Protecting the unseen

Julie Holmquist, Cortec® Corporation, and Tim Whited, MESA, USA, explore mitigating corrosion on cased pipeline crossings.

An estimated 1.18 million km (730 000 miles) of pipelines transport oil and gas around the world – enough to circle the globe over 29 times.[1] Of these, at least 485 288 km (301 544 miles) of pipelines transmit gas in the US alone, not including gas distribution and gathering lines.[2] Inevitably, these pipelines intersect many highways, roads, and train tracks, passing unseen many feet below. Often, these pipelines are encased in a larger pipe to protect against the extra load and the possibility of exterior damage, while also theoretically making it easier to repair and replace pipeline sections without disturbing traffic. Unfortunately, this unseen environment is also ripe for corrosion that could go unnoticed for many years. Because of this, MESA, a nationwide corrosion control services company headquartered in Tulsa, Oklahoma, has been on a journey for the last decade to fill these casings with a new form of corrosion protection developed in conjunction with Cortec Corporation. The efforts began in response to specific needs of a major pipeline operator, and have resulted in the creation and patenting of CorroLogic® VpCI® Filler technology. This specialty technology, based on a time-tested corrosion inhibiting chemistry, is an important corrosion mitigation strategy for pipeline owners to be aware of due to its particular aptitude for dealing with the unseen environment of cased pipeline crossings.

The cased pipeline crossing landscape

The landscape for protecting cased pipeline crossings is vast. For example, Tim Whited, CorroLogic VpCI Specialist

and NACE CP Specialist at MESA, who was an integral driver in the development of CorroLogic VpCI Filler, estimates that there are tens of thousands of cased pipeline crossings in the US alone, and that MESA has applied the CorroLogic VpCI Filler technology inside a few hundred casings. This means tens, if not hundreds, of thousands of cased crossings are future candidates for further protection.

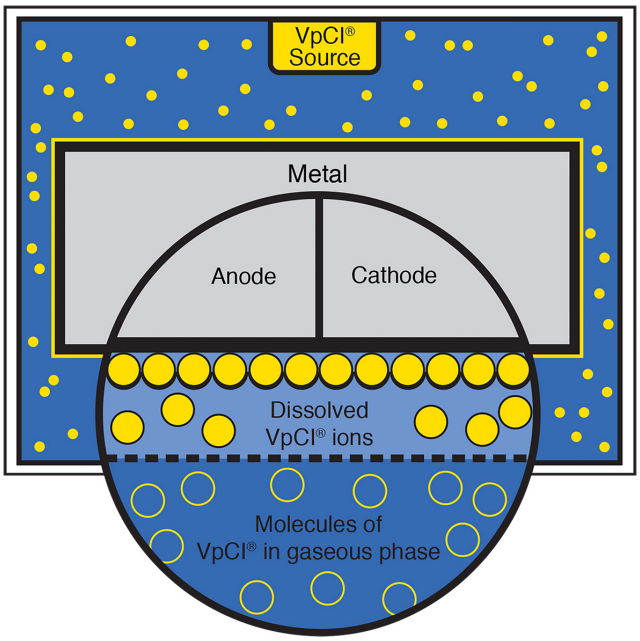

Figure 1. Vapour phase corrosion inhibitors (represented by yellow dots) have the ability to migrate through air and water to form a protective molecular layer on the metal surface. This is ideal for protection of unfilled spaces in cased crossings, as well as protection under disbonded coatings. (Source: Cortec)

While installing casings at pipeline crossings was once in vogue, it is increasingly going out of style with technologies such as horizontal directional drilling (HDD) and other sound alternatives to cased pipeline crossings becoming more dominant.[3] However, the fact remains that hundreds of thousands of pre-existing cased crossings are only getting older and will likely face more challenges as they age. Corrosion on the external surface of the carrier pipe inside cased crossings may be enhanced due to debris trapped inside the annulus during installation, and by moisture entering the annulus through failed seals and holes in the casing walls. Further, coating holidays on the carrier pipe may be a corrosion risk in the presence of an electrolyte (e.g. water) inside the casing annulus.[4] Metallic shorts between the carrier pipe and the casing can occur and are areas of concern for corrosion on the carrier pipe surface.

