CHEMICAL CORROSION CONTROL

Process Plant and Equipment Up-time

The basic engineering tradesmen and operators need to keep plant reliability up and operating costs down.

ABSTRACT

Chemical corrosion control. Chemical corrosion can destroy the containment materials in contact with a process. Means exist to mitigate and even prevent chemical corrosion. Keywords: process conditions, material compatibility, resistant, coating, lining, stress corrosion, rate of corrosion, spark testing.

ACCEPTABLE CORROSION

At times chemical corrosion is acceptable and one need only allow for it by using thicker materials. An example is the storage of sulphuric acid in mild steel tanks at ambient conditions and concentrations higher than 80%. Though the acid attacks the metal, the rate of corrosion is extremely slow. Using thick walled steel tanks with a corrosion allowance which takes decades to thin can be a cost-effective option.

Sulphuric acid absorbs moisture from the air. If the top layer in a mild steel tank is left undisturbed it will dilute and attack the steel. A 12mm steel plate can corrode through in 12 months. Circulating the acid weekly if it is stored in carbon steel tanks. For small quantities of sulphuric acid a suitable plastic tank can solve the storage and corrosion problem cheaply.

SELECT RESISTANT MATERIALS

Using more resistant materials will reduce the effect of chemical attack. Specialist metals and non-metals to contain aggressive environments are available. These can be expensive and their use is based on their cost effectiveness.

In particular, select low corrosion rate metals for diaphragms used in process instrumentation. It is false economy to select a 316 stainless steel diaphragm for a pressure transmitter on a tank of 98% sulphuric acid. Though corrosion tables indicate 316 stainless has a low corrosion rate, experience shows that after two years of service the diaphragm can fail by pin holing. For an additional 20% cost a Hastalloy C diaphragm provides a corrosion life 10 times longer.

COMPATIBLE COATINGS AND LININGS

Prevent chemical attack by coating in a material unaffected by the chemical. Rubber lining of hydrochloric acid storage tanks and plastic lining of process piping are examples. Teflon coating can protect a stainless steel sparge feeding sulphuric acid into a mixing vessel.

Rubber linings normally fail at joins. Check the correct procedure is used when they are mounted in place.

Always test the coating to prove there are no holes. High voltage spark testing is used on thick coatings and linings while the low voltage 'wet sponge' method is used on thin coatings.

CHANGED MATERIAL PROPERTIES

Heat from welding processes alters the metal properties at the heat-affected zone (HAZ) of the weld. Stresses are introduced into the metal and grain microstructures are altered. Consideration of the welding method, weld procedure and use of stress relief can mitigate the effects.

The effect of welding is particularly evident when hot caustic solutions are contained in mild steel vessels. Unless stress relieved, chemical attack can occur at the HAZ of the welds.

CONSIDER PROCESS CONDITIONS

Using corrosion tables without considering all the process conditions can lead to poor materials selection. Most published data on compatibility do not take into affect agitated conditions. Some data only applies to ambient temperatures. Data is normally not available on the effect of aeration. Nor is data readily available on the effect of other contaminants, for example chlorides with stainless steels.

In uncertain or changeable situations will occur in a vessel consult the material manufacturer and ask for their advice. If they cannot help, then the only remaining option is to conduct your own laboratory tests or field trials.

The chemical compatibility table below was derived from numerous published data. The most conservative temperatures were selected. Where no temperatures are shown ambient conditions apply.

Chemical corrosion control and mitigation requires creative use of a few basic principles.

CHEMICALS >>	SULPHURIC ACID 98%	SULPHURIC ACID 80%	SULPHURIC ACID LESS THAN 80%	HYDROCHLORIC ACID 28%	CAUSTIC 50%	CAUSTIC 25%	GASOLINE PETROL	DIESEL FUEL	DEMIN WATER	SEA WATER	ETHYL ALCOHOL
METALS	Hastalloy C (95 C)	Hastalloy C (95 C)	Hastalloy B (100 C)	Hastalloy B (70 C)	316L Stainless steel (95 C)	316L Stainless steel (80 C)	316 L Stainless steel	316 L Stainless steel	316 L Stainless steel	316 L Stainless steel	Carbon steel
In order of corrosion resistance	316L Stainless steel	316L Stainless steel	Alloy 20 (60 C)	Hastalloy C (40 C)			Carbon steel	Bronze, Brass		Bronze	316 L Stainless steel
	Carbon steel	Carbon steel			Carbon steel (40 C)	Carbon steel (95 C)		Carbon steel			Bronze
PLASTICS	Teflon (95 C)	Teflon (95 C)	Teflon (95 C)	Teflon (150 C)	uPVC (60 C)	uPVC (60 C)	uPVC (60 C)	Teflon (180 C)	Teflon (200 C)	Polyethylene (80 C)	Polypropylene (80 C)
In order of temperature limits	Polypropylene (80 C)	Polypropylene (80 C)	Polypropylene (80 C)	uPVC (60 C)	ABS (60 C)	ABS (60 C)		Polyethylene (60 C)	uPVC (60 C)	uPVC (60 C)	uPVC (60 C)
	uPVC (60 C)	uPVC (60 C)	uPVC (60 C)	Polyethylene (60 C)	Polyethylene (40 C)				Polyethylene (60 C)		
			Polyethylene (60 C)	ABS (60 C)							
ELASTOMER (Rubber)	Hypalon (50 C)	Viton (60 C)	Viton (120 C)	Viton (180 C)	Hypalon (140 C)	Hypalon (120 C)	Viton (50 C)	Nitrile Buna-N (80 C)	EPDM (95 C)	Hard Rubber (80 C)	Nitrile Buna-N (60 C)
In order of temperature limits	Viton (20 C)	Hypalon (50 C)	Neoprene (95 C)	Natural rubber (95 C)	Neoprene (95 C)	Neoprene (95 C)	Nitrile Buna-N (80 C)	Viton (80 C)	Hard Rubber (80 C)	Nitrile Buna-N (80 C)	EPDM (40 C)
			Hypalon (50 C)		Hard Rubber (80 C)	Hard Rubber (80 C)			Neoprene (80 C)	Viton (80 C)	
COATINGS			Fiberglass & vinyl ester (95 C)	Epoxy resins (95 C)	Epoxy resins (50 C)				Vinyll ester		
				Fiberglass & vinyl ester (80 C)	Fiberglass & vinyl ester	Fiberglass & vinyl ester					
				Asphalt resin (50 C)							

Table No. 1 Chemical compatibility of various materials in various chemicals

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