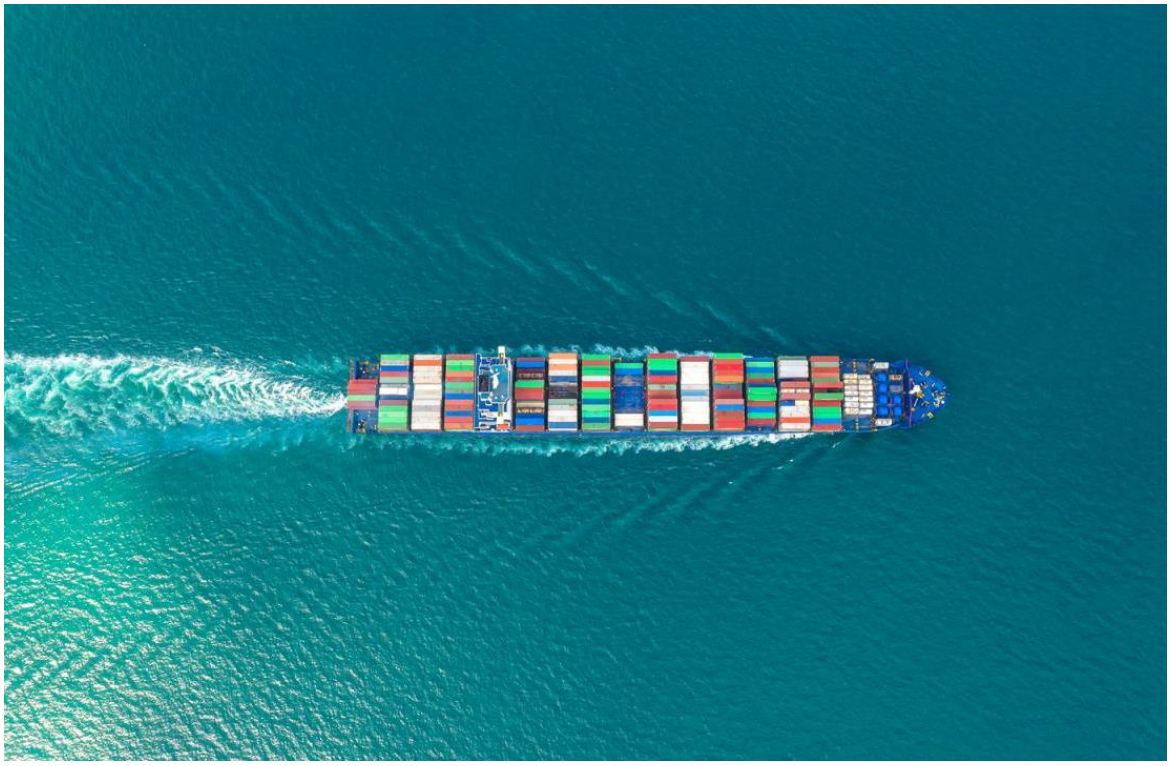
Breakthrough in air lubrication: Large ships glide on bubbles.

Liv Bjerg Lillevang 8. november 2022



Large sea-going vessels such as container and cruise ships can reduce fuel consumption by "gliding on bubbles." Illustration: Magnifier/Bigstock.

Air lubrication is a technology that is more than a hundred years old. Now it faces its commercial breakthrough.

"With our FluidicAL technology, a series of wing-shaped bands are fitted across the hull, dividing it into sections. From there, the air bubbles are sent out into the individual sections using a fluidic oscillator. That way, we can adjust the bubbles to a given section," he says.

According to Frode Lundsteen Hansen, this method of forming the up to 240,000 micro-bubbles per second per metre has a number of advantages compared to the technology installed at the front of the hull.

Bubbles can be generated more efficiently and be more easily controlled along the bottom of the hull, and it is possible to cover a more flat-bottomed ship.

Marine Performance Systems also advertises fuel savings of between 8 and 12 percent, depending on the ship.

An increase in the number of orders
Both of the technologies can be installed both on existing ships and those still in construction.

And there are quite a few ship owners who choose to do that.

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An example of one of the bands with fluidic oscillators that create about 240,000 micro-bubbles per second per metre along the ship's hull. Illustration: Marine Performance Systems.

New Scientist describes how, four years ago, British shipping analytics firm Clarksons Research had only registered a few dozen ships with air lubrication systems.

