly from one brand to another. We can just hear the Sonihull

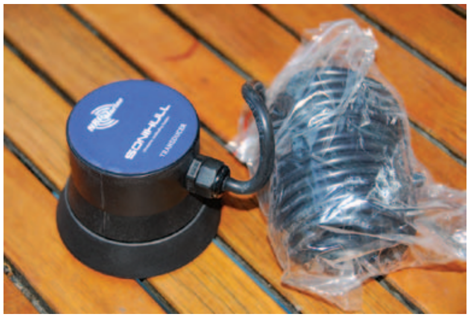
Getting a Buzz On

As Nigel says, installing an ultrasonic antifouling system is an easy project. The various systems may differ internally and in detail, but each has a black box that houses the electronics and one or more transducers. The former must be connected to power and mounted in some semi-accessible location. The latter must be bonded to the hull skin.

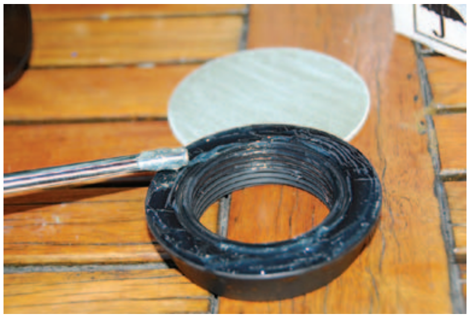
The jump from one to two transducers comes at the 32ft boatlength mark for Sonihull. Below 32ft, the transducer should be installed about two-thirds of the way aft, as close as possible to the boat's centerline. On bigger boats, the transducers should be at the one-third and two-thirds marks.

The Sonihull transducers are screwed into mounting rings that must be bonded to a flat surface. I had a problem finding suitable surfaces in the right locations for the transducers—ours being a 1970s boat, curves abound, and I was worried that the transducers would not make full contact with the fiberglass hull and therefore would not properly transmit those good vibrations. My solution was to cut a pair of disks out of a piece of 3/16in G10 sheet, epoxy the mounting rings to them, and then bond the disks to the hull with thickened epoxy, thus ensuring a flat surface for the transducers to work against.

The instructions advise you to mount the transducers clear of bulkheads that may dissipate the signal, but in my case this wasn't possible. **— Peter Nielsen**



The transducer, straight out of the box. The tightly coiled cable aids installation in tight places

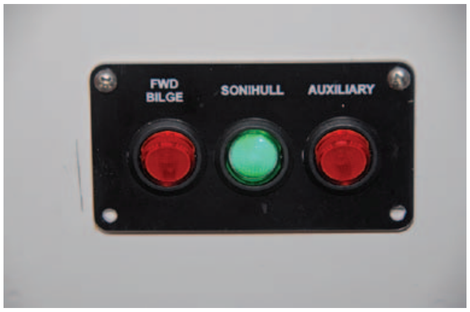


I applied epoxy resin to the mounting ring then clamped it to the G10 disk overnight

I smeared Vaseline into the threads and applied a thin layer to the mating surface to get rid of air bubbles that might inhibit transmission

I epoxied the mounting ring on its G10 disk to the hull, first sanding the area down to provide a key for the thickened adhesive

You can mount the control box anywhere within reach of the transducer cables



I had run out of breakers at the 12V switch panel, so I had this nifty little panel made up. I placed a 5 amp fuse in the power cable to the control box

transducers on our boat when close to them, whereas I have heard reports of transducers from other systems being noisy enough to where they are shut down at night.

ENERGY NEEDS

For many cruisers there is a significant question: how much energy will it take to run one of these systems? Most transducers have a peak power output of 50 watts (although some are as low as 25 watts, which limits their effectiveness), but this is only on an intermittent basis. Average power levels run from 2.5 to 5.0 watts per transducer. If we take a 40ft boat as a reference point, depending on the system and the number of transducers, this translates to an overall continuous load of somewhere between 0.6 amp and 1.1 amps at 12 volts (half this at 24 volts). This does not sound like much, but it adds up to between 15 amp hours (Ah) and 26 Ah a day at 12 volts. If a boat is on a mooring, that is between 450 Ah and 800 Ah over the course of a month. Without some auxiliary source of power, like solar, wind, a small fuel cell or shorepower, the batteries will get flattened, and the system will shut down.

