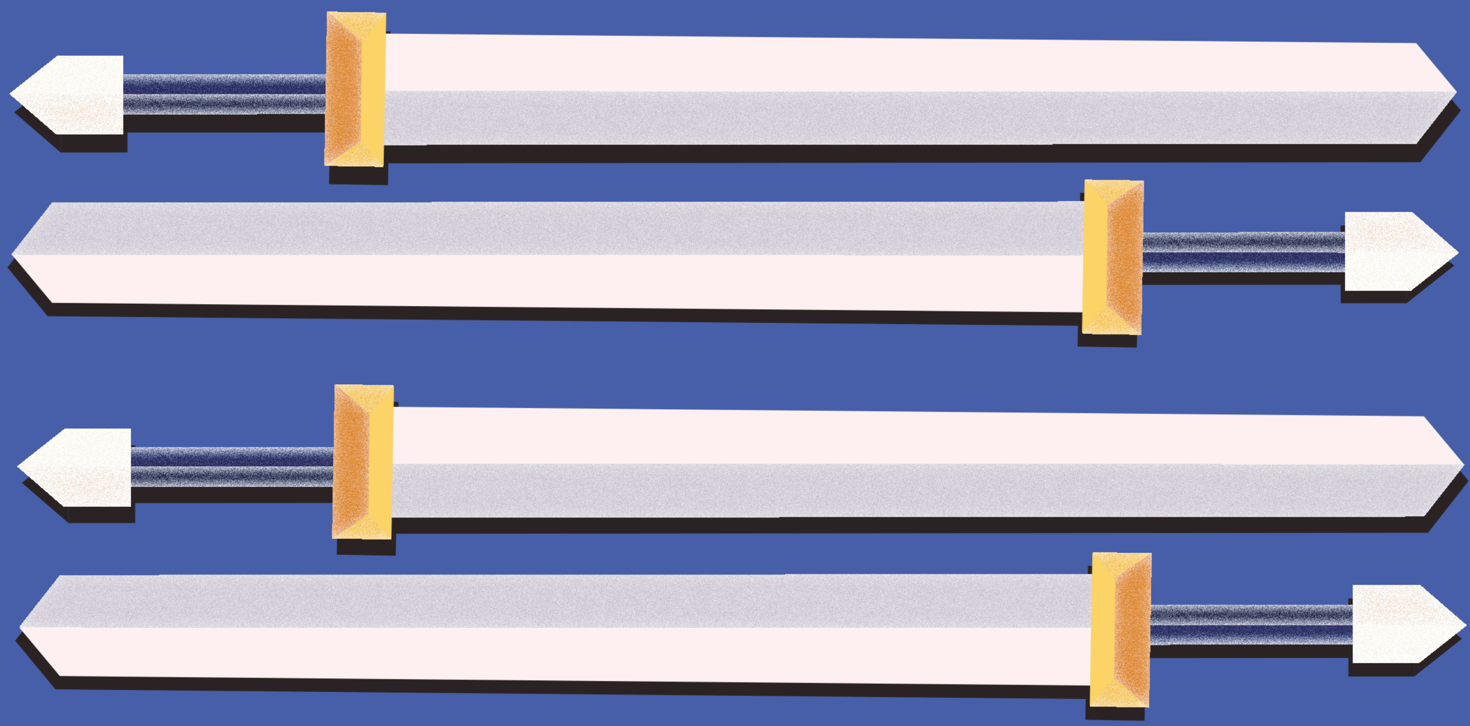
HYDROTESTING: A DOUBLE-EDGED SWORD



Julie Holmquist, Cortec® Corp., discusses how the oil and gas industry can overcome the inherent corrosion challenges of this integral part of pipeline safety.

Hydrotesting. In the world of oil and gas, you can't live with it... and you can't live without it. Using water for pressure testing is a matter of course that ensures unending kilometres of pipeline have the strength and integrity to transport hazardous fluids cross-country, and even under the sea. Unfortunately, the very process intended to confirm pipeline safety and reliability can actually undermine its integrity by introducing moisture and leaving metal surfaces vulnerable to corrosion. That is why the right corrosion inhibitor is an integral part of the pipeline commissioning process and why manufacturers, contractors, and operators should know where and how a corrosion inhibiting additive fits into the overall hydrotest procedure.

Figure 1. The very process intended to confirm vessel integrity can undermine it by introducing moisture and leaving metal surfaces vulnerable to corrosion. (Image courtesy of Cortec Corp.)

Figure 2. Pressure testing is such a vital component of hazardous fluid safety that it has become a pipeline rite of passage enshrined in standards throughout the world. (Image courtesy of Cortec Corp.)

Figure 3. Before commissioning, hydrotesting must be completed on each new segment of pipeline that is installed. (Image courtesy of Cortec Corp.)

Why is hydrotesting important?

Hydrotesting is such a vital component of hazardous fluid safety that it has become a pipeline rite of passage enshrined in standards throughout the world. In the US, the US Code of Federal Regulations includes a detailed list of requirements for hydrotesting hazardous liquid pipelines.[1] A fact sheet from the US Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) gives a good summary of these requirements, which include mandatory hydrotesting after construction or replacement, and before commissioning, to confirm that both the pipeline materials and the method of construction are sound.[2] But this is not the only phase of hydrotesting. In some cases, the code also calls for manufacturers to ensure the integrity of non-pipe components by hydrotesting,[3] an action taken before the component ever makes it to the construction site. Other relevant guidelines include the American Petroleum Institute (API) RP 1110 (recommended practice on pressure testing steel pipelines for gas and hazardous liquids)[4] and ISO 10802 (an international standard for hydrotesting of ductile iron pipelines for oil transmission).[5] Each standard is designed to evaluate integrity and confirm pipelines are strong enough to hold hazardous fluids/gases under pressure without leaking. Without these mandates for hydrotesting or some form of pressure testing, society would likely experience many more pipeline disasters from systems that fail under real life pressure.

