Coatings to cover all the bases

The market available to suppliers of cargo tank lining systems is expanding due to growing concerns about corrosion in the tanks of crude oil carriers, the steady rise in the volume of commodity chemicals shipped by sea and changing gasoline specifications

Suppliers of cargo tank linings have a large market to aim at, as most of the bulk liquid cargoes shipped by sea have the potential to benefit from carriage in lined tanks.
Tanks are lined primarily to ensure that the cargo is delivered to the customer contamination-free and on-specification. An important secondary benefit offered by the coating is protection of the hull structure from damage caused by aggressive cargoes.
The principal focus of the paint companies has traditionally been the product tanker sector, as charterers will not nominate an uncoated ship for the delivery of their clean petroleum products (cpp). Increasingly, product tankers are being built as flexible ships able to accommodate both refined products and "easy" commodity petrochemical cargoes.
Those pure epoxy tank lining systems compatible with cpp are, in the main, also compatible with commodity petrochemicals. Most paint suppliers also offer enhanced epoxy lining systems to ensure compatibility with as wide a range of "easy" chemical cargoes as possible.
Traditionally, chemical parcel tankers and crude oil carriers have been of limited interest to paint manufacturers. Chemical parcel tankers are built with stainless steel cargo tanks to cope with the wide array of aggressive, sensitive and high-value speciality chemicals and other bulk liquids such as fatty acids and lube oils. Stainless steel is easy to clean and helps minimise the risk of cargo cross-contamination caused by the residues of previous cargoes.

Crude potential
While chemical parcel tankers will continue to be built with predominantly stainless steel tanks and, thus, provide only limited scope for tank lining suppliers, the crude oil carrier market offers potential.
The opportunity has presented itself due to the threat of damage to the hull structural members in oil tankers rather than the risk of crude oil contamination. High rates of pitting corrosion have been experienced in the cargo tank bottom plating of a number of relatively new double-hull crude oil carriers, and some tankers of this type are also exhibiting general corrosion in the ullage space at the top of the cargo tanks.
Originally it was thought that the crude oil cargo itself was enough to minimise the risk of corrosion. No-one expected any corrosion to take place during a laden voyage while on the ballast voyage the inner tank plating would be protected by an oil film created during the crude oil washing process.
The new experience of cargo tank corrosion in double-hull crude oil carriers has prompted investigations into the cause. The studies have revealed that there are some complex processes underway which are sensitive to a range of outside factors, including the presence of various levels of water and sulphur in cargo tanks.
Although the investigators have made progress, the corrosion phenomenon is not yet fully understood. Against such a background, a number of crude oil tanker owners have adopted a cautious approach and have specified cargo tank linings, at least for the tops and bottoms of the tanks in their ships.
In addition, industry and governments are considering the feasibility of a mandatory requirement to coat those areas of crude oil cargo tanks vulnerable to corrosion with

a protective lining. The coatings used in such applications are comparatively simple formulations and not as expensive as the standard, pure epoxy tank coating systems.

A liquid market

The seaborne trade in bulk liquids comprises approximately 2bn tonnes per annum, with crude oil accounting for approximately 1.4bn tonnes of the total. Although the movement of crude oil by sea is a relatively mature trade, the current demand for new oil double-hull tankers is high because of the rules agreed at the International Maritime Organization and the European Union to accelerate the phaseout of single-hull tankers.

Approximately 475m tonnes of refined petroleum products are shipped by sea each year. Such cargoes are categorised as either clean or dirty petroleum products (cpp or dpp). Cpp's, or white oils, include aliphatic hydrocarbons such as diesel, gasoline, aviation fuels and naphtha. Dpp's include marine fuel oil, low sulphur waxy residue and carbon black feedstock.

The wide range of bulk liquids that comprise chemical tanker cargoes taken in aggregate constitute a trade totalling 105m tonnes per annum. There are four main constituent parts of this trade, as follows:

1. Organic chemicals

Organic chemicals account for approximately 53% of the cargoes carried by chemical tankers. Nine major chemicals make up the majority of this figure - methanol, methyl tertiary butyl ether (MTBE), styrene, xylene, ethylene glycol, ethylene dichloride, toluene, benzene and acrylonitrile. These are the basic intermediate organic chemicals; all, with the exception of acrylonitrile, are known as "easy" chemicals and are primarily carried in large volumes in coated chemical/product tankers. Methanol, a chemical with strong solvent properties, is carried in particularly large volumes, and a fleet of dedicated methanol carriers has slowly been established in recent years. The basic intermediates are processed, with other chemicals, to produce high-value speciality chemicals. Some 30-40 speciality organic chemicals are transported by sea in sizeable quantities each year. They are usually shipped in parcels of up to 2,000 tonnes onboard stainless steel chemical parcel tankers.

2. Inorganic chemicals

Inorganic chemicals make up approximately 15% of the total sea-borne chemical trade. The main cargoes in this category are phosphoric acid, caustic soda solutions, sulphuric acid and urea ammonium nitrate. They are usually aggressive cargoes and need to be carried in either stainless steel tanks or tanks with a special lining.

3. Vegetable oils and animal fats

Around 22 million tonnes of vegetable oils are shipped annually. The principal cargoes are palm oil, soya bean oil, sunflower oil, rapeseed oil and coconut oil. Also included in this category are the fatty acids and more aggressive by-products of the refining process such as acid oils and acid distillates. Animal fats include tallow and grease, which together account for around 2 million tonnes of trade per annum. The risk of vegetable oil contamination from certain previous chemical cargoes is a key issue and there are strict requirements governing immediate past cargoes. Shipowners need to take this factor into account when considering trade patterns, cargo tank linings and tank cleaning arrangements.