Some systems will run on AC power as well as DC, and in fact have an automatic transfer switch that preferentially selects AC over DC if AC is available. (This functionality may or may not be included in the base price.) Some systems will vary the output to the transducers based on the available power, ramping up the energy levels when AC power is available or battery voltage is high (such as when being charged), and then tapering down the energy levels if battery voltage is falling. All have a low-voltage cutoff threshold, at which point you have no antifouling.

Note that the energy that is being transmitted into the water is acoustic energy and not electrical energy. As such, it has no corrosion significance and will not affect sacrificial anodes, although it may improve their effectiveness by keeping them cleaner. The electrical frequencies in the generating devices should also not interfere with other onboard electronics, although a recommendation is sometimes made to not install transducers close to depthsounders.

NOT A COMPLETE SOLUTION

It is important to note that none of the systems on the market claim to be a complete antifouling solution. All recommend the use of conventional antifouling paint in conjunction with the ultrasonic antifouling system. Which raises the obvious question: If you've got to pay for the haul out and paint job, why bother with the ultrasonic system? There are, in fact, a couple of good reasons for installing one of these systems—if they work as advertised (we'll get to that in a moment):

First: you will be able to extend the intervals between antifouling paint jobs to two, three, four and maybe even five years. Fundamentally, depending on the marine growth in your area, and how often you typically need to renew the antifouling paint, you should be able to skip every other paint cycle. This alone will pay for the ultrasonic antifouling system in just one or two skipped cycles.

Second: the ultrasonic system will keep the hull and running gear (struts and propellers) cleaner between paint cycles. This will improve boat speed and/or reduce fuel bills. If you currently pay a diver to periodically clean the hull and running gear, it will reduce these costs as well, not to mention the paint loss that occurs at each scrubbing.

Ultrasonic antifouling systems only work on those parts of the hull that are immersed in the water. Some growth will still occur around the waterline, because this area is regularly exposed to air and gets plenty of sunlight, which encourages algal growth. However, typically an ultrasonic system will still partially treat it making it relatively easy to remove. In some tidal parts of the world boats are allowed to sink into the mud at low tide. The acoustic waves will be blocked by the mud, allowing growth in these areas. Even on other parts of the hull, staining is likely over time (which may be unsightly but will have little effect on performance). Finally, there is dead matter that may be floating in the water and which sticks to the hull, or dead matter created by the system itself. Movement through the water or a light brushing will generally remove this.

DOES IT WORK?

So, does it work? Over the past several years these systems have been installed in thousands of recreational boats, from simple cruisers up to superyacht size and even in ships, and thus far the feedback is positive. In our case it is still hard to say. This past year we did not renew the antifouling paint as we would normally have done, which represents savings that are half the cost of the system right there. After one season's use we also had very little live growth at the waterline and some streaks of what is almost certainly dead matter that washed off immediately with a pressure washer at our annual haulout. Our propeller, which we also treated with Forespar's lanolin-based LanOcote, was spotless.

The real test will come next year when we we find out if we can once again not renew our antifouling paint. If the hull comes out clean at the end of the season we will have already covered the cost of the system in reduced bottom painting costs. From that time on, we will be ahead of the game, with our contribution to the environment of noxious antifouling paint already down by four gallons. It is my hope that this time next year I will be able to report a definitively positive outcome to this experiment. S

Nigel Calder is the author of *The Boatowner's Mechanical and Electrical Manual*

Key questions

Are the generating devices rated at 50 watts?

Are there separate generators for each transducer?

Are the transducer cable connections watertight?

How noisy are the transducers?

What is the level of waterproofing of the control box, its cable connections, display devices and any external switches?

What level of information is provided by the display devices?

What is the power consumption on a daily/weekly/monthly basis?

Does your boat have the necessary energy resources?

Can the system run on shorepower and if so does the power supply have an automatic DC/AC transfer switch?

Will the system ramp up the transducer energy levels when there is a plentiful supply of power?

What is the cost? What is included in the base price and what is extra?