Combating Corrosion

How best to protect key assets

In the ongoing battle against corrosion, there are options to extend the life of key water assets – as **Corrie Cook** reports.

Dealing with aging facilities, constant pressure on maintenance budgets and a reducing public tolerance for asset failure are real challenges for infrastructure and asset owners.

Asset owners typically expect a 100-150 year design life from water management facilities, when design codes are most commonly for a 40-60 year lifespan. To extend the design life to be closer to an owner's expectation, durability design and management strategies are increasingly important.

Paul Vince, Material Science Manager at South Australia Water Corporation (SA Water), knows this only too well. "Corrosion is a thief," he says. "More and more water-based events are affecting all types of assets and there is more UV exposure on coatings. This inevitably means increased inspection cycles and careful design."

SA Water has responsibility for 700 concrete water storage tanks, many dating from the 1920s, and is now using Remotely Operated Vehicles (ROV) submersibles and drones in its efforts to spot the beginnings of corrosion. For every tank whose life they can extend for 12 months, the facility calculates it is saving up to A$1 million a year, per tank.

Vince was speaking at the asset management forum at the Australasian Corrosion Association's (ACA) recent Corrosion & Prevention conference in Adelaide. The ACA is a not-for-profit membership association established in 1955 which aims to reduce the impact of corrosion. It provides an expert knowledge base and disseminates information on corrosion and its control through training, seminars, conferences, publications and other activities across New Zealand and Australia.

"New water tank design doesn't include guttering nowadays, which means water can pond at the base of the tank and depending on the surrounding soils, can accelerate concrete corrosion," he explains.

Concrete sewers are also subject to corrosion from chlorides, sulphates, thermal cracking, and other challenges that pipes carrying organic waste need to withstand.

Exhumed sewer pipes are often found to be very thin at the crown, where acidic condensates formed by microbial action on hydrogen sulphides have eaten into the concrete. In extreme cases, this can result in complete loss of the pipe wall.

"Acidic and high sulphate conditions are very bad for concrete," explains Jonathan Morris, a senior asset management consultant. "A slime layer forms below the surface level of the wastewater, which houses bacteria that convert sulphates into hydrogen sulphide. When the hydrogen sulphide escapes from the water, it can be converted into sulphates in the above-water slime layers, which are converted into powerful acids by other bacteria."

Efforts to slow corrosion onset include careful design, specifying a concrete mix that includes fly ash, slag, silica fume or metakaolin, curing it appropriately and applying a protective surface coating.

Protecting steel water pipes from corrosion

As a material, stainless steel has great appeal for the water and wastewater industries. It doesn't need special coatings to make it corrosion resistant, it's very versatile in that design modifications are easily made on site, and it can often be cost competitive. Even bad welds can be cut out and re-done on site.

Choosing the wrong grade of stainless steel for an application, joining it to an incompatible metal, or creating tight crevices on its surface will all shorten its life, and therefore the life of the asset, says Morris. The standard grades in water management assets are type 304 and 316 which can provide "acceptable" performance, he says. "Although," he warns, "higher corrosion resistant grades should be used for more demanding applications."

For example, chlorination is the most common way to disinfect water in both potable and wastewater streams, but can promote corrosion in more conventional stainless steels.

"Research suggests there are few problems when chlorine is injected into the process stream and good mixing occurs. However, corrosion can occur when there has been long term, excessive dosing and where the concentrated chlorine has been injected against the metal wall," says international metallurgy expert Carol Powell.

When moist hydrogen sulphide and chlorides are present in closed wastewater systems like pipes, there's a risk of localised pitting and crevice corrosion for 304 and 316 grades. When condensates include dissolved sulphur dioxide such as in geothermal applications, the increased acidity means higher corrosion resistant grades are recommended such as austenitic (eg, 904L) or duplex (eg, 2205) grades.

"Duplex stainless steels are roughly twice as strong as austenitic stainless steels and also have better resistance to localised corrosion," explains Les Boulton of the Nickel Institute. They contain more chromium (19–32 percent) and molybdenum (up to five percent) and lower nickel percentages than austenitic stainless steels, which means wall thickness and weight can be reduced. There is now a hyper-duplex grade (2707) that performs well in extremely high temperatures such as those found in geothermal power plants.

A clean metal surface naturally passivates itself when exposed to air or aerated water conditions. This is the most corrosion-resistant state of any stainless steel.

"Corrosion, if it occurs, is usually found at crevices, but this can be avoided by correct grade selection for the chlorides present in the waters; guidelines are available to assist with this," says Powell. "Attention to detail during fabrication including the use of good welding and inspection procedures can help, because inferior welding and/or a poor surface finish can also encourage corrosion."

She points out that when raw water is used for hydrostatic testing of stainless steel pipelines and storage tanks, that are then left to stand for a number of weeks, there is a risk that inappropriate bacteria can colonise the asset, and microbiologically influenced corrosion (MIC) can begin. This is usually found where welds have not been cleaned of heat tint. Once this is removed, corrosion resistance is greatly improved.

"It's very important to drain and dry stainless steel systems after hydrotesting if the equipment is not going back into service immediately," said Powell. "If this is not possible, regular flushing of the system should limit potential MIC problems. Ideally potable waters, steam condensates where available, or filtered waters should be used for hydrotesting rather than raw waters."

The ACA is offering a number of seminars and training courses in New Zealand throughout the year. These include "Protecting infrastructure and assets against corrosion" in Auckland on 19 May, and "Corrosion in the oil and gas industries" in New Plymouth on 4 August. ACA's Corrosion & Prevention 2016 conference will be held in Auckland between 13-16 November bringing together researchers and practitioners from around the world who combat corrosion every day.

For further information on these and more, go to www.corrosion.com.au. **WNZ**