INTERNATIONAL MOLYBDENUM ASSOCIATION
THE VOICE OF THE MOLYBDENUM INDUSTRY

Safer seas with stainless steel

Chemical tankers are specialized ships carrying liquid cargoes that may be environmentally hazardous, flammable or highly reactive. They are designed and operated under special rules, and increasingly have built-in molybdenum-containing stainless steel tanks. Sailing around the world, they transport liquid goods safely over long distances. They represent a significant market for duplex stainless steels and molybdenum.

The term 'tanker' often brings to mind an image of the great supertankers plying the seas, carrying bulk and refined oil. These behemoths can have capacities exceeding 400,000 deadweight tonnes (dwt). Chemical tankers are smaller, typically 5,000–40,000 dwt, but are no less important to the world economy. Because chemical cargoes can be extremely corrosive, many of these ships are built with molybdenum-containing stainless steel tanks for longevity, safety, and flexibility. Duplex stainless steels, in particular, are more and more specified for the demanding conditions that the vessels must withstand.

Rules and classification of chemical tankers

All ships are subject to numerous stringent regulations regarding safe navigation, air pollution, and the discharge of liquids and solids. Ships that travel in international waters are subject to the International Maritime Organization (IMO) regulation known as the 'International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk', or IBC Code. This code establishes design standards based on the hazards presented by ships' cargoes.

Because chemical cargoes present many kinds of safety and pollution risks, construction and operation requirements for chemical tankers are much more stringent than those for oil tankers and commodity carriers. Tank design and fabrication are complex. The IBC Code includes provisions for cargo pumping and monitoring; tank coating, cleaning and venting; vapor detection and fire protection. It also promulgates specific requirements for tank heating, cross-compatibility, corrosion control, and cargo density. Chemical tankers are arguably the most technically sophisticated of all large cargo ships.

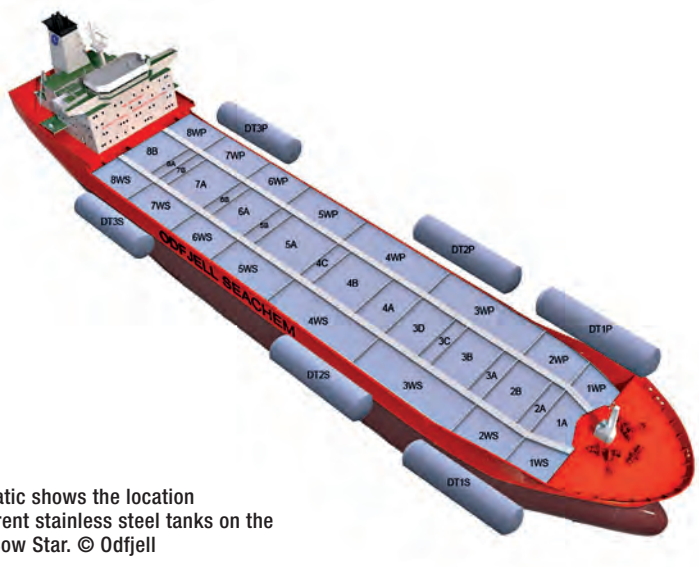
Chemical tankers can be categorized according to size, products carried, and markets served. **Parcel tankers** are relatively large vessels with multiple separate tanks carrying high-grade chemicals, often in stainless steel tanks; **product tankers** are also large, but they carry less difficult cargoes, frequently in coated-steel tanks; and **specialized tankers** are small to medium size, carry a limited number of chemicals in a dedicated trade and use either coated-steel or stainless steel tanks, depending on their cargoes.

The ship

Chemical tankers may be distinguished by an array of pipes that run above the ship's deck. Liquid chemicals are pumped via these pipes and their associated valves to load and unload the various tanks. For example, the large chemical tanker, the Odfjell SE Bow Star, built in 2004 at Poland's Szczecin New Shipyard, has thirty-four square and rectangular 2205 duplex stainless steel cargo tanks below deck and six cylindrical tanks mounted on the deck. The vessel is 183 meters long with a beam of about 32 meters and a capacity of 39,832 dwt. The construction of the tanks required 3,000 tonnes of duplex stainless steel (some 90 tonnes of molybdenum) and they provide 52,106 cubic meters of storage volume.

The cargo tank

Design and construction – Inboard tanks contain hatches, ladders, heating systems, piping and drains. Tank walls are typically 20–25 millimeters thick and are corrugated to increase tank stiffness. This enhances the ship's structural rigidity and saves weight compared to ›



The schematic shows the location of the different stainless steel tanks on the Odfjell SE Bow Star. © Odfjell

Interior of a stainless steel tank on a chemical tank ship. © Stolt Tankers

straight-walled tanks. The corrugations are about 1 meter wide and 1 meter deep. Tank fabricators must employ precision welding techniques to ensure weld integrity, and careful post-fabrication cleaning to ensure the quality and corrosion resistance of the stainless-steel surface. A typical size vessel requires about 1,500 tonnes of stainless steel.

Materials – Early chemical tankers used Type 304L stainless steel, but today a grade with 2.0–3.5% molybdenum is standard. Type 316 austenitic stainless steel and its variants are sometimes specified, but the duplex stainless steel grade 2205 is now the most widely used tank material.

This grade is popular because it is stronger and more corrosion-resistant than Type 316 stainless steel. The alloy's higher strength requires less steel and therefore reduces the ship's weight. Its superior corrosion resistance, due in large part to the addition of 3% molybdenum, allows it to carry a wider variety of aggressive liquids. The coefficient of thermal expansion of 2205 is closer to that of carbon steel than Type 304 or 316, making it more thermally compatible with surrounding carbon steel structures.

Cleaning – Tank cleaning is an essential part of chemical tanker operation, directly affecting both product quality and operating cost. Many owners consider it the most important operating cost because it is the one over which they have the most control. Stringent design codes and operating regulations tend to equalize capital and most operating costs for all operators across a given tanker size, so efficient cleaning practices can provide a competitive edge.

The tank material and its coating, if present, control the particular cleaning practice. Stainless steels do not absorb liquids like epoxy coatings on carbon steel tanks, and they are not porous like zinc silicate coatings. Because they are corrosion resistant, they are compatible with a great variety of cleaning methods and products, thereby offering owners a significant operating-cost advantage.

Chemical tanker ship market

The average life of a chemical tanker is 23 years. A 2012 study of 138 major chemical tanker operators showed some 1,800 ships to be operating at that time, of which about 400 had stainless steel ›

The chemical tanker Bow Sagami is docking for loading or unloading. © Odfjell

The topside of a chemical tank ship is busy with a myriad of pipes and valves. © Nordic Tankers

tanks. These numbers suggest a demand of 75–80 ships per year, 15–20 of which would contain stainless steel tanks. However, more recent statistics published by IHS Markit showed that 144 stainless steel-tanked ships were either under construction or on order in 2016–2017.

The market for new chemical tankers has historically grown at 1.3–1.7 times the rate of the global GDP. Increasing demand for chemicals and their worldwide production and trade favor a continued expansion of chemical tanker fleets, especially those using stainless steel tanks. Furthermore, ships are becoming larger and more complex. Ship replacement, market growth, and a continuing shift in alloy choice for tanks combine to produce a substantial market of tens of thousands of tonnes of duplex stainless steel every year. These factors imply that the demand for molybdenum in chemical tank ships will remain strong for the foreseeable future. (Curtis Kovach)