The Effects of Nanotechnology Coatings on Cavitation and Greenhouse Gas

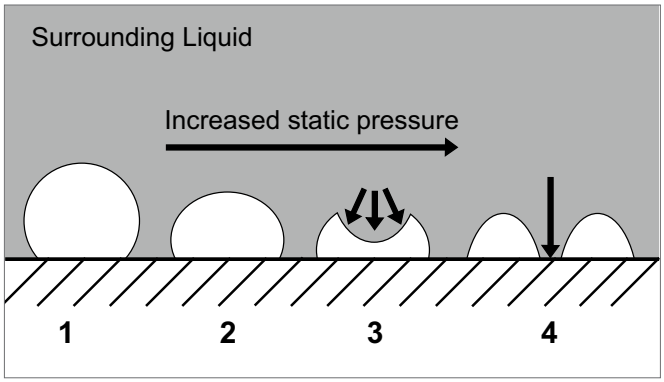
by Charles Foster, Founder

Cavitation

Cavitation is the formation of empty cavities caused by a liquid disturbed by highly turbulent forces. The result, due to the natural tendency for air to evacuate from its heavier environment, results in a natural implosion of the air bubble. Cavitation occurs when a liquid is subjected to rapid changes of pressure causing the formation of cavities in the lower pressure regions of the liquid.

Inertial cavitation is the process where a void or bubble in a liquid rapidly collapses, producing a shock wave. Inertial cavitation occurs naturally in the propulsion of mantis shrimps and pistol shrimps, as well as in the vascular tissues of plants. In man-made objects, it can occur in control valves, pumps, propellers and impellers.

Non-inertial cavitation is the process in which a bubble in a fluid is forced to oscillate in size or shape due to some form of energy input, such as an acoustic field. Such cavitation is often employed in ultrasonic cleaning baths and can also be observed in pumps, propellers, etc.



Cavitation bubble imploding close to a fixed surface generating a jet (4) of the surrounding liquid.

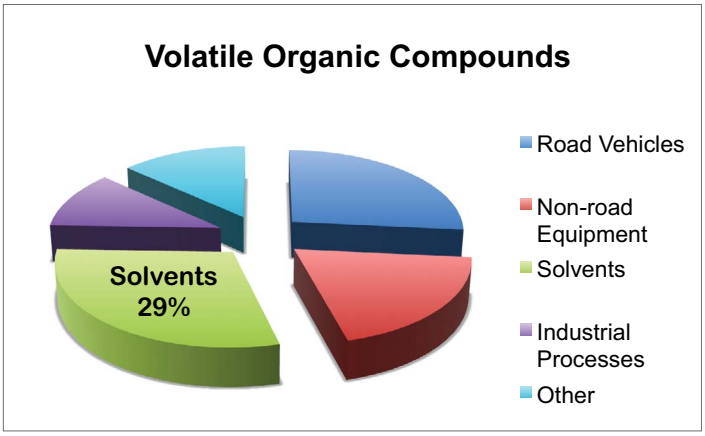
Cavitation and Marine Vessels

Since the shock waves formed by cavitation are strong enough to significantly damage moving parts, cavitation is an undesirable phenomenon. Cavitation reduction is specifically engineered into the design of machines such as turbines or propellers, and controlling the effects of cavitation is a major field in the study of fluid dynamics.

Cavitation is a significant cause of wear in ocean going vessels. When entering high pressure areas, these bubbles collapse on metal surfaces and boat hulls continuously, causing cyclic stressing of the surfaces. The most common example of this kind of wear is a pump impeller with curvatures which cause a sudden change in the direction of liquid.

Traditional Coatings

Marine biology has been adversely affected by the use of copper and tin as anti-fouling agents in traditional coatings and bottom paints. Studies have proven that there are high concentrations of these materials present in lakes and ocean waters worldwide. This is due to the use of ablative coatings which are designed to wear or shed away as the vessels pass though the water. These embedded components are exposing copper or tin from the surface of marine vessels in order to maintain toxic, pesticidal effectiveness, which destroys unfavorable marine growth, but compromises the marine eco-system.