4. Other chemicals and bulk liquid cargoes

The final group of cargoes is comprised of a number of unrelated commodities such as molasses, potable alcohols and lubricating oils.

Coating choice

The complex nature of the bulk liquid cargo market means that the tanker owner must exercise extreme care when selecting the most appropriate cargo tank coating system of systems for a chosen ship. The following factors need to be borne in mind when making the choice:

- maximum cargo compatibility, particularly if operating in the spot market;
- minimal operational restrictions on cargoes carried;
- low cargo absorption and retention characteristics;
- smooth surface and ease of cleaning;
- maximum corrosion prevention;
- long service life with minimal maintenance;
- simple and economical application; and
- clearly defined practical curing requirements.

International approach

International Coatings Ltd is the world's largest marine coatings company and the range of cargo tank coating products it has developed over a period of 40 years indicates how a portfolio of coatings capable of meeting the varied and changing needs of tanker operators can be established. Essential to the process of providing the most appropriate coating for a particular application is an ongoing close consultation and collaboration between the paint supplier and its customers.

International Coatings has developed a product range that, it claims, meets all the possible requirements that may arise in the tanker sector. That product range can be itemised as follows:

1. Interline 104

Interline 104 is a zinc silicate coating suitable for tankers engaged in the neutral solvents and chemicals trade, and is marketed as a system eminently suitable for the dedicated carriage of methanol. The coating complies with the US Food and Drug Administration (FDA) requirements for the carriage of liquid foodstuffs.

2. Interline 704

Interline 704 is a high-performance pure epoxy coating suitable for tankers engaged in the spot market, including in the cpp trades. The coating complies with the US FDA requirements for the carriage of liquid foodstuffs.

3. Interline 904

Interline 904 is an ambient-cured, high-performance epoxy coating offering a broad range of cargo carriage and sequencing possibilities. The coating is engineered to provide wide operational flexibility within the chemical and cpp spot market trades.

Developing coatings

Paint manufacturers are engaged in continuous product development, refining existing coating system ranges and developing new systems to meet shipowner requirements and the needs of a changing market.

The development of a new cargo tank coating is a long process, with a four-year time scale being typical. Following preliminary tests to ensure raw material compatibility, the development of one successful tank coating may require testing of more than 50 initial paint formulations.

After this initial formulation stage, International Coatings, at its Felling research and development centre in North East England, takes the following steps as part of the process of developing a new tank coating system.

1. Preliminary cargo resistance/screening tests

Screening tests for cargo resistance are carried out with a range of commonly encountered aggressive cargoes. Immersion takes place over a three-month period, with frequent inspections to identify any film defects. At the end of the exposure period, defect-free coatings then progress to the next stage.

2. T-girder screening tests

To simulate the complexities of tank structures and the variation in film thickness that will inevitably occur during application, the next stage examines the performance of prototype coatings applied to T-girders.
Coated girders are subjected to aggressive, "destructive" cargo sequences. This type of "worst case" testing can generate failures typical of those found in practice and allows potential candidate formulations to be identified for more extensive long-term testing.

3. Long-term cargo sequence tests/corrosion testing

Long-term T-girder testing is carried out in actual cargo sequences to simulate in-service conditions. Tests may continue for over two years to enable one or two formulations to be selected for final performance testing. Long-term corrosion testing is also carried out at this stage.

4. Final testing

Final laboratory tests are carried out before the product is introduced to the field trial stage. Typical tests include the following:

- evaluation of application and cure characteristics under different climatic conditions;
- compatibility with proprietary tank cleaning products and cleaning procedures; and
- independent testing.

"We also carry out detailed studies on cargo absorption, desorption and retention characteristics to fully establish the operating limits of the coating and identify those cargoes where the contamination risk is greatest," explains Jim Brown, marketing manager for International Coating Ltd. "This testing enables us to advise operators on sequencing, cargo uptake in relation to time and minimum venting/recovery times before further cargoes are loaded."

Application and trials

On completion of laboratory tests, successful coating products are applied to selected tanks on vessels. These in-service trials confirm the viability of the application, handling and performance characteristics of the product in a practical situation. Coatings will not be released into the market until after this exhaustive development process is complete and they have been shown capable of meeting the full range of in-service demands.
The application of coating systems in cargo tanks is not a simple task. It requires considerable care to ensure optimum performance and maximum coating lifetime. International offers advice and back-up support throughout the whole tank coating process, from steel preparation and abrasive blasting to final inspection, irrespective of where the application is taking place.

Resistance guides

Tank coating manufacturers monitor the bulk liquid cargoes carried by sea, keeping an eye out for new products in order that their compatibility with the in-house range of coating systems can be tested.
International Coatings has an extensive reference list comprising a track record of over 7,600 vessels coated. This is supported by relevant historical data and, in addition, a cargo resistance list, covering several thousand separate bulk liquid cargoes, can be made available via the internet, on a CD-Rom or in hard-copy format. These references provide specific advice relating to individual coatings together with guidelines for cargo sequencing and safe carriage. Where appropriate, full details of cargo restrictions and limitations are included in order to minimise carriage risks.
"Successful protection of cargo tanks is of critical importance for maximum operational flexibility and earning potential in the tanker sector," points out Jim Brown. "The correct choice of cargo tank coating is therefore essential.

"For a marine paint supplier to be able to meet the full range of tanker industry needs in the cargo tank coating sector, it is necessary to maintain a full portfolio of different coating systems, and to have this supported by a comprehensive new product development programme and a global network of technical service personnel."