OUR PERSPECTIVE

CORRISION CLUES

- Hydrogen molecules can get caught in a vessel and create a blister.
- Corrosion can occur when moisture penetrates the coating of a vessel.
- Coatings that use zinc offer better protection against corrosion.
- Corrosion damage happens when two dissimilar materials are coupled in a corrosive electrolyte.
- Corrosion can be prevented by monitoring paint on vessels and examining anodes in pipelines and vessels.

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CORROSION CAN BE PREVENTED

Corrosion is an issue often associated with used production equipment. Some of the lessons learned from 20-year-old equipment are a good guide to ensuring that newer equipment remains usable for a long time.

Corrosion can be found on a variety of equipment including:

- Pumpjacks – subject to corrosion on their structures, but also on their gear trains and bearings
- Oilfield vessels – corrosion caused by coming into contact with a variety of chemicals
- Coating – often found on deteriorated vessels resulting in pitting
- Tanks - corrosion found under paint along the welds
- Pressure vessels – corrosion causing blisters
- Pipelines – corrosion causing stress cracking
- Hardware – rusty bolts on valves and other attachments

To read about other types of corrosion visit: the Corrosion Doctors on www.petroassist.com.

The types of corrosion often seen in Canada's petroleum industry are hydrogen corrosion, filiform corrosion, stress corrosion cracking and galvanic corrosion.

Hydrogen Corrosion

My first encounter with hydrogen corrosion occurred when I was inspecting a pre-owned treater with Hank Andersen of Andersen Quality Assurance and Consulting Inc. The most common hydrogen corrosion is found in pressure vessels.

Hydrogen is a small enough molecule that it can migrate through steel and remain inside the material. Hydrogen atoms are formed from chemical reactions caused elsewhere in the process. Once the single atom meets up with another hydrogen molecule, it becomes larger and cannot find a way out of the material. This causes a blister to form along a vessel and could even split the shell. The blistering occurs in acidic environments such as water that has CO_2 or H_2S in the gas stream. Corrosion is not a problem in neutral or caustic environments or with high-quality steels that have low impurity and inclusion levels. But, older steel that may not be as pure as steel used in newly fabricated vessels. So it's important to look carefully at older treaters and separators and look for signs of corrosion. Corrosion in older vessels can be fixed by welding a patch of new steel over a blister, or by placing a manway or nozzle over the affected area. Corrosion repairs are best done by an experienced shop that has the right ABSA or ASME qualifications handle the repair.

Filiform corrosion

Filiform corrosion occurs under painted or plated surfaces and is caused when moisture penetrates the coating. This often happens on pumpjacks on the weld seams, and on tanks where the plates meet. The obvious fix is to make sure the metal is dry prior to coating. The other fix is to use a coating that resists absorbing water. Certain coatings are more prone to it than others. Coatings that contain zinc are recommended as they also offer some cathodic protection.

Galvanic Corrosion

According to the Corrosion Doctors (see www.petroassist.com), galvanic corrosion can be defined as, "Corrosion damage induced when two dissimilar materials are coupled in a corrosive electrolyte. The driving force for corrosion is an electric potential difference between the different materials. The less noble material will become the anode of this corrosion cell and tend to corrode at an accelerated rate, compared with the uncoupled condition. The more noble material will act as the cathode in the corrosion cell. A useful application of this type of corrosion is the sacrificial corrosion of zinc, magnesium or aluminum for the cathodic protection of a metallic structure most often made of steel."

Corrosion can be prevented by monitoring paint on vessels and examining anodes in pipelines and vessels. Invest in a regular monitoring program.

The condition of a treater can often be determined by the condition of the anodes. Anodes can be replaced with a block of zinc or aluminum designed to corrode in lieu of the shell of the vessel the anodes are in. If the anode is used up, this indicates a significant amount of galvanic corrosion is happening. The anodes are designed to protect the areas of the vessel where the coating has failed, or sometimes replace coatings in environments where coatings will not hold or are just impossible to apply. Galvanic corrosion may happen in a treater where a small chip occurs in the coating. Theoretically the anode will protect the exposed part of the treater shell. It's important to note that an anode can only protect that which it can "see". Therefor it's important to have anodes on both sides of baffles and internals to ensure long term protection.

Did you ever wonder why some of your temperature indicators corrode right on the threads, and others don't? The answer is galvanic potential. The *Galvanic Series* helps determine why some fittings corrode, and others don't.

Galvanic Series (Courtesy Corrosion Doctors)
"A galvanic series has been drawn up for metals and alloys in seawater, which shows their relative nobility. The series is based on corrosion potential measurements in seawater only."

The basic rule is this: The further apart in this series materials are, the higher the chance of galvanic corrosion between these two materials.

Materials that offer the most protection or are the most resistant to corrosion are listed below. But zinc is the most anodic or easy to corrode.

- Platinum
- Gold
- Graphite
- Titanium
- Silver
- Chlorimet 3
- Hastelloy C
- 18-8 Mo stainless steel (passive)
- 18-8 stainless steel (passive)
- Chromium steel >11 % Cr (passive)
- Inconel (passive)
- Nickel (passive)
- Silver solder
- Monel
- Bronzes
- Copper
- Brasses
- Chlorimet 2
- Hastelloy B
- Inconel (active)
- Nickel (active)
- Tin
- Lead
- Lead-tin solders
- 18-8 Mo stainless steel (active)
- 18-8 stainless steel (active)
- Ni-resist
- Chromium steel >11 % Cr (active)

Stress corrosion cracking

Regulators such as Canada's National Energy Board (NEB) are particularly interested in stress corrosion cracking (SCC) in pipelines. The NEB published a study called, "Stress Corrosion Cracking on Canadian Oil and Gas Pipelines" investigates both stress corrosion cracking due to stress on pressurized pipelines and corrosion found on welding but also examines the effect of potentially corrosive materials within the pipeline.

The study concluded that, "Stress corrosion cracking on pipelines begins when small cracks develop on the outside surface of the buried pipeline. Since SCC develops slowly, it can exist on pipelines for many years without causing problems. But if a crack becomes large enough, eventually the pipeline will fail and will either leak or rupture."

The SCC problems in pipelines are found in mainly on older lines that were built in the 60's and 70's. These lines were often coated with polyethylene tape used to protect the pipe. Unfortunately, the coating can separate and allow water to contact the pipeline. Ironically, the water corrodes the pipeline because the polyethylene is shielding the pipeline from cathodic protection devices.

In the meantime, corrosion can be prevented by monitoring paint on vessels and examining anodes in pipelines and vessels. A good inspection by an experienced inspector will identify problems before they become a serious concern.