Today, there are 78 of them, and at least 155 are set to be installed within the next few years. This trend is also in line with Marine Performance Systems's orders. Since 2020, they have installed their technology on two ships. Three more will follow before the end of the year.
"Next year has a really good pipeline for us. I can't put exact numbers on it, but we have a double-digit number of orders," Frode Lundsteen Hansen says.

Potential for tens of thousands of orders

He explains how he and the other co-founders of Marine Performance Systems threw themselves into the bubble technology back in 2018, when they saw that the shipping industry was having difficulty meeting the emission reduction requirements.

"The ship owners have already had the opportunity to invest in technologies such as air lubrication, but it is only now that they are held responsible for the ships' emissions that there is an interest in investing," Frode Lundsteen Hansen says.

And the current energy prices also help increase interest, believes his colleague, COO and co-founder of Marine Performance Systems Fulko Roos.

"Everyone agrees that the current oil prices are here to stay. Some believe that they will increase in the future," he says.

Therefore, there is enormous potential in the field of air lubrication, both Fulko Roos and Frode Lundsteen Hansen believe.

And there are tens of thousands of ships on which the technology could potentially be installed.

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The *Norwegian Joy* is one of several cruise ships equipped with air lubrication technology. Photo by Imaginechina Limited/Alamy Stock Photo

Riding on a Magic Carpet of Bubbles

by Chris Baraniuk November 12, 2020

Water is not as yielding as you think, says Noah Silberschmidt, founder and CEO of UK-based Silverstream Technologies.

For more than a century, gigantic steel vessels have been ploughing the oceans, generating seemingly unavoidable—and surprisingly costly—friction between ship and sea. But this friction can be reduced in an innovative way, says Silberschmidt, with the help of millions of tiny bubbles, each just a millimeter across. With the push to make shipping more efficient, ship owners are looking for new ways to reduce fuel consumption and emissions. One contender is Silverstream Technology's eponymous Silverstream System, a device installed in a ship's hull near the bow that generates a carpet of air bubbles flowing all the way to the ship's stern.

The concept underpinning the device—air lubrication—is not new, but advancing technology is allowing the company and its competitors to retrofit existing ships with air lubrication systems, or include them in new vessel constructions.

Air is less dense than water, which means that the bubbles reduce the resistance between the ship and the sea around its hull. It's a bit like gliding your hand through a gently bubbling hot tub versus a still bathtub.

Silberschmidt says that, over time, air lubrication can reduce fuel consumption by five to 10 percent. Fuel savings of a few percent might not sound like much, but Silberschmidt says shipping firms can spend between US $5- and $10-million on fuel for a single average-sized vessel every year.

Cruise lines Norwegian and Carnival have already installed Silverstream's devices on some of their vessels, and more installations are due to be announced soon, says Silberschmidt.

You can't blow bubbles for free, though. It requires energy to compress air and position it so that bubbles flow in a steady stream along the hull of a large, flat-bottomed vessel. Silverstream has cut the overall energy needed, however, by filling air release units—small cavities built into the underside of the ship—with air. The bubbles form because of the difference in pressure between the air in these cavities and the seawater below.

A phenomenon called Kelvin-Helmholtz instability occurs as the ship moves, which means that the air mixes into the water in the form of little bubbles that then glide rearward below the ship.

Relying as it does on physics, the bubble carpet itself is therefore "Mother Nature–

generated" says Silberschmidt. The light, bubble-rich water is akin to the white foamy crests topping waves you might see on a windy day at the beach, he adds.

There are certain conditions that need to be in place, though, for air lubrication to work, says Anthony Molland, professor emeritus of engineering at the University of Southampton in England. The effect of the carpet may be negligible in very rough seas, for instance, and ships have to be traveling quickly to maintain the flow of bubbles.

"If you simply blow the bubbles out and your ship's not going very fast—we've done it with models—the bubbles simply come out the side and don't do any work at all," he explains. But in those scenarios where the technique works, reducing emissions even by a little is worth it, says Silberschmidt: **"In this world, we have to do whatever we can."**

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Note – Bjarne Engelbrecht Larsen

For Detail related to Rayleigh Instability Please follow the open source course 1-3. Please follow the link below.
Rayleigh-Taylor Instability - Part 1 - YouTube
Rayleigh-Taylor Instability - Part 2 - YouTube
Rayleigh-Taylor Instability - Part 3 - YouTube

