



SUPERSONIC SUBMARINE : A MYTH OR REALITY

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Shanghai to San Francisco in less than two hours...in a future supersonic jetliner?No... in a submarine! Could never believe the press release by South China Morning Post on 24 Aug 14.ⁱ It claimed that a new technology has been developed by scientists at Harbin Institute of Technology by which submarines could attain speeds up to 5800 kmph and will be able to cover the transpacific distance of 9873 km in 100 minutes. Is this sensational news a show off or an authentic claim by China?

The Silent Arm

Submarines are never known for their great speeds. This silent arm of any maritime force is expected to use stealth as their main strength and utilize this to position herself in an advantageous position to target enemy's platform. Speeds, though vital for any military platform, were never considered an important factor for a submarine due to inherent constraints of underwater operations. The hydrodynamic drag of water is 1000 times more as compared to air. For this reason, a maritime platform (surface or underwater) is always at a disadvantageous position. According to the U.S. Department of Defense, the top speed of the attack submarines of the *Los Angeles* class is about 29 kt (46 kmph). Some published estimates have placed their top speed at 30 to 33 ktⁱⁱ. To attain higher speeds a submarine must overcome the water resistance using innovative design concepts coupled with a robust propulsion system for long underwater endurance. In achieving these goals one must not forget the basic requirement of remaining

'Silent'. The Chinese have used a revolutionary technology called Supercavitation to break the speed barrier.

Supercavitation & its Applications

Supercavitation is the use of cavitation effects to create a bubble of gas inside a liquid large enough to encompass an object travelling through the liquid, greatly reducing the skin friction drag and enabling achievement of very high speeds.ⁱⁱⁱ The bubble is bigger than the object and only the leading edge of the object actually come in contact with water. The rest of the object is surrounded by low-pressure water vapor, resulting in lowering the drag on the object. Since drag is proportional to the density of the surrounding fluid, the drag on a supercavitating object is drastically reduced.^{iv} By reducing friction, the speed increases dramatically. Theoretically, the fastest a supercavitating bubble can travel is the speed of sound underwater ie about 3,600 mph.^v Traditional propellers can't be used to generate that speed, since they have to touch the water.^{vi}

During the cold war, in 1972, the Soviet military used this technology and developed a torpedo called Shakval. This torpedo was able to attain a speed of 370 kmph, much higher than any conventional torpedo^{vii}.

In 1994, the US Navy began work on 'Rapid Airborne Mine Clearance System', based on this process. Their planned projectile was designed to cause destruction of sea mines up to 45 m depth. In the ongoing 'Underwater Express program' of US, the process of supercavitation is being utilised to develop an underwater platform to transport special operation groups (SEALS) at speeds up to 100 kt, for an hour at least. In 2004, Germany claimed to have developed a supercavitating torpedo called 'Superkavitierender' capable of speed more than 400 kmph.^{viii}

Limitations

If the process of Supercavitation can enhance the speed of an underwater platform to such an extent it would have revolutionized the dynamics of maritime warfare by now. The major limitations, before one can harness the fruits of this technological advancement, are as follows:

- (a) Maneuverability. A major limitation pertains to the maneuverability of the platform. The bubble, created by supercavitation process, around the platform isolates it from coming in contact with water. With the result, a conventional rudder responsible for steering the

vessel will be ineffective. For this reason, Shakval torpedoes were fired in a straight line, in the direction of target. This was acceptable keeping in mind the maximum range of the torpedo was limited to 15 km. However, in case of a submarine, while cruising at high speed during supercavitation, any part of the submerged vessel coming in contact with water will be sheared off because of difference in density. This can be a major limitation.

(b) Propulsion System and Endurance. Another challenge is to design a propulsion system that can launch the submerged vessel at high speeds, approaching 100km/h, to generate and maintain the air bubble. The endurance or operating range of a supercavitating platform will depend on the ability of its propulsion system to produce sustained high speeds over long distances. In case of torpedoes, it could be easily achieved due to shorter ranges. The same may not be possible for submarines. Moreover, the quantity of fuel required will be huge; initially to achieve the launch speed for supercavitation and thereafter to maintain those speeds over thousands of miles. It is pertinent to mention that about 2000kg of propellant was used by the Russian torpedo to travel a distance of just 15 km.

(a) Underwater Guidance/ Detection System. A submarine uses underwater detection system such as Sonar as its 'Eyes and Ears'. To initiate the supercavitation process, as per the SCMP report, the vessel is shown ejecting gas at its nose to maintain the bubble. This process is likely to generate heavy acoustic noise which will make the platform virtually blind. Active as well as passive sonars will be ineffective in such an environment. Being a short range platform, Shakval torpedo used wire guidance for command & control. The same is not possible for a submarine.