Basics of pipeline hydrotesting procedures

Hydrotesting should be done at several phases of a pipeline's life cycle. As suggested above, the first occasion is the manufacturing phase, before the pipeline segments/components are sent to the field. The second time is before commissioning of a new or replaced pipeline segment. Hydrotesting also occurs periodically on operating pipelines to confirm the pipelines are still in good condition.[6]

Understanding how hydrotesting is done provides a window into where and when corrosion protection may be needed. As the PHMSA fact sheet explains, the US federal code of regulations requires hydrotesting for several hours at 125% of the maximum operating pressure (MOP), plus additional time if the pipeline is not visible.[7] However, hydrotesting can be even more specific. It can include strength tests and leakage tests. In strength tests, water is added for 2 - 8 h with pressure and temperature recorded. A leak tightness test takes even longer, with pressure measured every hour, typically for 24 h. As each pipeline segment is tested, the contractor must keep detailed records for the pipeline operator, and both the operator and contractor should sign a certificate that confirms successful hydrotesting was completed on that segment. When the pipeline has been completely tested, a full report with all certificates and data should be given to the operator for verification.[8]

Hydrotesting is also done on operating pipelines. One of the largest pipeline companies in the world explained that their process for hydrotesting crude oil pipelines is to dye the hydrotest water and place it between two pigs to seal it off from the hydrocarbons. This slug of water is then delivered to the pipeline segment that needs hydrotesting, and the pressure is increased while a ground and air team look out for any spraying or pooling water that indicates leakage. This is all executed with the safety of the surrounding communities and environment in mind.[9]

Why should a corrosion inhibitor be added?

Unfortunately, the very activity designed to ensure the safety of hazardous pipelines can also be their Achilles heel. As noted, water is often used for pressure testing (hence the term 'hydrotesting'). Water in combination with oxygen and metal makes a perfect recipe for corrosion. The presence of salt or other contaminants increases the risk. Once corrosion starts, it is more likely to spread to other parts of the metal, deteriorating the internal surface and thinning the pipeline wall over time. While corrosion could create a leak by 'eating' a hole all the way through the metal, it could also simply weaken the pipeline enough to lead to a dramatic rupture when the corrosion-thinned wall can no longer withstand the pressure of the hazardous fluid. Either problem is dangerous and can be discouraged by adding a corrosion inhibitor to the hydrotest water.

Different timelines, different doses

When selecting a corrosion inhibitor for the hydrotest water, it is important to ask several questions. Is corrosion protection needed only during the hydrotest? Or will corrosion protection be needed for a longer period? Often, new pipelines are laid up for an extended period before they are commissioned. Sometimes the water is left inside the system for wet layup. Sometimes it is drained for a 'dry' layup. Other times it is literally dried out to prevent contamination.[10] If corrosion protection is desired from the point of hydrotesting through layup (until commissioning), a higher dose of corrosion inhibitor will be needed. For example, for one corrosion inhibiting hydrotest additive, the recommended dose ranges from 0.3% by weight for protection during hydrotesting only, to 3% by weight for ongoing preservation for 1 - 2 years of preservation after hydrotesting. If the pipeline undergoes dry or wet layup in a very harsh environment, an even stronger dose of corrosion protection may be needed. The use of seawater vs fresh water will also affect additive selection, as some inhibitors may be specially designed for offshore use and seawater hydrotesting, but may not be designed for post hydrotesting preservation. In these cases, it may be desirable to rinse the pipeline and apply another corrosion inhibitor – whether it be in the form of an additive or a corrosion inhibiting fogging fluid – for protection until commissioning.

The corrosion inhibiting mechanism

The VpCI®-649 Series is one portfolio of corrosion inhibitors that is especially practical for hydrotesting. These hydrotest additives not only provide active corrosion protection to the surfaces with which they come in contact but also leave behind a protective corrosion inhibiting film. This layer exudes corrosion inhibiting vapours that diffuse throughout pipeline internals and form a protective molecular layer in void spaces above the water level or throughout the drained pipeline. The corrosion inhibitor can be dosed at different levels for varying lengths of protection, which is why manufacturers can do themselves a favour by hydrotesting with enough corrosion inhibitor to provide ongoing protection as the pipeline segments travel to the installation site. Using a higher dosage of corrosion inhibitor is especially important when residual water is left inside a pipeline for extended periods. This reduces the need to completely dry the system for the sake of corrosion protection. In the case of the VpCI-649 Series, different tracers are available for easy detection to ensure proper concentration in the hydrotest water, allowing both the water and corrosion inhibitor to be reused in some cases for recycling efficiency and cost savings.

You can live with hydrotesting

Hydrotesting is an integral part of pipeline commissioning. It confirms the integrity of the system by exposing it to higher pressures than a pipeline typically experiences during operation. It is therefore an important precaution against pipeline failure and the danger posed to humans and the environment by the release of hazardous materials. Ironically, the exposure of metal to hydrotest water makes metal more vulnerable to corrosion attack, potentially undermining the integrity and service life of hydrotested pipelines over time. By implementing a corrosion inhibitor at every stage of hydrotesting – from manufacturing to installation to operation – manufacturers, contractors, and operators can make the most of their hydrotesting efforts while solving the corrosion conundrum easily and efficiently. Members of the oil and gas industry may not be able to live without hydrotesting, but thanks to corrosion inhibitors, they *can* live with it.

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