How urea-resistant tank coatings can improve fertilizer production

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Urea represents the most popular source of nitrogen fertilizer globally (Europe as a continent being the exception, where ammonium nitrate is more commonly used). Not only are urea-based fertilizers cost-effective in the quantity of nitrogen produced per gram of fertilizer, they carry less safety risk than ammonium nitrate.

However, urea's pH in water solutions means it can become a potential source of corrosion when stored, particularly when stored in tanks susceptible to internal moisture build up or condensation. This can be a particular issue in regions where climatic conditions can vary significantly – for example in Asia, the Middle East and North America – creating large differences in temperature between storage tanks and their contents.

It is therefore important to ensure carbon steel storage tanks are lined with an appropriate protective coating to safeguard their contents, retain the integrity of the tank and enable optimised production efficiency. The potential financial loss from being forced to take a tank out of service for repair can be catastrophic; shutdowns (either planned or unplanned) can cost facilities up to US$12 million/d.

Case study

Jotun was recently approached by a fertilizer manufacturer seeking an effective lining solution for the storage of liquid urea in a number of carbon steel tanks in China. A range of tests were undertaken at the company's laboratories to assess the chemical resistance of its coatings in a 40% urea solution in water.

Tankguard Plus, Tankguard SF and Tankguard Zinc – part of the company's TankFast range – were selected for the tests due to the protection provided against the high pH and their ability to allow the client to return to service faster. The range demonstrates broad chemical resistance capabilities across a number of industries, including fertilizer production and storage.

The two-component Tankguard Plus is a novalac epoxy that allows for up to 50% faster paint application and curing. It provides chemical and temperature resistance and allows for return to service in five days.

Tankguard SF, the solvent free novolac epoxy, can be used for wet-on-wet application, which gives the protection of two coats in the time of one coat. It has good resistance to a wide range of chemicals and can be applied in film thickness down to 150 micrometres (μm) and up to 500 μm.

Finally, Tankguard Zinc is an inorganic zinc silicate tank coating. It is used as a single coat system only and complies with ASTM D520 type II zinc dust. It provides chemical resistance 60% faster than an epoxy coating, without any mud-cracking.

The coating used also determines how quickly a tank is returned back to service.

The client originally requested the products to be tested at 20°C, but the decision was made to increase the temperature to 40°C to enhance the aggressiveness of the tests and ascertain what the products were capable of enduring.

Mild carbon steel panels measuring 75 mm wide by 150 mm high, with a thickness of 1.5 mm, were used for the tests. Two panels were coated with two coats of Tankguard Plus, each 125 µm for a total thickness of 250 µm, one panel was coated in Tankguard SF to a 400 µm thickness and one was coated in Tankguard Zinc at 100 µm thickness.

The market preferred test standard ISO 4628 was used to designate the impact on the coating while storing the urea, with specific examination of the degree of blistering, cracking and rust.

The panels were placed in separate jars containing a 40% solution of urea in water: 50% of each panel was immersed in the solution while the non-immersed 50% acted as a test for the impact of gas caused by the breakdown of the urea. However, no gas occurrence was identified.

The jars were stored for nine months in an oven at 40ºC. The panels were inspected every week for the first month and once a month thereafter to monitor the impact.

At the end of the storage period all of the products had experienced zero blistering, cracking and rust. The Zinc panel attracted a degree of zinc salt formation but this is normal and had no impact on the level of chemical resistance provided by the coating. Indeed, zinc salt passivates the coating and can act as further protection against urea and ultimately corrosion. The start of the salt formation was witnessed within the first few days of the test but it rapidly stabilised and did not negatively impact the urea, coating or carbon steel.

Figure 1. Test results with Tankguard Plus.

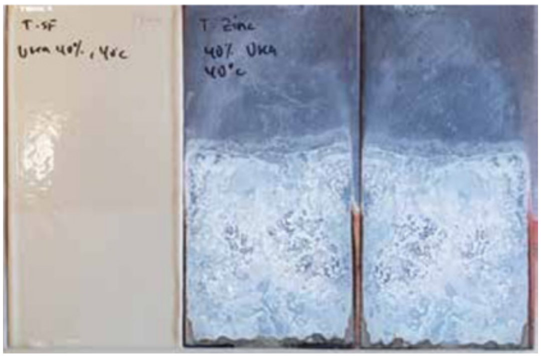

Figure 2. Test results with (L-R) Tankguard SF and Tankguard Zinc.

The only other change witnessed was a slight discolouration of the panel coated in Tankguard SF, but this did not affect its protective qualities.

It is accepted that laboratory conditions can never fully replicate those experienced in the field, such as possible temperature fluctuations. However through the test, it was demonstrated that the products can provide protection when immersed in a 40% solution of urea in water at double the operational temperature set by the client, and are therefore suitable for lining steel tanks used for the storage of urea.

Alternative solutions

There are some alternatives to lining a tank. Ultimately, the two questions that facilities need to ask themselves are: what do they need to protect the tank and product from; and what is the most commercially viable option? If a large tank is required, it usually makes the most commercial sense for it to be made of carbon steel which, as a result, means the tank and its contents should be protected with a lining.

For small tanks, there are other options. Examples include stainless steel tanks or glass reinforced plastic/polymer (GRP) tanks. Stainless steel is resistant to most chemicals – with halogen being the most common exception – and typically does not require a lining. However, it is a very expensive material when compared to carbon steel and an appropriate lining. They can also be difficult to construct, due to the hardness of the material and the restrictions on materials used when welding and heat working. This naturally affects labour costs during construction.

GRP tanks are most frequently used for holding and storing water, although certain types of plastics are resilient to acids and, providing a tank is small, there are some GRP tank options that do not require a lining. Again, these are more expensive than carbon steel. It is also crucial to ensure that the correct quality of plastic or polymer is used so that the tank survives for the intended lifetime. In addition, a GRP tank can typically only be used to store the chemical it was originally designed for, meaning there is less flexibility in the use of the tank.

As with all tanks and their contents, it is important to ensure they will be adequately protected.