The good news is that Southwest Research Institute (SRI) findings suggested a high level of safety at cased crossings in 2007. However, although corrosion related catastrophes at these crossings appear to be few and far between, their study shows that when a corrosion failure does occur, it can be drastic and even life threatening. One of the most extreme cases reported by SRI occurred in 1985. A natural gas pipeline running under Kentucky State Highway 90 ruptured, the gas ignited and burned a large area, five people were killed in a house, and three were burned running from a mobile home. The cause was attributed to "unsuspected and undetected atmospheric corrosion", according to the National Transportation Safety Board report. Factors such as cyclic water condensation and

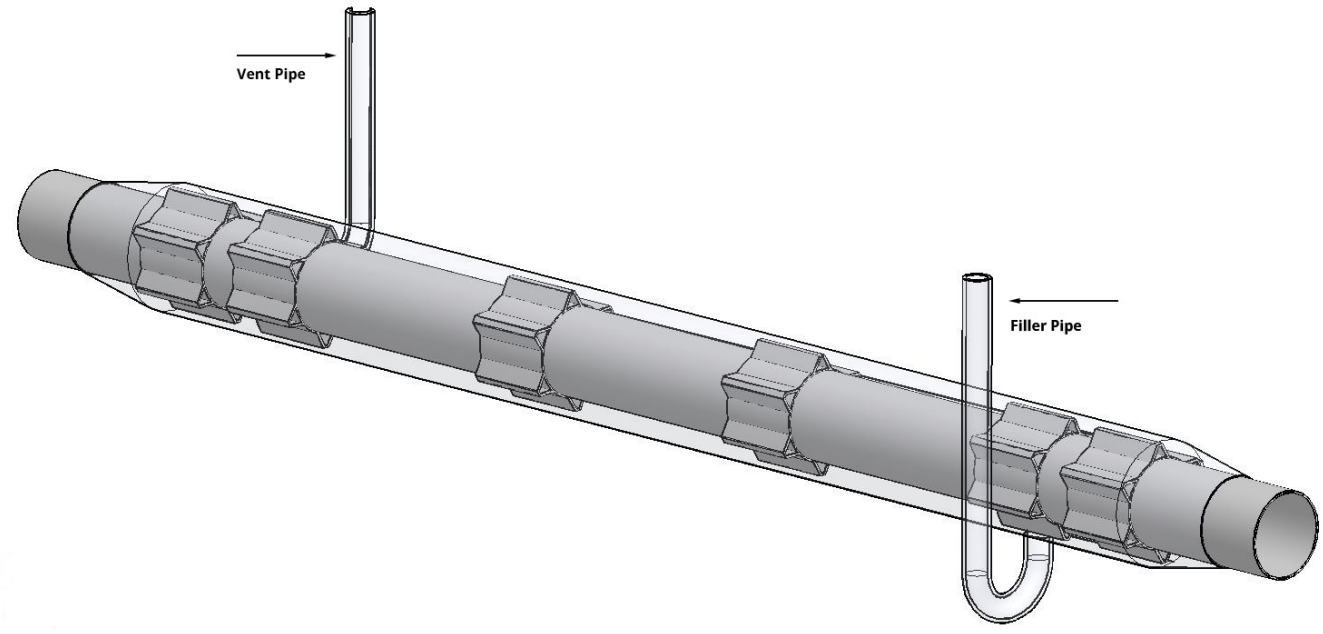

Figure 2. Cased pipeline crossing illustration showing internal carrier pipe, insulating spacers, casing, end seals, and vent/filler pipes. (Source: Cortec. CAD drawing courtesy of Tommy Lee)

coating damage due to high heat from a nearby compressor station were also indicated. Another case from 1980 was less serious but involved a casing short in a kerosene pipeline.

Figure 3. The centre pipe is the ventilation duct to the pipeline casing buried underground at this pipeline crossing. A similar vent on the 'low side' (ventilation to the bottom of the pipe) is where CorroLogic VpCI Gel application is ideal. The left pole is where the electrical potential can be measured to determine CP condition. (Source: Cortec, courtesy of Eric Uutala)

Figure 4. CorroLogic VpCI Gel is pumped through the filler pipe into the lower portion of the casing until it can be detected coming out the other side. Inevitably, it often picks up some of the debris contaminating the inside of the casing, which is why the right sample is darker than the left one. (Source: Cortec, courtesy of Eric Uutala)

The short was believed to have been present for a decade. Groundwater had leaked in and caused corrosion thinning on the bottom of the carrier pipeline inside the casing. The study found that five out of 11 reportable pipeline incidents in the Office of Pipeline Safety (OPS) database from 7 August 1984, to 8 November 2006, were tied to corrosion. SRI also concluded based on data that shorted casings tended to have a higher corrosion rate.[5]