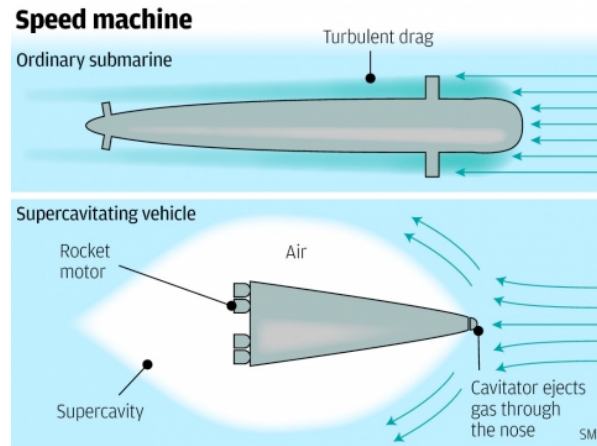


Image: South China Morning Post

The Chinese Claim

The Chinese have claimed very confidently that they are very close to finding solutions to all these problems. As per their research, the supercavitation vessel would constantly "shower" 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. After its speed had reached 75km/h or more the vessel would enter the supercavitation state. The man-made liquid membrane on the vessel surface could help with steering because, with precise control, different levels of friction could be created on different parts of the vessel.^{ix} Basically, increasing or decreasing the liquid membrane would manipulate friction to steer the ship.^x They have admitted that a powerful underwater rocket engine is required to be developed for longer endurance.

Reality or Myth

Developing a high speed torpedo is one thing, but making a supersonic submarine capable of crossing the Pacific is quite another. Shakval was produced to prove the supercavitation technology. It was a very short range platform which could attain high speeds for 2-3 minutes. Achieving the required launch speed (75-100kmph) to create the bubble, and thereafter sustaining those speeds, over hours, by a submarine is questionable. Even, the Underwater Express program of US, a technology demonstrator, is aiming to achieve speeds up to 100 kt.

The Chinese idea of steering using liquid membrane around a submarine hull may not be a workable solution. A submarine travelling through oceans needs to have a robust and prompt steering system for safe navigation and tactical manoeuvres.

Besides the maneuverability issue, developing an underwater engine capable of high speeds over long ranges will be a bigger challenge. Rocket engines, generally, have very short endurance of few minutes. Nuclear power might be a possibility.^{xi}

Further, the limitation of remaining blind due to the noise generated by the cavitation process will be a big handicap, which cannot be overlooked. It is unthinkable to imagine a submarine operating underwater without any effective sonar.

In the end, one may ask as to why an underwater platform needs so much speed. Submarines are generally positioned in chosen areas for offensive or defensive tasks. Remaining silent over long periods without compromising their position and detecting enemy's platform using acoustic means will always remain their concept of operation. Without these traits, if at all, a supersonic submarine is developed in future, it may not be of much tactical value. It is felt that there may be some other motive behind this press release. It remains to be seen as to what is the real agenda of Chinese scientists in this project.

(Disclaimer: The views and opinions expressed in this article are those of the author and do not necessarily reflect the position of the Centre for Air Power Studies (CAPS))

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ⁱ "Shanghai to San Francisco in 100 minutes by Chinese supersonic submarine", <http://www.scmp.com/news/china/article/1580226/shanghai-san-francisco-100-minutes>, 24 Aug 14, accessed on 26 Aug 14.

ⁱⁱ "[Los Angeles-class submarine](http://en.wikipedia.org/wiki/Los_Angeles-class_submarine)",

http://en.wikipedia.org/wiki/Los_Angeles-class_submarine, accessed on 27 Aug 14.

ⁱⁱⁱ "Supercavitation", <http://en.wikipedia.org/wiki/Supercavitation>, accessed on 27 Aug 14.

^{iv} "Supercavitation projectiles potentially have 200,000 less drag than a regular object in water",

<http://beforeitsnews.com/science-and-technology/2014/08/supercavitation-projectiles-potentially-have-200000-less-drag-than-a-regular-object-in-water-2716804.html>, 26 Aug 14, accessed on 27 Aug 14.

^v "All About the Pacific Ocean's Newest SUB: Supersonic Underwater Bullshit",

<https://news.vice.com/article/all-about-the-pacific-oceans-newest-sub-supersonic-underwater-bullshit>, 28 Aug 14, accessed on 28 Aug 14.

vi “Shanghai to San Francisco in 100 minutes: China reveals plans for 'supersonic submarine' using an underwater bubble - and it could even help you swim faster”, <http://sgtalk.org/mybb/Thread-Believe-It-or-Not-China-reveals-plans-for-supersonic-submarine>, 28 Aug 14, accessed on 28 Aug 14.

vii “VA-111 Shkval”, http://en.wikipedia.org/wiki/VA-111_Shkval, accessed on 26 Aug 14.

viii Ibid.

ix “Shanghai to San Francisco in 100 minutes by Chinese supersonic submarine”, <http://www.scmp.com/news/china/article/1580226/shanghai-san-francisco-100-minutes-chinese-supersonic-submarine?> 24 Aug 14. accessed on 26 Aug 14.

x “Chinese reportedly working on submarine that would ‘fly’ in an ‘air bubble””, <http://www.washingtonpost.com/news/morning-mix/wp/2014/08/26/the-chinese-are-reportedly-working-on-submarine-that-would-fly-in-an-air-bubble>, 26 Aug 14, accessed on 27 Aug 14.

xi “China’s supersonic submarine, which could go from Shanghai to San Francisco in 100 minutes, creeps ever closer to reality”, <http://www.extremetech.com/extreme/188752-chinas-supersonic-submarine>, 27 Aug 14, accessed on 28 Aug 14.

