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How coatings contribute to an owner’s bottom line

In a downturn the ability to move quickly between different cargoes is imperative. Selecting the right coating extends the range of cargoes and reduces the time needed to switch between them, says Douglas Robinson*

A key decision for owners of maritime chemical and product tankers is choosing the cargo tank lining/coating or tank material that delivers the highest return on investment (ROI).

The wide range of liquid chemical cargoes carried in tankers divides into three categories:

- Organic chemicals, made from hydrocarbons such as oil and natural gas, which are used to produce other chemicals or to make plastics and resins. This group represents about 60 per cent of the liquid chemicals market and includes methanol, MTBE, xylene, styrene, benzene, toluene and others.
- Inorganic chemicals, which are mostly acids, make up another 15 per cent of the liquid transport market.
- Vegetable oils and animal fats, such as palm oil and soybean oil, are used as feedstock for a range of industrial processes. They make up the remaining 25 per cent of the carriage market.

Each chemical cargo is classified according to its carriage requirement, as defined by the International Bulk Chemical Code, which imposes strict regulations on the design of the ship, equipment on board, and handling procedures.

IMO assigns a grade to each cargo depending on its flammability, toxicity, corrosiveness and reactivity. The carriage of a certain chemical requires the shipowner to check if that cargo matches the tanker’s capabilities.

Obviously, if shipowners want to maximise the sales potential of their fleets, they should carry the most profitable high-specification cargoes whenever possible, and should accept offered cargoes to make full use of the ship’s cargo volume. This means ships should be able to carry organic chemicals and vegetable oils/animal fats that comprise 85 per cent of the liquid carriage market. Tremendous financial benefits stem from maximising cargo tanks on every voyage.

Shipowners must assess the various types of cargoes and plan to upgrade existing ships and/or purchase newbuilds to carry higher specification cargoes that mean more profit, and/or provide more versatility.

The next thing to consider is what type of tank material or lining/coating best serves needs. One possibility is to construct stainless steel tanks. The other is to specify carbon steel tanks with a conventional protective coating such as phenolic epoxy or zinc silicate, or with Marineline, a high-performance polymer-based lining/coating.

To determine which approach delivers the highest ROI, the following must be taken into account: performance capability; tank construction; application and inspection; and ongoing operating and cleaning issues.

A stainless steel tank has a passivated surface that resists corrosion and rusting so it can carry a range of chemicals. Stainless steel tanks are used by about 24 per cent of all chemical tankers of 1,000 dwt and above classified by IMO since 1999. Stainless steel has a good performance history but it comes with a high entry point for newbuild construction and costly ongoing maintenance. The performance of a stainless steel tank drops off dramatically when exposed to halogen salts, especially chlorides that penetrate the passivation and allow corrosive attack. Chlorides are one of the most common elements in nature, resulting in ideal conditions for corrosion or chemical attack that mean extensive repair and maintenance costs. To combat this problem, more shipowners are specifying duplex stainless steel tanks, which offer higher corrosion resistance—at a price.

Zinc coatings account for about 5 per cent of the market. Conventional zinc coating is durable, heat resistant and abrasion resistant, and provides good mechanical strength. The main drawback is a zinc coating’s limited service capability: it only provides resistance for pH values between 6 and 9, so carrying chemicals outside this range can severely damage the coating, forcing an entire tank relining and recoating. Zinc coating is not resistant to acids, caustics, and acid-containing oils and urea.

Some shipowners use zinc-lined carriers for dedicated methanol service. But when a ship carries methanol to its destination and returns with no backhaul cargo, it is surely a
profit drain. Also, the porous chemical structure of zinc coating allows some cargo absorption. Non-volatile oil-like cargoes are retained, which can cause problems with purity in subsequent cargoes, limiting backhauling and service.

Conventional epoxy and phenolic epoxy coatings represent about 59 per cent of the chemical tanker market. These are used for a range of services including some organic acids, alcohols, edible oils, fats, and solvents. These coatings, however, are unsuitable for very corrosive liquids. Many manufacturers specify that no aggressive cargoes be loaded in the first three months. After carrying an aggressive cargo, the next cargo to be carried should be an approved non-aggressive one, so as to prevent any coating problems. This juggling of cargoes takes its toll on profitable cargo sequencing and compromises versatility, all reducing potential profits.

The final option for shipowners is to specify MarineLine 784, from Advanced Polymer Coatings. MarineLine has captured about 12 per cent of the tanker market since its introduction a decade ago, largely because of its high chemical resistance, versatility and ease of cleaning. MarineLine 784 is formulated with a unique polymer using 28 functional groups per molecule. When fully cured, the coating forms a nearly impermeable 3D screen-like structure with up to 784 cross-links, compared with the minimal cross-linking of an epoxy that only uses two functional groups per molecule to form 4 cross-links. A more permeable surface with fewer cross-links allows easy chemical attack and cargo absorption (see graphic below)

MarineLine’s main benefits are that it allows ships to carry a wide range of aggressive cargoes and CPPs, PFADs, bio-fuels, methanol, ethanol and others, and to easily switch cargoes. MarineLine is also generally recognised as safe (GRAS) for food-grade cargoes, and complies with FDA regulations and all applicable food additive regulations.

Typically, washing is first carried out with sea water at a certain temperature to remove cargo residues, where possible followed by washing with freshwater to remove chlorides. For some cargoes only fresh water is used.

Maintaining a quality stainless steel tank requires passivation at various points throughout the cargo tank’s lifecycle. Passivation is dependent on cargoes carried. It is estimated that 16 per cent of an entire stainless steel tanker’s maintenance budget is devoted to maintaining its tanks over the lifetime of the ship.

In zinc-coated tanks, traditional cleaning chemicals can destroy zinc when cleaning a dyed gasoline, gasoil, or vegetable oil cargo and switching to methanol or MEG. Only zinc-safe cleaning chemicals can be used. Zinc silicate tanks are inherently porous, and previously carried cargos can migrate into pores and capillaries.

Phenolic epoxy coatings have very high absorption properties, and have high restrictions for cleaning and cargo loading. There are strong cargo restrictions on the carriage of edible oils and other sensitive chemicals. Also, after carriage of aggressive water-soluble cargoes, no steam, ballast water, wash water, slops or aqueous cargoes may come into contact with the phenolic epoxy coating before its coating condition is restored by ventilation. All these ‘extra’ cleaning requirements and carriage limitations of stainless steel, and zinc and epoxy coatings translate into lost revenue.

MarineLine’s surface is easily cleaned with common chemicals, eliminating the need for long ventilation times, greatly reducing the risk of next-cargo contamination, and allowing the ship to get back into service faster. Independent laboratory tests show MarineLine to be equal if not better in cleaning and chemical resistance when compared with stainless steel and other coatings. Carriage of methanol in MarineLine tanks requires forced ventilation for 24 hours after completion, and steaming of cargo tanks is not allowed after discharge of methanol.

In laboratory surface topography tests measuring surface roughness, with the lower number being more slippery, MarineLine (Ra 0.7 to 0.9) leads the pack compared with phenolic epoxies (Ra 1.8 to 2.1) and stainless steel (Ra 3.2 to 4.5).

One reason why MarineLine stands out from other coatings is that it is ready for loading of all cargoes in the resistance list upon delivery. Other coatings must wait a while for natural cure before certain non-aggressive cargoes can be loaded, and with certain aggressive cargoes the waiting period may be up to three months of service and hot curing.

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