Ønsker man at gå i detaljer vedr. stabilitet, når man færdes på en overflade med to forskellige massefylder kan det adresseres med udgangspunkt i vurderinger som ved Rayleigh-Taylor in stabilitet. Altså et kendt og på ingen måde et uoverstigeligt problem.
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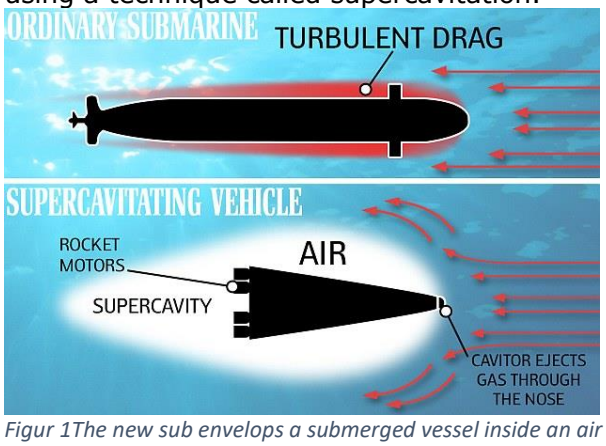
US Navy is developing 'supersonic submarines' that could cut through the ocean at the speed of sound using a bubble

By MARK PRIGG FOR DAILYMAIL.COM, 28 June 2016

- Vessel travels inside a 'bubble' to reduce drag.
- This allows it to reach supersonic speeds.
    - Technique could also be used to develop superfast swimsuits.

As swimmers know, moving cleanly through the water can be a problem due o the huge amounts of drag created - and for submarines, this is even more of a problem. However, US Navy funded researchers say they have a simple solution - a bubble. Researchers at Penn State Applied Research Laboratory are developing a new system using a technique called supercavitation.



Figur 1The new sub envelops a submerged vessel inside an air bubble to avoid problems caused by water drag.

The new idea is based on Soviet technology developed during the cold war.

SUPERCAVITATION

The new sub is based on Soviet tech. developed during the cold war. Called supercavitation, it envelopes a submerged vessel inside an air bubble to avoid problems caused by water drag.

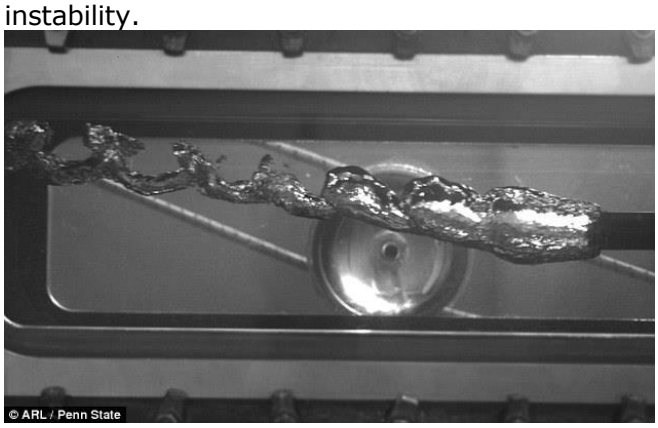
A Soviet supercavitation torpedo called **Shakval was able to reach a speed of 370km/h or more - much faster than any other conventional torpedoes.**

In theory, a supercavitating vessel could reach the speed of sound underwater, or about 5,800km/h, which would reduce the journey time for a transatlantic underwater cruise to less than an hour, and for a transpacific journey to about 100 minutes, according to a report by California Institute of Technology in 2001.

Called supercavitation, it envelopes a submerged vessel inside an air bubble to avoid problems caused by water drag.

However, the technique also results in a bumpy ride - something the new team has solved.
'Basically supercavitation is used to significantly reduce drag and increase the speed of bodies in water,' said Grant M. Skidmore, recent Penn State Ph.D. recipient in aerospace engineering.
'However, sometimes these bodies can get locked into a pulsating mode.'

To create the bubble around a vehicle, air is introduced in the front and expands back to encase the entire object. However, sometimes the bubble will contract, allowing part of the vehicle to get wet. The periodic expansion and contraction of the bubble is known as pulsation and might cause instability.



Figur 2Photograph of a second order pulsating supercavity in the Penn State ARL Garfield Thomas Water Tunnel facility's 12-inch diameter water tunnel. The circular object is a window mounted hydrophone.

'Shrinking and expanding is not good,' said Timothy A. Brungart, senior research associate at ARL and associate professor of acoustics.
'We looked at the problem on paper first and then experimentally.' The researchers first explored the problem analytically, which suggested a solution, but then verifying with an experiment was not simple. The ideal outcome for supercavitation is that the gas bubble forms, encompasses the entire vehicle and exits behind, dissipating the bubble without pulsation.