2005 EPA report designates solvent use as the largest source of VOC emissions in the U.S.

Traditionally, coatings have been created with the use of high (volitile organic compound) VOC solvents. When oxides of nitrogen (NOx) and VOCs react in the presence of sunlight, ground level ozone is formed, a primary ingredient in smog. A 2005 U.S. EPA report designates road vehicles as the second largest source of VOCs in the U.S. at 26% and 19% from non road equipment which is mostly gasoline and diesel stations. At 29%, the number one source of VOC emissions is solvents which are used in the manufacture of paints, paint thinners, architectural coatings and other products.

Ozone is beneficial in the upper atmosphere, but at the ground level the ozone gas irritates the Respiratory system, causing coughing, choking, and reduced lung capacity. In the United States, ozone is responsible for an estimated $500 million in reduced crop production each year.

Regulations have limited the use of commonly used solvents which were necessary to forming a protective film with properties that provided an effective barrier to corrosion and environmental degradation.

The new low VOC regulations have left formulators with few alternative choices, and as a result, the coatings which comply with the regulations have a diminished performance and life expectancy. The coatings borne out of this strict regulation do not perform as well and require more frequent reapplication to maintain protection of the substrate. This means that accumulative reapplications release over time far greater amounts of VOC's into the air as the higher voc predecessors would have during fewer applications. Evolution Surface solutions has created low voc formulations that perform as well or better than the former conventional high VOC banned coatings.

Evolution Surface Solutions Nanotechnology Coatings

Evolution Surface Solutions has created low VOC nano-composite coatings for fiberglass hulls and metal surfaces that provide anti-corrosion protection and reduce damage to surfaces due to cavitation. The Evolution Surfaces coatings are critically balanced in their hydrophobic and hydrophilic properties to produce maximum protection and reduction of friction without creating additional turbulence.

Super-hydrophobic coatings are predominantly electro-negatively charged, which means they repel negatively charged fluids. Water is both positively and negatively charged as its molecule has one oxygen and two hydrogen atoms. The oxygen is positively charged and the two hydrogen atoms are negatively charged, which means water is more negatively charged than it is positively charged.

The predominantly negatively charged super-hydrophobic coatings can cause an increase in cavitation at the contact surface, most noticeably occurring to propellers which rotate under high RPM under force generated by the vessel's power plant. The repelling effect generated by negatively charged coatings and water tend to disrupt the flow of the water because of the increased tension between the two. Under power forces, this translates into an increase in pressure at the interface disrupting flow. A super-hydrophilic coating, in comparison, would create a vacuum which would similarly disrupt the flow of water under power. Both super-hydrophobic and super-hydrophilic coatings produce a lack of synchronicity between coeffcient of friction of the interacting compounds.

As compared to super-hydrophobic coatings the Evolution coatings offer a significant reduction in cavitation damage. This reduction is due to tension being relaxed at the water contact interface with moving surfaces and their respective charges as it relates to the charge of water and coating. This reduction results in less turbulation due to what Evolution characterizes as balanced atomic lubricity which equalizes tension between elements or compounds or any combination thereof. Reducing the resistance in this case allows the flow of water over a treated surface to closely match the natural COF properties of contact materials in this power driven condition. The inorganic nano-composite components and high crosslink density of Evolution Surfaces coatings provide protection against corrosion and environmental degradation which typically destroy conventional organic coatings.
The balance of these properties provide ease of cleaning and the reduction of marine microorganism attachment to the coated surfaces without the need of anti-fouling or anti microbial agents which have been proven to harm marine biology.

These coatings are designed as thin film long term protectants, which during application, reduce accumulation of VOCs released in the atmosphere caused by frequent reapplication of conventional coatings.

Evolution Surface Solutions TruNano Marine Armor

After four weeks in the ocean, a fiberglass hull coated with TruNano Marine Armor shows minimal algae and marine growth, and is easily cleaned.

Coated with TruNano Marine Armor, this metal plate was submerged in fresh water for two months. It shows minimal growth, and is easily wiped clean.

EVOLUTION
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