Although serious incidents are few and far between, they underscore the importance of preventing and not just mitigating corrosion. Fortunately, catching the problem before it gets too serious is more likely in this day and age since the Pipeline and Hazardous Materials Safety Administration of the US DOT (PHMSA) now requires inspection of "hazardous liquid pipelines" every five years and "natural gas transmission pipelines" every seven years.[6] Whited explains that this can be done through inline inspection (ILI) tools that use GPS to identify corrosion anomalies on the carrier pipe surfaces inside cased crossings.[7] When corrosion anomalies are detected, it is often a sufficient reason to add extra corrosion protection. SRI reported in 2007 that about 10% of the crossings whose data they analysed had a corrosion anomaly of 20% wall thickness or more. They noted that, according to the modified 'ANSI/ASME B31G-1991 (R2004) Manual for Determining the Remaining Strength of Corroded Pipelines' standard, repair is not necessarily needed for pipes with anomalies of less than 20% wall thickness. However, mitigation of active corrosion is required.[8]

While the preceding data provides a good outlook for pipeline safety, it is also a call to action for pipeline integrity management going forward. The important thing is to identify corrosion and apply a mitigation technique before it is too late. When the SRI study was prepared, mitigation options were limited primarily to wax fillers. The prospect of greater effectiveness and convenience has since improved with the development of CorroLogic Gel Filler.

Developing a new solution for cased pipeline crossings

The landscape for cased pipeline crossing protection changed in 2010, when a major pipeline operator with 2000 cased crossings approached Cortec Corporation about finding a solution to corrosion anomalies found in some of their cased pipeline crossings – both unfilled and wax filled. Tape coating disbondment was also a concern, as were the ingress of water and air, and the presence of debris. The pipeline operator developed a list of criteria and brought it to Cortec for a solution. Some of the characteristics included the need for a corrosion inhibitor that could migrate under disbonded coatings and protect areas not completely filled with the product (i.e. air pockets or head space). The corrosion inhibitor needed to work in multiple phases – in the vapour phase, and in liquids or solids. It also needed to turn into a gel once inside the casing, and so discourage further water from entering the casing. Another important factor was the ability to conduct CP to the carrier pipe.[9]

Cortec's CorroLogic VpCI Filler technology was developed in response to these needs and was patented several years later. The gel filler is comprised of two parts that are mixed onsite. The product is intended to gel at the last moment so it forms a soft, viscous substance within the casing annular space. Vapour phase Corrosion Inhibitors diffused throughout the gel form a protective molecular layer on all metal surfaces in direct contact with the gel. They also have the ability to migrate in vapour form to areas that are difficult to reach – hence the potential for them to find their way under disbonded coatings and adsorb onto the metal at coating holidays. In 2014, the basic technology was described and included in the NACE Standard SP0200-2014 for steel-cased pipeline practices.[10] The technology also falls within PHMSA requirements for acceptable alternatives to addressing shorted carrier pipes when it is not practical to clear the short using isolation.[11]

Protecting one casing at a time

With an estimated 200 000 or more cased pipeline crossings in the US, not to mention those around the world, use of CorroLogic Gel Filler is essentially only getting started. Many pipeline operators around the globe stand to benefit from this method of corrosion mitigation that protects unseen, difficult-to-reach spaces. Reasons for adopting the technology are varied. Some pipeline owners are responding to an existing problem. They have found external corrosion anomalies in their carrier pipeline during ILI and are looking to treat it. Others are responding to regulations in critical areas. Some are even more proactive. Whited explained that many operators will fill both regulated and unregulated cased crossings. "There's a movement amongst many operators to just address all of their casings [...]", he said. "It's part of their integrity management practice [...] Pipelines inside of casings can have corrosion growth that occurs in that environment sometimes, and it's difficult to get at those and fix them, so many operators like the idea of just filling the casings and expecting to be done with them at that point."[12]

Applying CorroLogic Gel Filler is one of the most comprehensive ways to do so. Even though it is impossible to see what is happening inside the casing (e.g., debris blockage, insulator collapse, etc.), CorroLogic VpCI Filler helps provide well-rounded protection through its multi-phase protective action, allowing it to infiltrate under disbonded coatings and into air pockets while the gel aspect discourages ingress of water and debris, and the corrosion inhibitors help neutralise the corrosive effect of any water that does get in. Another benefit of the CorroLogic Gel Filler is that it provides a medium allowing CP current distribution to the carrier pipe.

Conclusion

Prevention and mitigation of carrier pipe external corrosion anomalies within the unseen and difficult to access environment inside cased pipeline crossings is a big challenge. To get the most comprehensive protection without having to dig anything up, remove pipes, or obstruct traffic, CorroLogic Gel Filler is an excellent option, both for corrosion response before the rust gets too bad, and for preventative action to make sure all cased pipeline crossings are tucked in a blanket of corrosion inhibiting gel that compensates for some of the deficiencies and intricacies inside the annular space. When dealing with the unseen, CorroLogic Gel Filler makes corrosion protection less of a mystery to achieve.

Figure 5. Sign on cased pipeline crossing vent indicates when the casing was protected by MESA. (Source: Cortec, courtesy of Eric Uutala)

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