

Higher cross-link density coatings keep chemical cargoes purer

When customers ask how does the patented MarineLine cargo tank coating keep chemicals pure from port to port, the discussion leads to a basic understanding of the chemistry behind polymers.*

These are the basic building blocks used in high performance coatings.

Most coatings have adsorption and absorption qualities based on the cross-link density of the polymer used.

A) Adsorption is a surface condition and can be removed easily.

B) Absorption is the penetration of chemical molecules into the molecular structure of the coating.

Absorption is more difficult to remove and requires long drying times and/or chemical cleaning. Absorption also depends on whether the coatings molecular structure is open or closed. In polymer chemistry this is called cross-link density of the cured polymer.

The higher the cross-link density, the lower the absorption rate. A simple analogy is to compare chicken wire to mosquito screen. The chicken wire keeps the chickens in, but also allows flies and mosquitos to enter. The mosquito screening also keeps the chickens in, but does not allow flies and mosquito to enter.

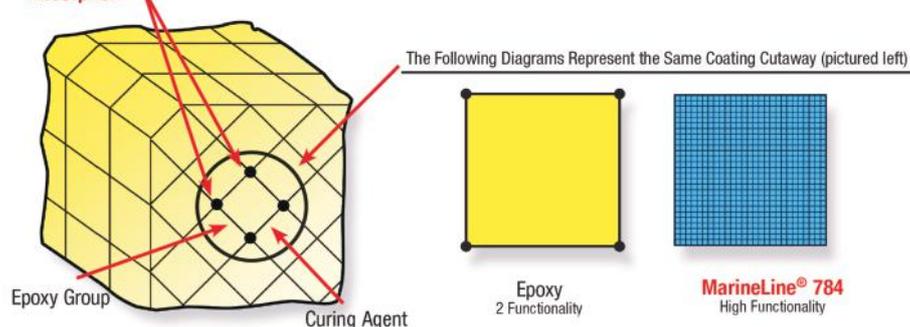
Thus, a higher cross-link density coating is like the mosquito screen, as it keeps out both large and small chemical molecules, such as acids, solvents, etc, effectively protecting the underlying surface. To get the highest cross-link density, the polymer must be fully cured, as presented in the illustration above, where higher cross-linking density is shown of a cured coating.

Normal Phenol epoxies never really obtain a full cure, even over an extended period of time. The cross-linking density depends on the type of epoxy used and the type of curing agent/hardener used. The higher the functionality of the epoxy, the higher the cross-linking.

Functionality is the number of Oxirane/epoxy end caps that can be cross-linked with the curing agent. The initial reaction between the epoxy end caps and the curing agent creates exothermic heat, which is a chemical reaction that releases heat, which helps molecules rotate around to find unreacted end caps.

As the structure polymerises (hardens), it becomes more difficult to cross-link the epoxy

► The Greater the Distance Between the Cross-links, the Greater the Permeation Causing Chemical Attack and Absorption



end caps that become unreachable, even over long periods of time. A portion of the epoxy end caps do not cross-link, and this number could be as high as 30% in some cases.

Cross-linking improvements

Advanced Polymer Coatings (APC) research chemists have found that to get the highest percentage of cross-linking in the MarineLine coating (96 to 100%), heat is required to force the hard-to-reach epoxy end caps to cross-link.

Heat curing early in the cross-linking (polymerisation) stage helps in keeping the molecules mobile and forces them to cross-link to form a tightly knit structure.

Once the polymer cross-links, at atmospheric temperature, to a certain point (75 to 85%), then over time it becomes almost impossible to force cross-linking unless a significantly higher temperature is used then required in the early stage of polymerisation. That is why heat curing during the early stage of polymerisation is important.

APC places a very high focus on proper heating curing of MarineLine in order to create a high cross-link density, thus creating a smooth virtually impermeable coating barrier between the steel tank and the chemicals carried. This is key to maintaining purity of the chemical cargoes carried.

Ongoing coating maintenance and proper tank cleaning (tank decontamination from previous cargoes carried) are also important components of any cargo tank purity discussion. Normally epoxy and Phenol epoxy coatings absorb solvents and other chemicals, and may take a long time to dry out. They may also require extensive use of cleaning chemicals to fully wash the surface of the

coating.

However, for the higher cross-link density MarineLine coating, the entire cleaning operation is faster and easier, as cargoes do not permeate coating, according to shipowners using MarineLine cargo tank coatings. When/if needed, approved cleaning detergents are provided on the APC website (www.adv-polymer.com) for MarineLine, as well as a complete cargo resistance list.

In conclusion, selecting the best cargo tank coating is paramount for purity success because - the higher the final cross-link density the less cargo absorption, and the less possibility of cargo contamination. TO



APC's Donald Keehan.

**This article was written by Donald Keehan, Chairman, Advanced Polymer Coatings.*