The researchers report the results of their analytic analysis and experimentation online in the International journal of Multiphase Flow.

The ARL researchers decided to use the Garfield Thomas Water Tunnel facility's 12-inch diameter water tunnel to test their numerical calculations.

Figur 3 In theory, a supercavitating vessel could reach the speed of sound underwater, or about 5,800km/h.. Pictured, a BAE Systems artists impression of next generation submarine.

'The water tunnel was the easiest way to observe the experiment,' said Brungart. 'But not the easiest place to create the pulsation.'
Creating a supercavitation bubble and getting it to pulsate in order to stop the pulsations inside a rigid-walled water tunnel tube had not been done.
'Eventually we ramped up the gas really high and then way down to get pulsation,' said Jules W. Lindau, senior research associate at ARL and associate professor of aerospace engineering.
They found that once they had supercavitation with pulsation, they could moderate the air flow and, in some cases, stop pulsation.
'Supercavitation technology might eventually allow high speed underwater supercavitation transportation,' said Moeney.
China is also developing a'supersonic' submarine that could travel from Shanghai to San Francisco in less than two hours.
Researchers say their new craft uses a radical new technique to create a 'bubble' to surround itself, cutting down drag dramatically.
In theory, the researchers say, a supercavitating vessel could reach the speed of sound underwater, or about 5,800km/h.
The technology was developed by a team of scientists at Harbin Institute of Technology's Complex Flow and Heat Transfer Lab.

Li Fengchen, professor of fluid machinery and engineering, told the **South China Morning Post** he was 'very excited by its potential'.
The new sub is based on Soviet technology developed during the cold war.

Called supercavitation, it envelopes a submerged vessel inside an air bubble to avoid problems caused by water drag.

A Soviet supercavitation torpedo called Shakval was able to reach a speed of 370km/h or more - much faster than any other conventional torpedoes.

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The Chinese system constantly 'showers' a special liquid membrane on its own surface.

Although this membrane would be worn off by water, in the meantime it could significantly reduce the water drag on the vessel at low speed.

After its speed had reached 75km/h or more the vessel would enter the supercavitation state, Li said.

However, Li admitted problems still needed to be solved before supersonic submarine travel became feasible. A powerful underwater rocket engine still needs to be developed.

The technique could even be used to aid swimmers, he believes. 'If a swimsuit can create and hold many tiny bubbles in water, it can significantly reduce the water drag; swimming in water could be as effortless as flying in the sky,' he said

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For Nørder er der mere end 100 papers om emnet herunder og ikke begrænset til

International Journal of Multiphase Flow | Vol 84, Pages 1-324 (September 2016) | ScienceDirect.com by Elsevier side 155-164.

Modeling of hydrodynamic cavitating flows considering the bubble-bubble interaction

Key Laboratory of Thermo-Fluid Science and Engineering, Ministry of Education, School of Energy and Power Engineering, Xi'an Jiaotong University, Xi'an, 710049, China

Efterskrift:

Der pt er +500 skibe, test af militærudstyr, der kan understøtte og sikre en direkte anvendelse til at inddrage denne teknologi kosteffektivt og direkte i alt fra Seafare Drones til de operations støttende enheder, platforme.

Undertegnede har udført LES modeleringer i perioden fra 1990 til -95 med efterfølgende opfølgninger. Anbefaling er at fuldbyrde fuld skala test, ud fra de mange erfaringer der allerede foreligger.

Venligste Hilsner
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Vilnius NATO, Summit Communiqué, 11 July 2023

69. Climate change is a defining challenge with a profound impact on Allied security facing present and future generations. It remains a threat multiplier. NATO is committed to becoming the leading international organisation when it comes to understanding and adapting to the impact of climate change on security. We will continue to address the impact of climate change on defence and security, including through the development of innovative strategic analysis tools. We will integrate climate change considerations into all of NATO's core tasks, adapt our infrastructure, military capabilities and technologies ensuring resilience to future operating environments.

To contribute to the mitigation of climate change, we are committed to significantly cutting greenhouse gas emissions by the NATO political and military structures and facilities; we will also contribute to combatting climate change by improving Energy efficiency, transitioning to clean Energy sources, and leveraging innovative next-generation clean technologies, while ensuring military effectiveness and a credible deterrence and defence posture.

We will continue to strengthen our exchanges with partner countries, the scientific community, as well as other international and regional organisations that are active on climate change and security. We welcome the establishment of a NATO Centre of Excellence for Climate Change and Security in Montreal.