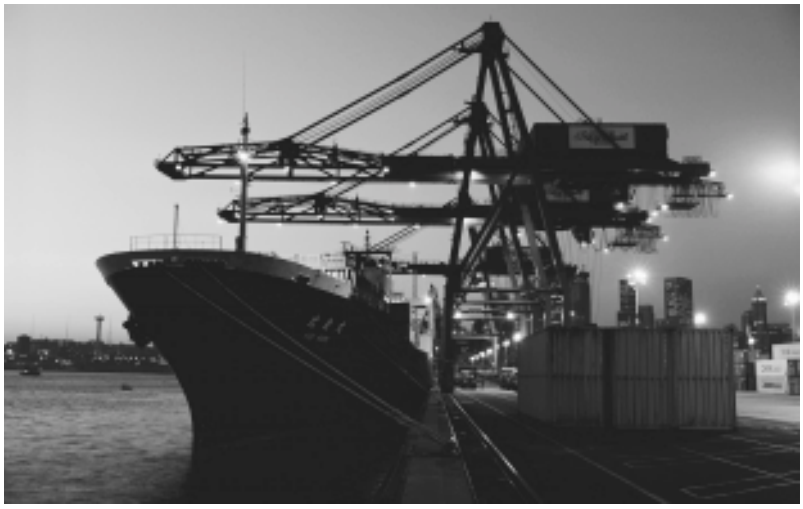
Why are marine engineers turning to titanium for corrosion resistance?



It helps ships come in with lower costs and better performance

Titanium is the ultimate solution to the problems that traditionally plague seawater tubing and piping: leaks caused by corrosion/erosion and clogging caused by biofouling, that lead to expensive downtime and maintenance or replacement.

Compared to copper-nickel alloys and stainless steels, titanium exhibits unsurpassed corrosion immunity, and excellent erosion resistance in salt and polluted waters. Coupled with high strength and low density, this means unexcelled weight savings, reduced maintenance and life-of-ship service for low life cycle costs.

With increased availability and affordability, and ease of on-ship fabrication, titanium is a proven solution on vessels from ferries and fishing boats, to Naval ships and deep sea submersibles, for heat exchangers, piping systems and dozens of other applications.

A combination of properties imparts a synergy of benefits

When titanium's unique characteristics are exploited in design, rather than simply using it to replace parts made of other materials, the benefits are dramatic:

Low initial cost: Titanium's high strength and low density, combined with its natural corrosion resistance, means it needs no corrosion allowance. Therefore it can be specified in thinner cross-sections, using less metal per unit of area, and its higher per-pound cost is effectively offset, especially when life cycle costs are also considered.

Significant weight savings: Titanium's properties permit thinner walled tubing and pipe and allow higher water velocities and decreased volume, leading to smaller schedule sizes. This translates to weight reductions of 70% or more.

Reduced maintenance costs: Because it is immune to corrosion, and resistant to biofouling, titanium pipe and tube requires fewer overall inspections and no flushing or draining.

Low Life Cycle Cost: Titanium offers life-of-ship service, with no maintenance, and can improve overall uptime and performance. This can equate to life cycle costs that are 50% less than copper-nickel, and a return on investment of as much as 800% over a ship's 40 year life.

Titanium: The ultimate choice for marine service

NATURAL IMMUNITIES AND RESISTANCES TO SEAWATER

Titanium's remarkable ability to resist corrosion and erosion in seawater is due to its unique protective oxide film, which forms spontaneously in the presence of even trace amounts of oxygen. If scratched or damaged, the highly adherent film instantly heals itself.

Seawater corrosion immunity: Titanium is immune to corrosive attack in all natural and harsh waters, including sea, polluted, brackish, fresh and high purity waters, to 600°F. Sulfides, sulfates, carbonates, and chlorides do not affect it.

Seawater erosion resistance: Titanium naturally resists erosion by high velocity seawater, up to 120'/sec, in the absence of suspended solids. Under sand-laden seawater conditions, which are extremely detrimental to copper and aluminum based alloys, flow rates can be as high as 15'/sec.

MIC immunity: There has never been a reported case of microbiologically influenced attack on titanium, which makes it unique among common engineering metals.

Biofouling: Where copper-nickel alloy life expectancies are less than acceptable due to biofouling, titanium's oxide film is uncompromised by marine deposits. Biofouling can occur but is effectively controlled by high water velocities, or by chlorination, sponge ball cleaning, ultraviolet radiation or ozone generation.

Crevice corrosion & pitting immunity: At temperatures less than 180°F (82°C) crevice corrosion and pitting are totally absent, even if marine deposits form.

SCC & corrosion fatigue resistance: In all seawater services, commercially pure titanium is essentially immune to stress corrosion cracking and does not suffer significant loss of fatigue properties.

Galvanic corrosion: Titanium is not subject to galvanic corrosion in seawater, but may accelerate corrosion of the other member of the galvanic couple.

Non-toxic, non-pyrophoric: Titanium does not display any toxicity toward marine organisms or mammals and tolerates extreme temperatures (1832°F, 1000°C).

Hydrogen uptake: The oxide film is an excellent barrier to hydrogen gas intrusion.

TYPICAL ALLOYS FOR MARINE SERVICE

With the wide selection of titanium alloys available, optimum choice for a given marine application is almost always possible. Selection for is governed by strength and formability properties, corrosion resistance, or both. The most common grades for salt water service are Grades 1, 2, 7, 11, 12, 16 and 17, with Grade 2 the most widely used. There are also a variety of other grades for various marine applications.

UNIQUE MECHANICAL PROPERTIES

Strong: Titanium has a significantly higher yield strength and strength-to-weight ratio than copper nickel alloys or stainless steels.

Light weight: Titanium is half the density of copper nickel alloys and 55-57% that of stainless steels. This accounts for a minimum 50% weight savings in service water piping throughout the ship.

Flexible: Titanium's low modulus plus its high density make it highly shock resistant.

High operational thermal conductivity: Thermal conductivity for titanium is up to 30% higher than stainless steels. Although thermal conductivity is lower than in copper-nickel, titanium's reduced wall thickness and lack of biofouling allows titanium heat exchangers to perform as efficiently, or even more efficiently, than those of copper-nickel.

Non-magnetic: Titanium is ideal for use in applications sensitive to interference, such as housings for electronic equipment.

Easy to fabricate: Titanium plate, sheet, pipe and tubing are readily cut, bent and drilled in shipyard on on-ship environments, using the same equipment and techniques used for stainless steels and nickel base alloys. Tungsten Inert Gas welding can be performed without a vacuum and GMA, plasma resistance, friction, electron beam, laser and pressure welding are also used.

TITANIUM FROM STEM TO STERN.

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